

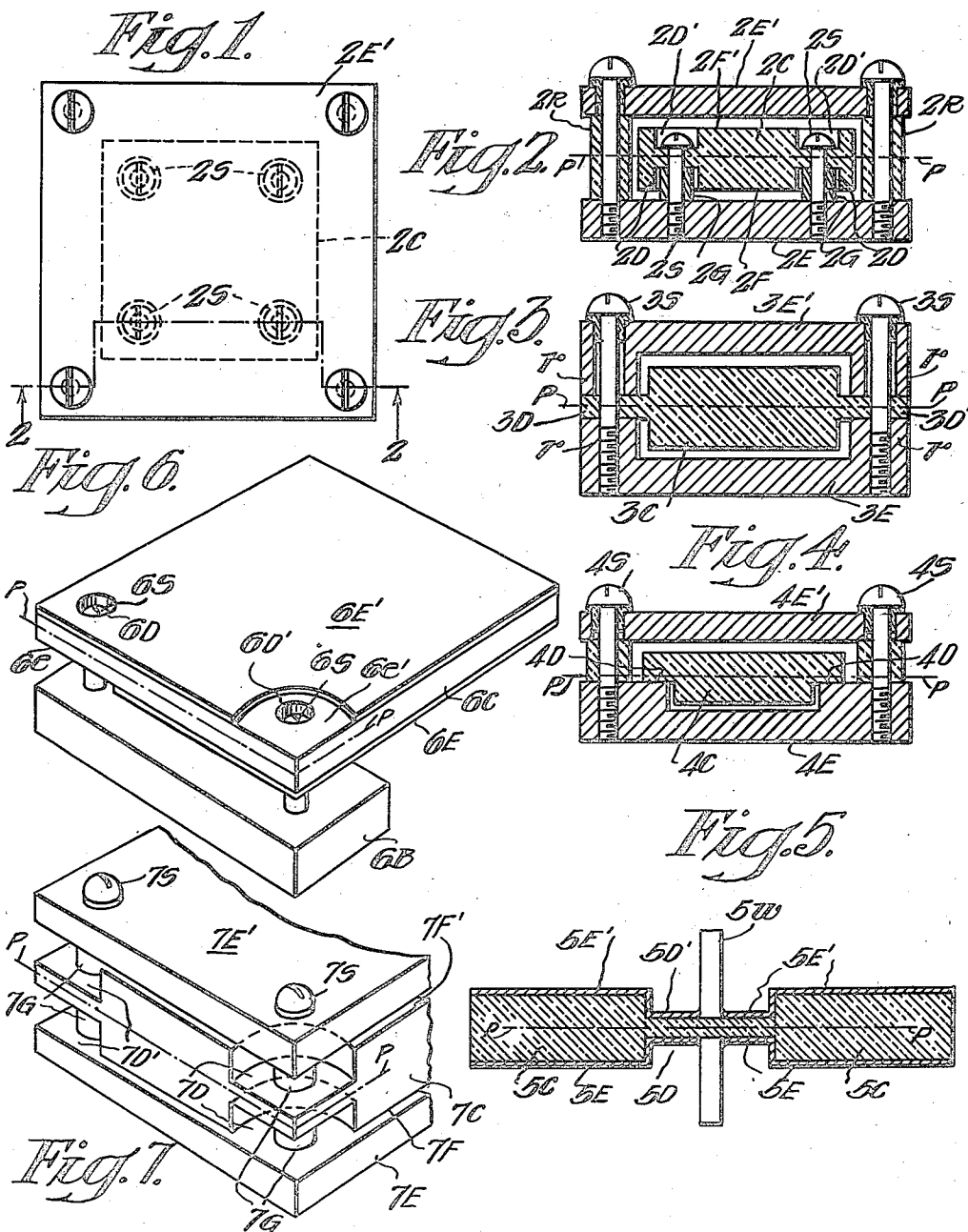
Dec. 2, 1941.

P. D. GERBER

2,264,692

ART OF MOUNTING PIEZOELECTRIC ELEMENTS

Filed July 31, 1940



Inventor

Paul D. Gerber

By

J. J. Hoff

Attorney

UNITED STATES PATENT OFFICE

2,264,692

ART OF MOUNTING PIEZOELECTRIC ELEMENTS

Paul D. Gerber, Woodlynne, N. J., assignor to
Radio Corporation of America, a corporation of
Delaware

Application July 31, 1940, Serial No. 348,907

10 Claims. (Cl. 171—327)

This invention relates to the art of mounting piezoelectric elements and has special reference to improvements in methods and means for mounting quartz elements of the type that exhibits a "shear-mode" of vibration. Thus, it will be understood that the invention herein described is applicable to all quartz resonators and oscillators except so-called "X-cut" crystals which, as is well known to those skilled in the art, exhibit a "longitudinal" type of vibration.

The principal object of the present invention is to provide an improved mount for shear-mode crystals and wherein the necessary clamping or other mounting force is applied to the crystal in a manner which results in the minimum sacrifice in amplitude and constancy of vibration.

Other objects and advantages, together with certain preferred details of construction will be apparent and the invention itself will be best understood by reference to the following specification and to the accompanying drawing wherein

Figure 1 is a top plan view of a pressure air-gap mounting embodying the invention,

Figure 2 is a sectional view taken on the line 2—2 of Fig. 1,

Figures 3, 4 and 5 are sectional views showing other crystal mounting arrangements within the invention,

Figures 6 and 7 are views in perspective of still other crystal assemblies embodying the invention.

It can be demonstrated that a quartz piezoelectric element of the type that exhibits a shear-mode of vibration has its zone of minimum oscillatory movement in a plane which is centered through all of the minor surfaces of the element. It has previously been recognized that in installations requiring the use of a clamping force it is usually advantageous to apply such force along a nodal plane or along a nodal axis of the crystal element. In an effort to apply this teaching of the prior art to crystals of the shear-type, it has previously been proposed to bevel the sides of the crystal element to a knife edge and to apply the clamping force inwardly in the direction along the said knife edges. Obviously, when the crystal is operated in such a mounting it may become fractured or chipped adjacent its thin edges. Of perhaps more importance is the fact that the clamping force in such a mount is applied to the crystal in the direction or directions in which it vibrates, and the oscillations may, for this reason, be damped to an undesired degree.

The foregoing and other disadvantages inherent in known methods of mounting shear-mode crystals are substantially obviated in accordance

with the present invention by applying the mounting force to the crystal element adjacent and in a direction normal to its plane of minimum oscillatory movement. To this end, referring now to the drawing (wherein like reference characters designate the same or corresponding parts in all figures), the opposite electrode faces F , F' of the crystal C , or one of them, is provided with one or more cut-away portions or detents D , which extend into the crystal to a point adjacent its plane P — P of minimum movement, and the clamping, gravitational, or other mounting force is applied to the base of the cut-away portion or portions, i. e., in a direction normal to the plane (P — P) of minimum oscillatory movement.

In Figs. 1 and 2, the invention is shown as applied to a so-called "pressure, air-gap type" of mounting. In this case, the crystal $2C$ is supported above a bottom electrode plate $2E$ on insulating grommets $2G$ which extend into the detents $2D$ in the adjacent electrode faces $2F$ of the crystal. The top electrode $2E'$ is supported on insulating spacers $2R$ above the top electrode face $2F'$. A clamping force is applied to the crystal by means of screws $2S$, the heads of which are received in the detents $2D'$, which are in register with the bottom detents $2D$ and are spaced inwardly away from the edges of the crystal.

In the pressure air-gap type of mounting shown in Fig. 3, the edges of the crystal $3C$ are cut away to provide a pair of oppositely located outwardly extending integral arms $3D$, upon which the rims r of a pair of cup-shaped electrode $3E$, $3E'$ are seated. The clamping force is applied adjacent the central plane of minimum movement as by means of screws $3S$ which extend through the rims of the electrodes $3E$, $3E'$ and the arms $3D$, $3D'$ on the crystal.

Fig. 4 shows the invention as applied to an air-gap holder of the gravity type wherein the crystal $4C$ is supported without any clamping force upon an integral rim $4D$, which is provided for the purpose, adjacent its opposite ends. The rim $4D$ may extend entirely around the crystal, if desired, and its base may, in any event, coincide with the plane P — P of minimum oscillatory movement.

In the embodiment of the invention shown in Fig. 5, the detents $5D$, $5D'$ in the crystal $5C$ are adjacent its center and the electrodes $5E$, $5E'$ are in the form of metallic films applied directly to the opposite electrode faces of the crystal. A pair of electrode leads $5w$ are shown cemented to

the crystal within the central detents, beneath but in contact with the film-like electrodes.

In Fig. 6, as in Fig. 5, the electrodes which are here designated 6E, 6E' are in the form of metallic films applied directly to the electrode faces of the crystal 6C. In this case, however, the detents 6D within which the mounting force is applied are at the opposite corners of one end of the crystal and the mounting elements 6S extend through the crystal. In order to obviate the possibility of a short circuit between the opposite electrodes 6E, 6E', the "plating" adjacent the diagonally opposite corners of the crystal may be erased, as indicated at 6e, 6e'. The mounting elements 6S which, as in the embodiments of the invention shown in Figs. 2, 3 and 7, may be in the form of screws, are shown affixed to a supporting block 6B. Ordinarily, the crystal assembly of this embodiment of the invention will be mounted in a vertical position.

Fig. 7 shows another embodiment of the invention wherein the crystal assembly may be mounted in a vertical position without sacrifice of rigidity. Here, as in Fig. 6, the detents 7D, 7D' within which the clamping force is applied are at the opposite corners of one end of the crystal 7C. The electrodes, however, are in the form of separate plates 7E, 7E', and are maintained in spaced relation with respect to the electrode faces 7F, 7F' of the crystal by insulating grommets 7G through which the clamping force is applied to the crystal adjacent and in a direction normal to its plane P-P of minimum movement.

Various modifications of the several embodiments of the invention herein described will suggest themselves to those skilled in the art. It is to be understood, therefore, that the foregoing is to be interpreted as illustrative and not in a limiting sense, except as required by the prior art and by the spirit of the appended claims.

What is claimed is:

1. Method of mounting a quartz piezoelectric element of the type that exhibits a shear-mode of vibration, said method comprising applying a mounting force to said element adjacent and in a

direction normal to its plane of minimum oscillatory movement.

2. Method in accordance with claim 1 and wherein the mounting force applied to said element comprises a clamping force.

3. Method in accordance with claim 1 and wherein said mounting force is gravitational in character.

4. In combination, a quartz piezoelectric element of the type that exhibits a shear-mode of vibration, and means for applying a mounting force to said element adjacent and in a direction normal to its plane of minimum oscillatory movement.

5. In combination, a quartz piezoelectric element of the type that exhibits a shear mode of vibration, and means for applying a clamping force to said crystal in opposite directions adjacent and in a direction normal to its plane of minimum oscillatory movement.

6. In combination, a quartz piezoelectric element of the type that exhibits a shear-mode of vibration, said element having a cut-away portion which extends in a direction substantially normal to its electrode faces to a point adjacent the plane of minimum oscillatory movement of said element, and means for mounting said element adjacent its said cut-away portion.

7. A quartz piezoelectric element of the type that exhibits a shear-mode of vibration, said element having a cut-away portion which extends in a direction substantially normal to its electrode faces to a point adjacent its plane of minimum oscillatory movement.

8. The invention as set forth in claim 7 and wherein said cut-away portion lies adjacent the center of said quartz element.

9. The invention as set forth in claim 7 and wherein said cut-away portion is provided in each of the electrode faces of said quartz element.

10. The invention as set forth in claim 7 and wherein said cut-away portion lies adjacent an edge of said quartz element.

PAUL D. GERBER.