

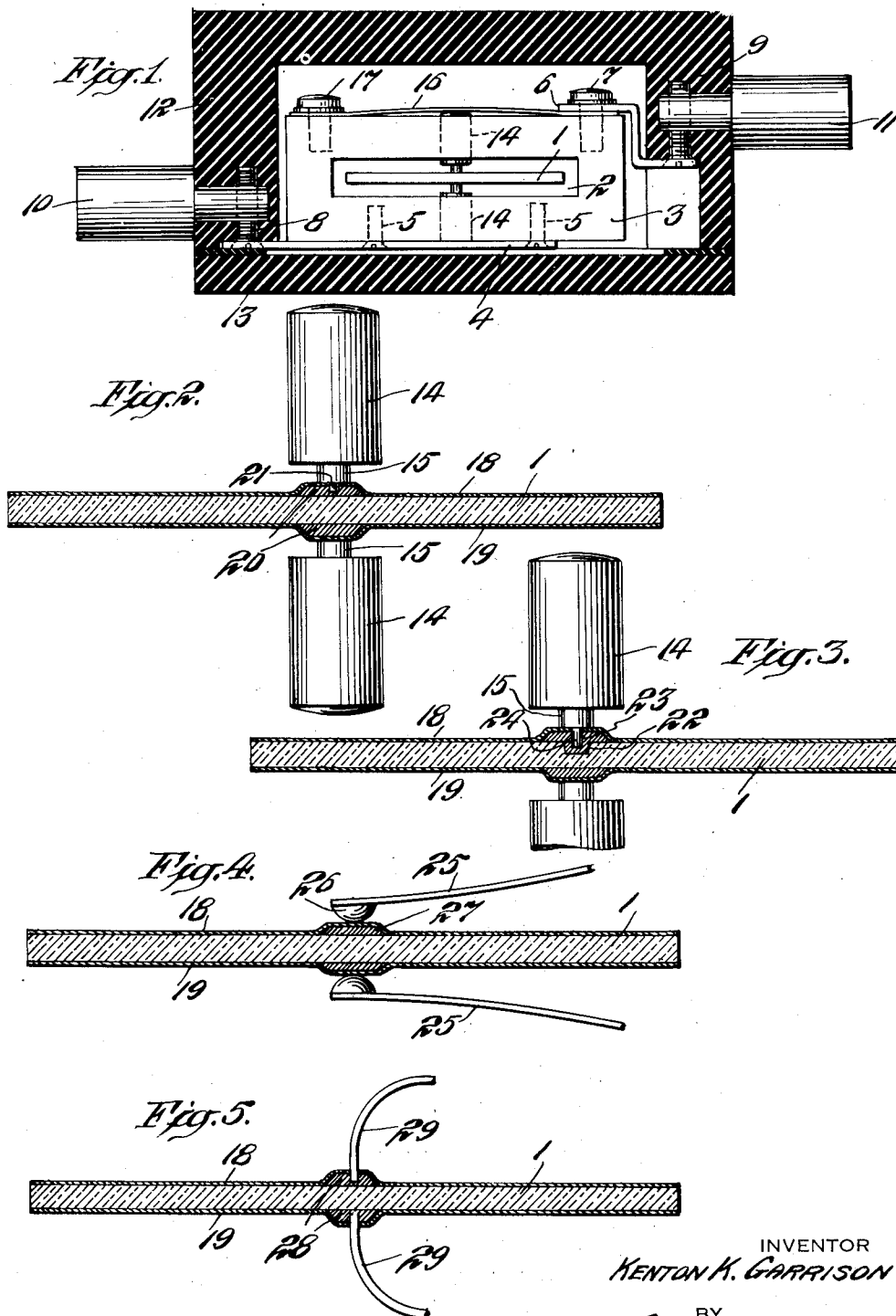
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PIEZOELECTRIC CRYSTAL STRUCTURE

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PIEZOELECTRIC CRYSTAL STRUCTURE

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This invention relates to piezoelectric crystal structures and conductor mountings therefor designed for greater durability and to avoid certain objectionable conditions of mountings as heretofore used, particularly as related to fractures or breaking of electrical contact of the electrode coatings in the region of the connecting support.

A prominent cause of failure and difficulty encountered with the present methods of crystal mountings results from the customary practice of directly connecting the supporting pins or wire conductors to the electrode coatings as for instance by solder connections. A danger of fracture and resulting failure results particularly from the extreme thinness of the electrode coatings as employed. Electrodes of extreme thinness are employed by reason of their desired electrical characteristics and to avoid or reduce to a minimum interference such as damping or attenuation of the natural and determined crystal vibrations. This direct connection of the supporting wires with the electrode is deficient in mechanical or structural strength not only by reason of the thinness of the electrode material but is further weakened particularly with soldered connections by the alloying of the solder with the electrode metal reducing its adherence to the crystal surface. In certain structural forms, particularly in mountings operating with contour mode of vibration of the crystal a degree of increased mechanical strength is customarily obtained by drilling of the crystal at the nodal point for the reception of the end of the mounting wire but there still remains a substantial degree of structural weakness at the union of the wire with the electrode such as to result in failure when subjected to shock or vibratory stresses.

In accordance with the present invention a more rugged and durable mounting support for resonance elements having electrodes of the desired minimum thickness is provided by initially applying to the surface of the crystal, a localized small area deposit or sublayer of metal, positioned at the nodal area of the crystal and point of support. This localized metal layer, desirably of silver, is provided for mechanical reinforcement and is of a metal or alloy strongly adherent to the crystal surface. The electrode metal is thereafter applied to the crystal surface with the material thereof extended onto and over the localized silver deposit. The thus reinforced supporting or connecting portion is then drilled for the reception of the end of the supporting pin or conducting lead.

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The localized sublayer is of a thickness which in the instance of certain mountings will provide a satisfactory and adequate support for the crystal without the necessity of any welding or soldering connection to the electrode and thereby avoiding disruptive stresses on the latter, while at the same time providing the required good electrical connection. In further accordance with the invention in providing adequate support of crystals of greater thickness and size, the crystal may be drilled at the region of its nodal point and the sublayer reinforcing metal may be applied to fill the bore with a surface extension onto the crystal surface. The electrode material is then adherently applied thereover. A bore is then formed by drilling through the electrode and into the reinforcing metal for the reception of the supporting pin or conducting lead for supporting of the crystal in like manner and desirably with a supporting pin formed to effect a clamping engagement with the electrode by pressure applied between the supporting pin and crystal.

The described and other features and advantages of the present invention will be more fully understood by reference to the accompanying drawings wherein like characters are applied to the corresponding parts in the several views.

In the drawings:

Fig. 1 is a vertical sectional view of a typical resonator unit assembly showing the crystal and mounting unit in elevation;

Fig. 2 is a vertical section through the center of a crystal element of the pin mounted type and showing the supporting pins in elevation;

Fig. 3 is a similar view illustrating the features of the invention as embodied in the crystal structure wherein the crystal element is drilled in one face thereof;

Fig. 4 is a central sectional view of the crystal structure employing the nodal area reinforcement of the invention adapted for spring contact support;

Fig. 5 is a further modification of the type of mounting for directly securing upon the end of conductor leads.

In the preferred embodiment of the features of the present invention as here illustrated, the resonator or crystal element is shown enclosed within and supported by a holder of a standard type. In this structural embodiment the crystal is indicated at 1 positioned within an opening 2 of an elongated rectangular holder 3 of insulating material having a lower terminal plate 4 attached thereto by screws 5 and an upper ter-

terminal plate 6 of angular formation secured to the holder by a screw 7. The terminal plates 4 and 6 are longitudinally extended and connected by screws 8 and 9 to the externally extended terminal pins 10 and 11 for circuit connection. The screws 8 and 9 also as shown secure the mounting assembly to an insulating container 12 having a removable cover 13.

The crystal or resonator element is mounted at its central and nodal point by means of vertically aligned supporting pins 14 of which the lower pin is shown fitted to a vertical aperture in the lower portion of the holder to bear upon the lower terminal plate 4. The pin is formed at its upper end with a reduced diameter contact shoulder portion 15 engaging the under surface of the crystal. The upper supporting and contact pin aligned therewith is fitted to an aperture in the upper portion of the holder to extend therethrough and at its inner end is similarly formed with a reduced contact shoulder portion engaging the upper surface of the crystal. Its upper end is extended beyond the holder aperture and resiliently engaged by a spring 16 of flat metal having its right hand end portion underlying the terminal 6 for electrical connection and secured at its opposite end by the screw 17 threaded to the holder. The arrangement insofar as described accordingly provides for supporting of the crystal with a rest bearing upon the lower pin 14 and with pressure engagement of the upper pin 15 therewith and with the circuit closed to the respective terminal pins 10 and 11 through the crystal elements by the supporting engagement with the electrodes thereof.

In accordance with the invention the resonator or crystal element is of the usual rectangular plate formation provided on its opposite faces with electrode layers or coatings 18 and 19 and is likewise provided at its central or nodal portion with a localized sublayer of reinforcing metal 20 adherently applied to the crystal preparatory to the applying of the electrode thereon and over which the electrode metal is adherently applied in a thin layer as by spraying by the well known Schoop method.

This sublayer may be applied as a silver paste such as that known as Hanovia 122 A composed of free silver, lead borate and a solvent which upon baking has good adherence to the crystal surface.

This small area sublayer 20 may have a thickness of from .0002" up to .020" depending on the mounting method, and is heat treated or baked at from 500° to 550° C. with slow cooling. This thickness is not critical and may be varied. Thereafter the electrode metal is as shown applied to the crystal surface to overlie the circular reinforcement and in the mounting arrangement as disclosed in Fig. 2 the upper sublayer 20 is drilled through the electrode material providing a small bore for the reception of a pin or wire contact extension 21 integral and concentric with the reduced shoulder 15 of the upper pin 14. This bore desirably does not extend through the layer 20 which provides that there shall be butt end electrical contact if pin engagement occurs at the bottom of the bore and if such engagement is absent, similar butt end engagement will occur under the spring mounting pressure between the end surface of the shoulder 15 and the electrode in clamping arrangement. In either instance, good electrical contact is insured without imposing disruptive stresses upon the relatively thin electrode material. In this arrangement of

Fig. 2 the crystal has a rest bearing upon the lower pin 14 and the sublayer 20 provides a reinforcing boss of added conductive metal thickness effective to maintain operating conductivity in the instance of wear penetration of the electrode material.

In the illustrated embodiment of Fig. 3 a modification is shown wherein the crystal element is drilled in one surface to provide a bore 22 in the centralized or nodal area for mounting attachment. In this instance the sublayer metal 20 is applied to fill the bore with an upward and outward extension of the metal providing a reinforcing circular bead. The electrode material is then similarly applied thereover and a central bore 23 drilled through the electrode and into the sublayer 20 for the reception of the connecting and supporting pin extension 24 corresponding generally to the structure of Fig. 2. The sublayer associated with the lower electrode is correspondingly employed as wear reinforcement.

In Figs. 4 and 5 other suitable modifications embodying certain features of the invention are disclosed as incorporated in other known types of mounting. In that of Fig. 4 the mounting of the crystal is by means of opposed resilient spring contacts 25 in opposed relation having pressure engagement at the central nodal point of the crystal element by means of the contact beads 26. In this instance the localized sublayers 27 are applied to underlie the electrode material for wear reinforcement as in connection with the lower pin support of the preceding figures. In the disclosure of Fig. 5 the sublayer reinforcing metal indicated at 28 and underlying the electrode material 16 and 17 is drilled in corresponding manner to the upper mounting of Fig. 2 for the reception of the end of supporting and conducting wires 29 in resiliently opposed relation and alignment as employed in the customary lead or wire supported crystal mountings as used for the mounting of crystals of very small sizes.

The mounting of the crystal with elimination of rigid union with the electrode material, results in increased stability of operation over long periods of use. In this connection and as will be appreciated, the effects of wear incident to vibrations or shock, will have no appreciable effect upon the conditions of support or upon the maintenance of good electrical contact. In the embodiment of the invention as disclosed in Figs. 2 and 5 there is presented the advantage of eliminating losses due to chipping of the crystal incident to drilling into the crystal itself.

While there is shown and described desirable embodiments of the features of the invention, it will be understood that varied modifications may be made therein without departing from the scope thereof as defined in the appended claims.

What is claimed is:

1. A piezoelectric device comprising a crystal, said crystal having a localized area metal deposit adheringly applied at a nodal region, electrode coatings adheringly applied over the crystal faces and over the metal deposit and said deposit being drilled to provide a bore for the reception of a mounting pin.

2. A piezoelectric device comprising a crystal, said crystal having a localized area metal deposit adheringly applied to opposite faces of the crystal at its nodal region, electrode coatings adheringly applied over the crystal faces and over the metal deposits and at least one of said deposits being drilled to provide a bore for the reception of a mounting pin.

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3. A piezoelectric device comprising a crystal, said crystal having a localized area metal deposit adheringly applied at its nodal region, electrode coatings adheringly applied over the crystal faces and over the metal deposit and said deposit being drilled to provide a bore for the reception of a mounting pin and a mounting pin slidably fitted within the bore.

4. A piezoelectric device comprising a crystal, said crystal having a localized area metal deposit adheringly applied at its nodal region, electrode coatings, adheringly applied over the crystal faces and over the metal deposit and said deposit being drilled to provide a bore for the reception of a mounting pin in position of non-engagement with the crystal and a mounting pin slidably fitted within the bore.

5. A resonator element of the character described comprising a crystal element having localized area metal deposits on its opposite faces adheringly applied at its nodal region, electrode coatings adheringly applied to the crystal faces and extended over the metal deposit and said element being formed with at least one bore in a deposit adapted to receive a mounting pin slidably fitted thereto and resiliently engaging supporting means for the crystal including a pin slidable within the bore.

6. A resonator element of the character described comprising a crystal element having localized area metal deposits on its opposite faces adheringly applied at its nodal region, electrode coatings adheringly applied to the crystal faces and extended over the metal deposits and adapted for resiliently supporting the crystal with slidable engagement with the deposits.

7. A resonator element of the character described comprising a crystal element having localized area metal deposits on its opposite faces adheringly applied at its nodal region, electrode coatings adheringly applied to the crystal faces and extended over the metal deposit, said crystal

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being formed with at least one bore in a face thereof within which the deposit metal extends and having a bore formed therein for the reception of a supporting pin and a supporting pin slidably fitted to the bore.

8. A resonator element of the character described comprising a crystal element having localized area metal deposits on its opposite faces adheringly applied at its nodal region, electrode coatings adheringly applied to the crystal faces and extended over the metal deposit, said crystal being formed with at least one bore in a face thereof within which the deposit metal extends and having a bore formed therein for the reception of a supporting pin and a supporting pin slidably fitted to the bore and formed for shoulder engagement with the electrode.

9. A resonator element of the character described comprising a crystal element having localized area metal deposits on its opposite faces adheringly applied at its nodal region, electrode coatings adheringly applied to the crystal faces and extended over the metal deposit and said element being formed with aligned bores in the deposits adapted to receive mounting pins slidably fitted thereto.

10. A piezoelectric device comprising a crystal, a localized area metal contact piece secured to said crystal, an electrode coating covering said contact piece and the adjacent surface of said crystal, said contact piece being drilled to provide a bore for the reception of a mounting pin.

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