

July 14, 1936.

H. J. SCOTT

2,047,387

HOLDER FOR PIEZOELECTRIC CRYSTALS

Filed Dec. 23, 1931

FIG. 1

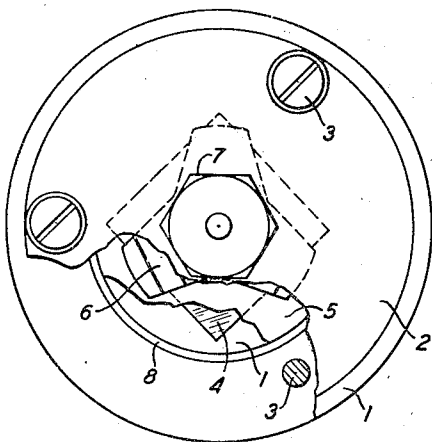


FIG. 3

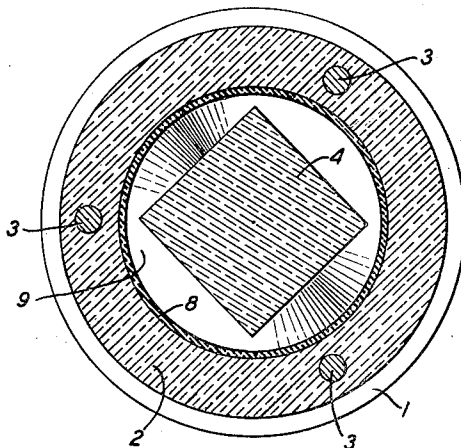


FIG. 2

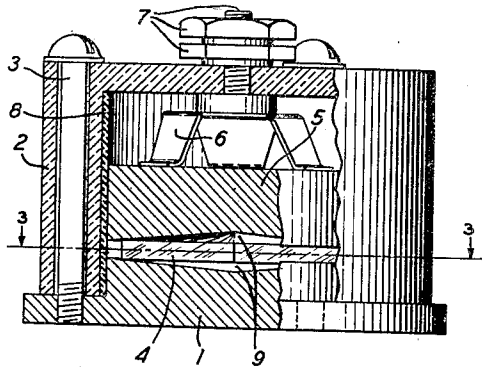


FIG. 4

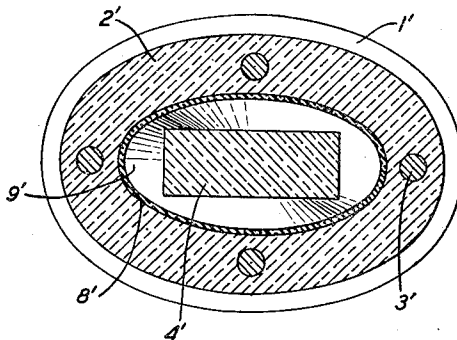


FIG. 5

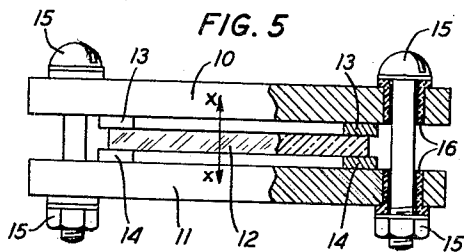
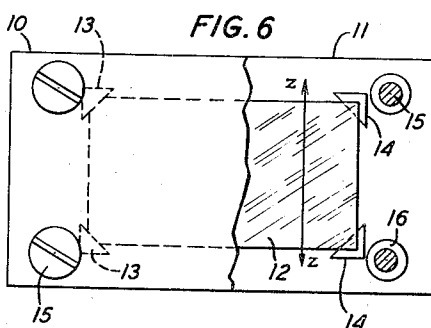


FIG. 6



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2,047,387

HOLDER FOR PIEZOELECTRIC CRYSTALS

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Application December 23, 1931, Serial No. 582,689

9 Claims. (Cl. 171—327)

This invention relates to piezo-electric crystals and particularly to the mounting and electrodes used with such crystals.

As is well known the vibration frequency of piezo-electric crystal bodies employed for frequency determining purposes in oscillation generators, filters and other electrical apparatus depends to a considerable extent on the manner of associating the crystal with its electrodes. In most of the crystal mountings in use at present, the entire surface of each electrode is spaced from the crystal body, and in one particular mounting which is described in Patent 1,883,111 to G. M. Thurston, October 18, 1932, the crystal is clamped between the electrodes along the edge of the crystal. The crystals employed are usually of the parallel-cut or perpendicular-cut type, a parallel-cut crystal being here defined as a piezo-electric crystal cut so that its electrode, or principal, faces are parallel to both the optical and electrical axes of the natural crystal, and a perpendicular-cut crystal being a crystal cut so the above mentioned faces or surfaces are parallel to the optical axis and perpendicular to the electrical axis. While satisfactory results have been obtained in clamping parallel-cut crystals, considerable difficulty has been encountered heretofore in clamping perpendicular-cut crystals, the reason being that parallel-cut and perpendicular-cut crystals differ greatly in their manner of vibration.

Aside from the desirability of clamping both parallel-cut and perpendicular-cut crystals in such a manner as not to appreciably affect the crystal vibration, it is desirable to mount and clamp the crystal so that walking or sliding of the crystal is positively prevented.

It is one object of this invention to clamp a piezo-electric crystal in a more satisfactory manner than heretofore achieved.

It is another object of this invention to provide a simple, rugged and inexpensive piezo-electric crystal mounting adapted to prevent the crystal from walking or sliding.

It is a further object of this invention to clamp a piezo-electric crystal having its faces cut perpendicular to its electrical axis without affecting appreciably its normal vibration.

In one embodiment of the invention a crystal holder designed to clamp satisfactorily either parallel or perpendicular-cut crystals, and either polygon-shaped or circular crystals, comprises two electrodes each having a coniform recessed surface positioned adjacent to the crystal, and means for clamping the crystal between these electrode surfaces. The clamping force is effective

only at the corners of a polygon-shaped crystal, which in both parallel-cut and perpendicular-cut crystals are relatively quiescent. The coniform surface and the clamping prevent the crystal from walking or sliding from its normal position and also permit an accurate predetermination of the spacing between the central portions of the electrodes and the crystal faces.

The invention will be more fully understood from the following description read in connection with the drawing in which like reference numerals designate elements of similar function and in which:

Fig. 1 represents a plan and partial cross-sectional view of a crystal holder constructed in accordance with the invention and designed to mount square and circular crystals;

Fig. 2 represents an elevation view of the same crystal holder, the holder being partially broken away to expose the interior;

Fig. 3 represents a cross-sectional view of the same holder taken along the line 3—3 shown in Fig. 2;

Fig. 4 represents a cross-sectional view of an elliptical holder designed for oblong crystals, the plan and elevation views being similar to the views illustrated in Figs. 1 and 2; and

Figs. 5 and 6 are elevation and plan views, respectively, of another crystal mounting in which a perpendicular-cut crystal is clamped at the corners.

Referring to Figs. 1, 2, and 3 a metal base plate or electrode 1 and cover 2 of insulating material are rigidly secured together by screws 3 for the purpose of providing a suitable housing for a square piezo-electric crystal 4 which is stimulated in the vibration by the metal electrodes 1 and 5. The base electrode 1 may be connected to a circuit with which the crystal plate is associated by means of a conductor, not shown, and the upper plate 5 may be connected to such circuit through spring retainer member 6 and screw fastening means represented generally by reference numeral 7 and associated with another conductor. Reference numeral 8 designates a lining member used for the purpose of insuring a close fit between the electrode plate 5 and the cover member 2. In a practical embodiment the member 8 is constituted by a fiber bushing turned down on the inside to make an accurate fit with the electrode.

As will be seen from the drawing the faces of the electrodes 1 and 5 adjacent to the crystal 4 are recessed to form a coniform cavity and portions of the cavity surfaces are in positive engagement with the corners of the square crystal 4. It

should be noted that the portions of each of the cavity surfaces 9, which are in engagement with the diagonally opposite corners of the crystal 4, are disposed in converging planes symmetrically related to the plane of the opening of the cavity, this last mentioned plane being perpendicular to the plane of the paper and including approximately the reference line 3—3. Obviously, the shape of the cavity may be other than coniform, that is, it may be similar to a truncated cone or a pyramid or a sphere, the important requirement being that the cavity surfaces 9 contact the square crystal 4 only at the four corners or apices each of which is formed by a face surface and the surface of two adjacent sides. In the case of a truncated cone-shaped cavity, the major portion of the cavity surface may, of course, be positioned parallel with the face of the crystal.

A square crystal having four side faces is illustrated but the holder described above may also be used without modification for mounting a circular crystal, in which case the surfaces 9 engage the crystal circumferentially and at the edges formed by the top and bottom, or principal, crystal faces with the cylindrical side face of the crystal. The crystal plate itself may conform to any of the conventional types so far as concerns its relation to the natural axis or dimensions of the natural crystal from which it is cut. It may be desirable in certain instances to bevel slightly the edges of a circular crystal and the corners of a polygon-shaped crystal at the point of contact with the electrodes for the purpose of preventing the crystal from cracking or chipping.

The crystal plate 4 is rigidly clamped between the electrodes 1 and 5 at the points of engagement mentioned above, the dimensions and restoring force of the spring retaining member 6 being such that when the cover and base portions of the holder are rigidly fastened together by screw fastening means 3 the lower electrode 1 and the upper electrode 5 are pressed against the corners of the crystal with considerable force. It has been found that if the clamping is made sufficiently rigid to insure an absolute absence of relative movement of the crystal plate and its immediately associated structure under the stress of operation or transportation and handling the frequency will remain stable and the rigid clamping will not be attended by excessive damping, that is, loss of activity of the crystal plate. Still further, the actual clamping of the crystal results in an unsubstantial change of frequency. Slight adjustment of the frequency may be made by changes in the clamping pressure.

In view of the shape of the electrode surfaces 9 lateral movement of the crystal, that is, walking or sliding of the crystal in a plane perpendicular to the plane of the drawing and including the line 3—3, is positively prevented. Consequently the crystal frequency stability realized in using the holder of the invention is much greater than is the case in many holders of the prior art. Furthermore, since the electrode are in contact with the crystal over an almost infinitesimal area and since a relatively large distance separates the central portions of the electrodes and crystal, adhesion and "wringing" of the crystal and electrode surfaces, which occur in many holders in use at present when the crystal becomes heated, are also eliminated. Another distinct advantage of the crystal mounting of the invention is that the spacing between the electrode surfaces out of contact with the crystal and the faces of the crystal, which spacing is a de-

termining factor of the crystal frequency, may be accurately predetermined.

Referring to Fig. 4 a plan cross-sectional view taken through the crystal holder comprising electrodes each having a cone-like recessed surface of elliptical cross-section is illustrated. This holder and electrodes are designed especially for clamping an oblong flat crystal plate. The plan and elevation views of this holder are, with obvious modifications, similar to the views illustrated in Figs. 1 and 2, respectively, for the circular holder and, consequently, these views have been omitted from the drawing. In Fig. 4 the numerals 1' and 2' designate the base plate and cover, respectively, which are held by means of screws 3'; and numeral 4' denotes the oblong crystal. Reference numeral 8' designates a lining member and numeral 9' designates the surface of the cone-like cavity of base plate 1.

As explained in connection with the circular holder the electrode surface 9' is of such contour as to engage only the corners of the oblong crystal 4'. Obviously, the exact shape of the cavities or recessed portions of the electrodes engaging the oblong crystal 4' may be other than cone-like and still be elliptical in cross-section throughout its depth as, for example, egg-shaped.

In Figs. 5 and 6 an elevation and plan view are shown, respectively, of a mounting which is suitable for clamping perpendicular-cut crystals as well as parallel-cut crystals. The housing and accessory structure have been omitted for the sake of simplicity. Referring to these two figures, reference numerals 10 and 11 designate, respectively, a top electrode and a bottom electrode and numeral 12 designates a perpendicular-cut crystal. The crystal 12 is in contact with the salient portions 13 and 14 of electrodes 10 and 11, respectively, these portions being spaced and dimensioned so as to contact the crystal only at its corners.

The crystal 12 is clamped between the salient portions 13 and 14 of the electrode by means of the screw and nut assembly represented generally by numeral 15. The apertures in electrodes 10 and 11 through which the screws of the assemblies 15 extend are fitted with bushings 16 as is common in assemblies of this nature. The electrical axis of the crystal is represented by the double-headed arrow X—X in Fig. 5 and the optical axis is represented by the double-headed arrow Z—Z in Fig. 6.

As indicated in the above description, the crystal 12 is clamped only at corners of its electrode faces, it having been discovered that the corners of a principal face of a perpendicular-cut crystal as well as the apices each of which is formed by a principal face surface and two adjacent side faces, are quiescent, and that the remaining surface of the electrode faces of the crystal including the boundary or edge of the faces intermediate the corners are in general not quiescent. The complex nature of the vibration of the perpendicular-cut crystal is not clearly understood at the present time. Tests have indicated, however, that it does vibrate like a diaphragm of a telephone receiver in two directions, that is, in the direction of its length and also in the direction of its width, the corner portions only of the crystal faces being quiescent.

Although the invention has been described in connection with certain preferred embodiments it should be understood that it is not to be limited to such embodiments. Obviously, the crystal mounting of the invention is suitable for use in

connection with polygon-shaped crystals other than oblong or square crystals and other means for clamping the crystal may be employed without exceeding the scope of the invention.

5 What is claimed is:

1. A method of rigidly mounting a polygonal piezo-electric crystal having two of its surfaces cut perpendicularly to its electrical axis utilizing electrodes and clamping means associated with
10 said electrodes, which comprises including said crystal between said electrodes so that said surfaces face the electrodes and clamping only the corners of said crystal between said electrodes.

2. In combination, a perpendicular-cut crystal
15 body of polygon shape, electrodes therefor, and means including said electrodes for clamping said body between the electrodes only at corners of said body.

3. In combination, a flat crystal body, electrodes arranged to contact said crystal, and means including said electrodes for clamping
20 said body between the electrodes, the electrode surfaces contacting said crystal being disposed at an acute angle with respect to a principal face and a side face of said crystal, substantially.

4. In combination, a rectangular piezo-electric crystal having faces cut perpendicular to its electrical axis, electrodes therefor, said electrodes each having four salient portions spaced
30 and dimensioned so as to engage only corners of said faces, and means including said electrodes for clamping the crystal between said salient portions.

5. In combination, a polygon-shaped piezo-electric crystal having faces cut perpendicularly to its electrical axis, a holder therefor comprising two spaced electrodes, the opposing faces
35 of which are each recessed to form a conical

cavity, the crystal being positioned within at least one of the conical cavities, and means including the said electrodes for clamping said crystal between the surfaces of the cavities.

6. In combination, a polygon shaped crystal
5 having faces cut perpendicular to its electrical axis, a holder therefor comprising two spaced electrodes the opposing faces of which are each recessed to form a cone-like cavity having an elliptical cross-section, and means including said
10 electrodes for clamping said crystal between the surfaces of the cavities whereby said crystal is clamped only at its corners.

7. In combination, a piezo-electric crystal, a holder therefor comprising two spaced electrodes,
15 the opposing faces of which are each recessed to form a cavity having convergent surface areas, and clamping means including said electrodes, said crystal being positioned between and so as to contact the convergent areas of at least one
20 of the electrode cavities, and rigidly clamped, whereby lateral movement of the crystal is prevented.

8. In combination, a piezoelectric crystal, a holder therefor comprising two spaced electrodes
25 the face of one of which is recessed to form a cavity having convergent surface areas, and clamping means including said electrodes, said crystal being positioned in the electrode cavity between and so as to contact said surface areas,
30 and said crystal being rigidly clamped between said electrodes.

9. A piezoelectric device, comprising a housing, a disc-shaped piezoelectric oscillator provided in the housing, and two concavely curved electrodes disposed in the housing and touching the oscillator, the concave sides of the electrodes facing the oscillator.
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