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PIEZOELECTRIC CRYSTAL APPARATUS

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Fig.1.

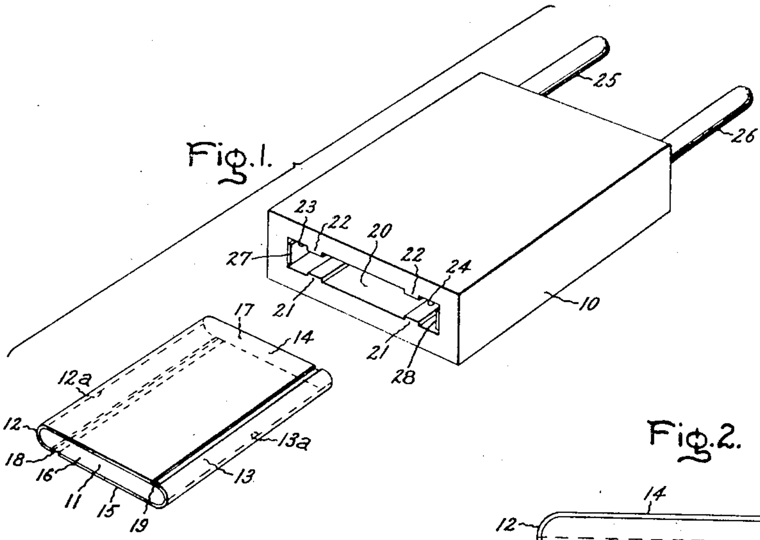


Fig.2.

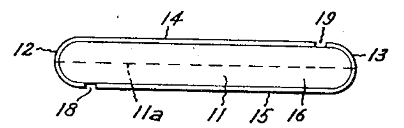
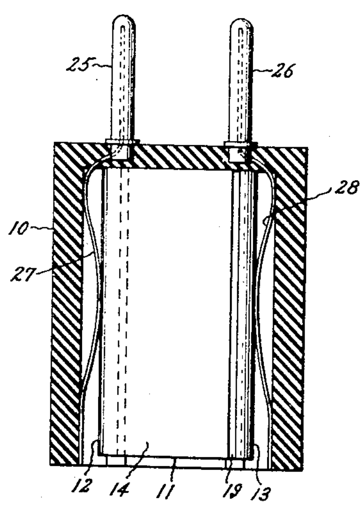


Fig.3.



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PIEZOELECTRIC CRYSTAL APPARATUS

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10 Claims. (Cl. 171—327)

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Our invention relates to piezoelectric crystal apparatus, and particularly to the art of mounting piezoelectric crystals. The invention contemplates a crystal element having plated or metalized electrode surfaces, and has for its object the provision of a new and improved inexpensive, easily assembled, and rugged crystal mounting characterized particularly by improved activity and a high order of frequency stability.

Our invention itself will be more fully understood and its objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawings, in which Fig. 1 is an exploded perspective view of a piezoelectric crystal apparatus embodying our invention; Fig. 2 is an end view of the metalized piezoelectric crystal element itself; and Fig. 3 is a sectional view of the crystal holder showing the crystal element positioned therein.

Referring now to the drawings, we have illustrated at Fig. 1 a piezoelectric crystal apparatus comprising a substantially rectangular laminar piezoelectric crystal element or plate 11 and a unitary slotted cell or casing 10 preferably formed of any well-known molded plastic insulating material. The flat plate 11 may be formed of quartz, tourmaline, Rochelle salts, or a like substance possessing piezoelectric properties. Preferably, the plate 11 is a Y cut or an AT cut quartz crystal of the thickness shear type having its X or electrical axis substantially perpendicular to the longitudinal minor faces 12, 13. Such a plate exhibits a nodal plane 11*a* through the center of the crystal and parallel to the major faces. The nodal plane 11*a* intersects the minor faces 12 and 13 along nodal lines 12*a* and 13*a*, respectively. Preferably, the minor faces 12 and 13 are rounded between the planes of the major faces, as clearly shown at Fig. 2.

The plate 11 is shown provided with a pair of metalized electrode surfaces 14 and 15, each of which includes the greater portion of one of the major faces of the plate and also one of the adjacent minor faces 12, 13. The electrodes 14 and 15 comprise a plating or other film-like adherent coating of suitable electric conducting material, such as silver, gold, tin, or the like, and may be formed by thermal evaporation, chemical deposition, or other suitable well-known process. The Z-axis minor faces 16 and 17 are uncoated, and the metal plating is divided into two electrically isolated electrode surfaces by removal of the plating longitudinally of the crystal plate along opposite sides of the major faces, as illustrated at

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18 and 19. Thus, each electrode surface includes substantially all of one major face and at least a portion of one adjacent X-axis minor face, or edge, of the crystal plate.

The unitary insulating casing 10 is substantially rectangularly slotted at 20 and is open at one end loosely to receive and support the crystal plate 11. The slot or cavity 20 is slightly larger in all directions than the crystal plate 11, thereby to permit limited movement of the plate with respect to the casing 10. The cavity 20 is provided with inwardly extending plateau portions shown in the drawings as two pairs of longitudinal ridges 21 and 22. The ridges of each pair are spaced apart by slightly less than the width of the crystal plate 11, and the pairs of ridges are spaced apart by somewhat more than the thickness of the crystal plate. Thus, the longitudinal edges 23 and 24 of the cavity 20 are of slightly greater depth than the crystal supporting portion. If desired, the crystal supporting portion of the cavity may be of uniform depth, so that a single large plateau is formed. It is preferable, however, to recess the cavity between the ridges 21 and between the ridges 22 to provide a greater air space between the major faces of the crystal and the sides of the casing.

External electric connection with the crystal plate is made by a pair of external pin or prong connectors 25 and 26 which may be molded into or otherwise mounted upon the insulating casing 10, preferably at the ends thereof opposite the open end of the cavity 20. To complete the electric connection, a pair of electric contact springs 27, 28 are positioned within the deep longitudinal edge portions 23 and 24 of the cavity 20 for resilient engagement with the X-axis minor faces of the crystal element 11 along the nodal lines 12*a* and 13*a*. As best shown at Fig. 3, the contact springs 27, 28 are electrically connected to the external prong connectors 25 and 26 and are leaf springs of arcuate form arranged to engage the minor faces 12 and 13 of the crystal 11 substantially in the center of the nodal lines 12*a* and 13*a*. The leaf springs 27 and 28 are relatively light and provide no appreciable mechanical support for the crystal element 11 within the casing 10. These springs provide only sufficient pressure upon the X-axis minor faces of the crystal to effect a sufficient electric contact between the springs and the metalized electrode surfaces. Since the springs engage the crystal plate only along nodal lines, they do not effect any appreciable restriction of crystal activity.

It may now be observed that our piezoelectric crystal apparatus may be easily assembled or disassembled simply by sliding the crystal plate 11 edgewise into or out of the cavity 20. Since each pair of supporting ridges 21 and 22 is spaced apart slightly less width than the width of the crystal element itself, and since the leaf springs 27 and 28 are arcuate in shape, electric contact is automatically made with the X-axis minor faces of the crystal as the crystal is slipped into the slot. As previously mentioned, the springs 27 and 28 provide no appreciable mechanical support for the crystal, but apply only sufficient pressure to make good electric contact. It has been found that sufficient spring pressure to make such electric contact may be applied to the electrical- or X-axis faces of a crystal without appreciably restricting its activity. This is especially true when spring contact is made only along the nodal lines in the manner shown. On the other hand, if an attempt is made resiliently to support the crystal either by pressure upon an active portion of the minor faces or by pressure across the edges of the major faces, appreciable restriction of the activity of the crystal is encountered. According to our invention, the crystal element itself experiences no such restriction of activity by reason of the fact that its effective mechanical support is solely by loose positioning within the slotted casing 10, while electrical connection is made separately by the light springs 27 and 28. It may also be noted that movement of the crystal element within the slot 20 has no effect upon the frequency stability of the crystal by reason of the fact that the electrode surfaces, being formed by metalization of the crystal element itself, are fixed in position with respect to the crystal surface. Thus, movement of the crystal within the casing causes no change in spacing between the crystal and its electrodes.

It will of course be evident that, if desired, a suitable cover plate may be placed over the open end of the casing 10 to retain the crystal plate within the cavity.

While we have described only a single preferred embodiment of our invention by way of illustration, many modifications will occur to those skilled in the art and we therefore wish to have it understood that we intend in the appended claims to cover all such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. Piezoelectric crystal apparatus comprising a slotted casing of insulating material, a laminar piezoelectric element loosely supported within said slotted casing for limited movement in all directions, said element having two metalized electrode surfaces each comprising the greater portion of one major face and at least a portion of one of a pair of opposite minor faces of said element, a pair of external electric connectors mounted upon said casing, and spring means electrically connected to said external connectors and positioned within said casing in engagement with said metalized minor faces, said spring means providing no appreciable mechanical support for said piezoelectric element.

2. Piezoelectric crystal apparatus comprising a slotted casing of insulating material, a laminar piezoelectric element loosely supported within said slotted casing for limited movement in all directions, said element having one pair of opposite minor faces each rounded about a central nodal line and having two metalized electrode surfaces each comprising the greater portion of one major face and at least a portion of one of said pair of minor faces, a pair of electric external connectors mounted upon said casing, and spring means electrically connected to said external connectors and positioned within said casing for engagement with said metalized minor surfaces along said nodal lines, said spring means providing no appreciable mechanical support for said piezoelectric element.

3. The combination comprising a piezoelectric crystal plate having two metalized electrode surfaces, each said surface comprising the greater portion of one major face and at least a portion of one of a pair of opposite minor faces of said plate, a hollow container of insulating material having internal dimensions slightly larger than said plate thereby loosely to support said plate upon the inner walls of said container, a pair of external electric connectors attached to said container, and spring means electrically connected to said external connectors and positioned within said container in engagement with said metalized opposite minor faces.

4. The combination comprising a piezoelectric crystal plate having two metalized electrode surfaces, each said surface comprising the greater portion of one major face and at least a portion of one of a pair of opposite minor faces of said plate, said minor faces being rounded between said major faces and being characterized by central nodal lines, a hollow container of insulating material having internal dimensions slightly larger than said plate thereby loosely to support said plate upon the inner walls of said container, a pair of external electric connectors attached to said container, and spring means electrically connected to said external connectors and positioned within said container in engagement with said metalized opposite minor faces along said nodal lines.

5. Piezoelectric crystal apparatus comprising a slotted casing of insulating material, a piezoelectric crystal plate loosely supported within said slotted casing by the inner walls thereof, said plate having two metalized electrode surfaces each comprising the greater portion of one major face and at least a portion of one of a pair of opposite minor faces of said plate, a pair of external electric connectors mounted upon said casing, and a pair of leaf springs electrically connected to said external connectors and positioned within said casing between said metalized minor faces of said plate and the adjacent walls of said casing.

6. Piezoelectric crystal apparatus comprising a substantially rectangular crystal plate having two metalized electrode surfaces, each said surface comprising the greater portion of one major face and at least a portion of one of a pair of opposite minor faces of said plate, a substantially rectangularly slotted casing of insulating material open at one end loosely to receive and support said plate, said slot having opposite longitudinal edges of greater depth than a central plateau portion of slightly less width than the width of said plate, a pair of external connectors mounted upon said casing, and a pair of arcuate leaf springs electrically connected to said external connectors and mounted in said longitudinal edge portions of said slot to engage said opposite minor faces of said plate without providing appreciable mechanical support for said plate.

7. A cell for a piezoelectric crystal which op-

erates in a thickness mode and has minute thickness relative to its broadside dimensions, said cell comprising a non-conducting body having a cavity therein shaped to receive said crystal edgewise through an opening in one wall of said body and having contact members positioned therein to be engaged when said crystal is inserted in said cavity at opposite edges of said crystal by electrodes carried by said crystal.

8. A cell for a piezoelectric crystal which operates in a thickness mode and has minute thickness relative its broadside dimensions, said cell comprising a non-conducting body having a cavity therein shaped to receive said crystal edgewise through an opening in one wall of said body and having contact members positioned along the narrow edges of said cavity to be engaged when said crystal is inserted in said cavity by electrodes carried by said crystal.

9. A cell for a piezoelectric crystal which operates in a thickness mode and has minute thickness relative to its broadside dimension, said cell comprising a non-conducting body having a cavity therein shaped loosely to receive said crystal edgewise through an opening in one wall of said body and having electric spring contact members positioned therein to be automatically engaged when said crystal is inserted in said cavity at opposite edges of said crystal by electrodes carried by said crystal.

10. A cell for a piezoelectric crystal which operates in a thickness mode and has minute thickness relative to its broadside dimension, said cell comprising a non-conducting body having a cavity therein shaped to receive said crystal edgewise through an opening in one wall of said body and having contact members positioned along the narrow edges of said cavity to be engaged when said crystal is inserted in said cavity by electrodes carried by said crystal, and a crystal having electrodes on its major faces, each of said electrodes extending over an adjacent minor face to engage corresponding contact members when inserted in said cavity.

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