March 2, 1943. S. A. BOKOVOY ET AL 2,312,746

ART OF MOUNTING PIEZO-ELECTRIC ELEMENTS

Filed June 27, 1941

Fig. 1.

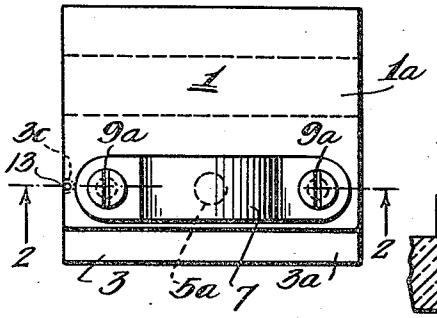


Fig. 2.

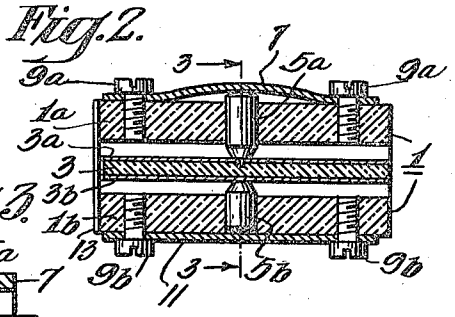


Fig. 3.

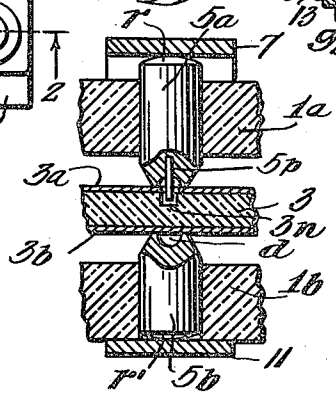


Fig. 5

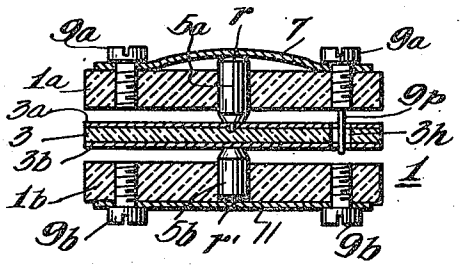
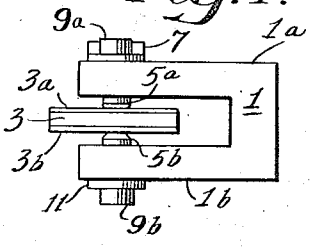


Fig. 4.



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ART OF MOUNTING PIEZOELECTRIC ELEMENTS

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Application June 27, 1941, Serial No. 400,068

9 Claims. (Cl. 171—327)

This invention relates to the art of mounting piezo-electric crystal elements and has special reference to the provision of improvements in nodal mounting arrangements of the type wherein the electrodes for the crystal are in the form of adherent conductive coatings or metalized films.

The present invention is predicated upon an appreciation of the fact that node-mounted metalizer crystals theoretically or potentially possess the following advantages over similar mountings wherein the electrodes are in the form of separate plates: (1) a substantial reduction in the possibility of arcing at high voltages, (2) elimination of changes in frequency due to changes in spacing between the electrodes and the crystal, (3) a much smaller holder or crystal compartment may be used, and (4) the use of stainless steel and other now war-scarce electrode materials is obviated.

The foregoing potential advantages of node-mounted metalized-crystals have not heretofore been achieved in practice principally because the oscillatory movement of the crystal causes the electrode coatings to wear away almost immediately at the nodal points of support, thus breaking the electrical continuity of the circuits associated therewith. In an effort to avoid this most serious difficulty it has heretofore been proposed (see Schneider U. S. Patent 2,194,676) to provide a combined support and lead securely cemented directly to and at right angles to the crystal plate. One very real objection to such an arrangement is that there are very substantial differences in the temperature coefficients of expansion of the quartz, the cement, and supporting elements, hence fractures may develop adjacent the areas of attachment. Nor are the advantages of node mounting fully achieved by making the oppositely extending nodal supports integral with the crystal (see also Schneider U. S. Patent 2,194,676) since in this case, if the integral extensions are of a size sufficient to prevent breakage when subjected to shock, their mass is so great as to inhibit maximum oscillatory movement of the main body of the crystal.

Accordingly, the principal object of the present invention is to provide an improved nodal mounting for metalized piezo-electric crystals, and one possessing all of the aforesaid potential advantages and none of the disadvantages of analogous prior art mounting arrangements.

Another and important object of the present invention is to provide an improved combination of crystal and holder for "secondary frequency-standard" work and adapted for use in aircraft, floating beacons, and other mobile equipment of the type normally subjected to shocks and tremors of substantial magnitude.

The foregoing and other objects are achieved in accordance with the invention by the provision of a pair of oppositely located rotatable bearings through which a clamping force is applied to the metalized electrode faces along a nodal axis which usually lies adjacent the center of the crystal. Thus, any normal operating force tending to cause relative movement between the metalized faces of the crystal and its support is translated into rotary movement of the entire assembly whereby friction tending to wear away the metalized crystal faces is obviated. Suitable means are provided, where necessary or desirable, for limiting the degree of rotary movement of the assembly within the holder and to prevent displacement of the crystal in the event that the assembly is subjected to vigorous shocks or tremors of external origin.

Other objects and advantages will be apparent and the invention itself will be best understood by reference to the following specification and to the accompanying drawing, wherein:

Fig. 1 is a top plan view of a crystal holder, with its cover removed, and embodying the invention;

Fig. 2 is a sectional elevation taken on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged fragmentary section taken on the line 3—3 of Fig. 2;

Fig. 4 is a side elevation of the crystal holder shown in Figs. 1, 2, and 3; and

Fig. 5 is a sectional elevation of a modified embodiment of the invention.

In the drawing, wherein like reference characters represent the same or corresponding parts in all figures, 1 designates generally an insulating support or yoke which may conveniently comprise a U-shaped member, the legs 1*a*, 1*b* of which are spaced far enough apart to provide a clearance space for a quartz or other piezoelectric crystal 3. As indicated at 3*a*, 3*b* the crystal 3 is provided at its opposite major surfaces with a pair of adherent metalized coatings or films which comprise the electrodes for the crystal. The nodal axis or zone of minimum oscillatory movement of the particular crystal illustrated extends between its major surfaces adjacent the center thereof, and it is along this axis or zone that the clamping or mounting force is applied to the metalized electrode faces 3*a*, 3*b* of the crystal through a pair of axially aligned cylindrical bearing members 5*a*, 5*b* which are mounted to permit of rotatable movement in oppositely located circular holes in the arms 1*a*, 1*b* of the yoke or frame 1. The actual clamping force in this case is supplied by a bowed metal spring 7 which is clamped at its opposite ends to the outer surface of the supporting yoke 1, by means of screws 9*a*, and which bears at its center against the bearing member 5*a*. A preferably inflexible metal strip 11 secured by screws 9*b* to

the other leg 1b of the supporting yoke prevents axial outward movement of the opposite bearing member 5b. The illustrated embodiment of the invention wherein one flexible (7) and one inflexible (11) strip supply the clamping force is to be preferred over a construction employing two flexible clamping members, since in the latter case, when the assembly is subjected to sudden shock two springs may give rise to a reciprocating or "hunting" movement which, though quickly damped, may result in a more or less permanent unevenness in the pressure applied to the crystal.

As shown more clearly in Fig. 3, each of the bearing members 5a, 5b is preferably rounded at its outer end as indicated at r, r' to minimize friction at the point at which it contacts its retaining member or spring. Thus, in the absence of any restraining force the crystal and its bearing members are free to rotate as a unit about their common axis so that during normal operation, there can be no friction tending to wear away the film-like electrodes 3a and 3b at the points where the said supports contact the said films.

The electrical continuity between the bearings and the film-like electrodes is in nowise affected even when the angular range of rotation of the assembly is a full 360°, nor is the oscillating performance of the crystal per se appreciably affected by such rotation. In some cases, however (as where an oblong crystal is to be contained in a closure of the smallest possible dimensions), it is desirable to limit the said angular range of rotation and to this end any suitable limiting or restraining means may be employed. Thus, referring particularly to Figs. 1 and 2 the crystal may be provided with a small notch 3c adjacent one or both ends thereof, preferably remote from its corners for engagement with a wire 13 which is anchored to the opposite legs of the U-shape yoke 1. Alternatively, as shown in Fig. 4, the crystal may be provided with a recess or hole 3h for receiving a small pin 9p which may conveniently be attached to one of the screws 9a which hold the retaining member (7 or 11) in position on the outer surface of the yoke 1.

Referring particularly to Fig. 3: In some cases, as where the installation may be subjected to shocks of a magnitude capable of causing the crystal 3 to shift its position on the bearings 5a, 5b, one or more additional pins p may be provided to prevent such displacement. The additional pin or pins may be mounted in or on one or both of the bearing members 5a or 5b and extend into a hole or recess 3n, provided for the purpose along the nodal axis of the crystal.

Referring still to Fig. 3: It will be observed that the leading ends of the bearing members 5a and 5b are of dished construction, as indicated at d so that each presents an annular surface to one of the metalized surfaces 3a or 3b. This construction has been adapted irrespective of the presence or absence of the retaining pin 5p since in practice it has been found that lathe-cut bearings may possess high spots adjacent their centers which are not easily removed by a lapping process.

Since the screws 9a are electrically connected to the electrode 3a through part 7 and bearing 5a and screws 9b are connected to the other electrode, 3b, through part 11 and bearing 5b, the said screws may be employed as binding posts for connecting the crystal 3 to an external circuit, not shown.

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

What is claimed is:

1. holder for a piezoelectric crystal comprising a support, a pair of bearings journaled for rotation in said support and between which said crystal is adapted to be clamped.

2. The invention as set forth in claim 1 wherein at least one of said rotatable bearings is mounted to permit of axial movement and wherein means are provided for applying a clamping force to said crystal through said axially movable rotatable bearing.

3. A holder for a piezoelectric crystal comprising a support, a pair of bearings journaled for rotation in said support and between which a crystal is adapted to be received, and means including said rotatable bearings for applying a clamping force to said crystal of an intensity sufficient to normally prevent relative movement between said bearings and said crystal.

4. The invention as set forth in claim 3 and wherein means are provided for limiting the angular range of rotation of said crystal and its said bearings.

5. The invention as set forth in claim 3 wherein said crystal is provided with a cut-away portion and at least one of said bearings is provided with a part adapted to be received within said cut-away portion of said crystal.

6. In combination, a piezoelectric crystal having metalized electrode faces, a support, and a pair of bearings journaled for rotation in said support, and means for applying a mounting force to said crystal through said rotatable bearings of an intensity sufficient to normally prevent relative movement between said rotatable bearings and said metalized electrode faces.

7. In combination, a piezoelectric crystal having a nodal axis and a pair of metalized electrode faces, a support, and a pair of axially aligned bearings journaled for rotation in said support for applying a clamping force to said metalized electrode faces along said nodal axis.

8. A holder for piezoelectric crystal comprising a support, a pair of bearing members journaled for rotation on said support and arranged in spaced relation for rotatable movement about a common axis, at least one of said bearing members being mounted to permit of longitudinal movement along said axis, and spring means for applying a biasing force to said longitudinally movable member in a direction and of an intensity normally sufficient to maintain said piezoelectric crystal between said pair of bearing members.

9. The invention as set forth in claim 8 and wherein the surfaces of the bearing members which are presented to said crystal are of dished construction.

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