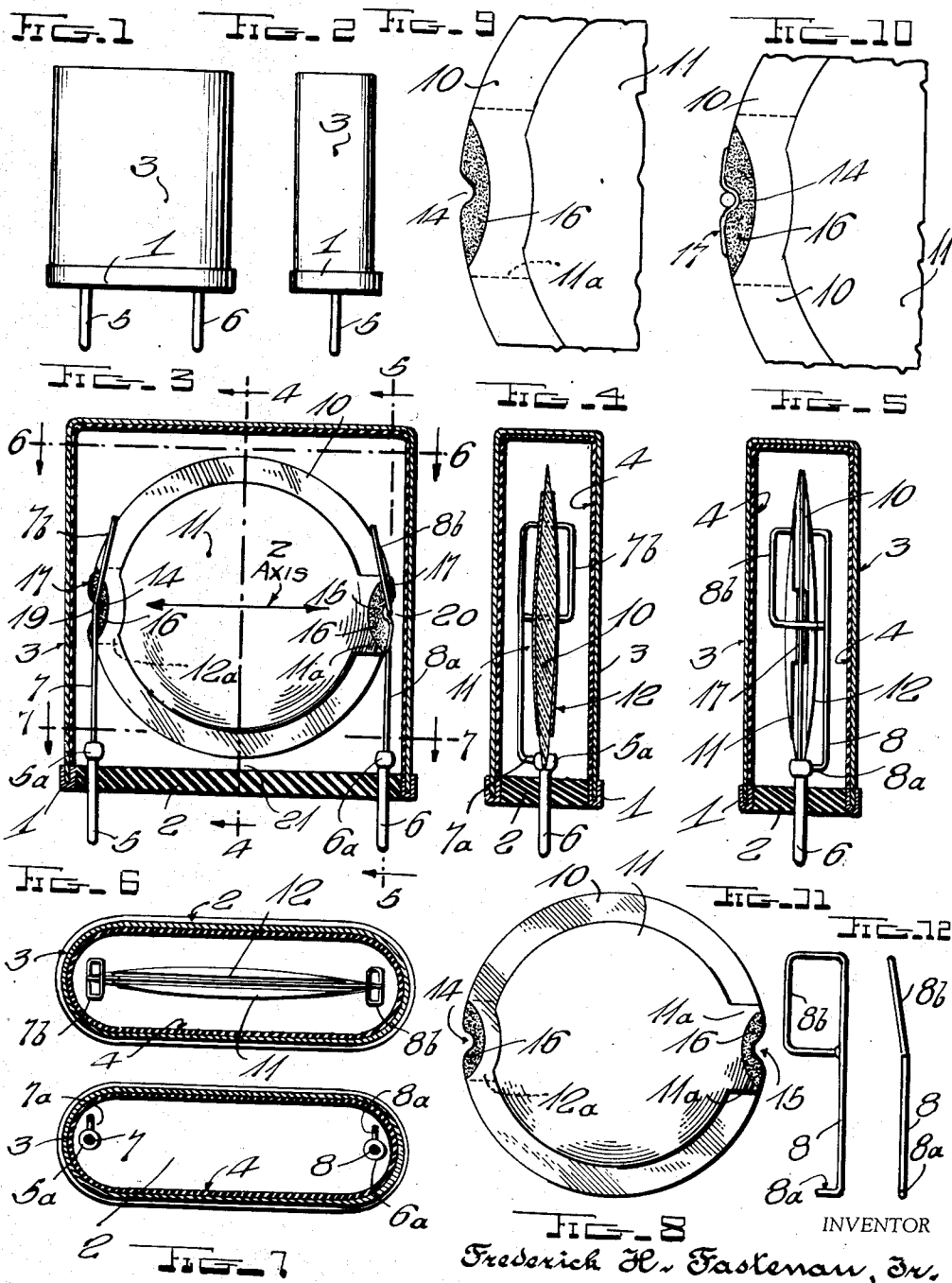


Jan. 11, 1955

F. H. FASTENAU, JR.
METHOD OF MOUNTING AND CONSTRUCTION OF MOUNTING
FOR LOW FREQUENCY PIEZOELECTRIC CRYSTALS
Filed Dec. 21, 1951

2,699,508



BY

John B. Brady

ATTORNEY

1

2,699,508

METHOD OF MOUNTING AND CONSTRUCTION OF MOUNTING FOR LOW FREQUENCY PIEZO-ELECTRIC CRYSTALS

Frederick H. Fastenau, Jr., Carlisle, Pa., assignor to Selectronics, Inc., Carlisle, Pa., a corporation of Delaware

Application December 21, 1951, Serial No. 262,848

6 Claims. (Cl. 310-9.4)

My invention relates broadly to a piezo electric crystal system, and more particularly to a method of fabrication and assembly and to an improved construction of holder for piezo electric crystals.

One of the objects of my invention is to provide a method of fabricating and assembling low frequency piezo electric crystals in holders or supports for utilization of maximum piezo electric activity therefrom.

Another object of my invention is to provide a holder for low frequency piezo electric crystals operating below 2,000 kc.

Still another object of my invention is to provide a construction of holder for low frequency piezo electric crystals in which the crystals are notched along the Z axis and conductive materials introduced into the notches to which mechanical and electrical connection may be made for both mounting the crystals and establishing electric connection with electrodes mounted on opposite faces thereof.

A further object of my invention is to provide a construction of mounting for low frequency piezo electric crystals for establishing connection with the opposite electrodes of piezo electric crystals which allow displacement in three dimensions whereby vibration or shock to which the piezo electric crystal may be subjected is prevented from setting up stresses or strains which may impair the mechanical or electrical connection to the piezo electric crystal.

A still further object of my invention is to provide a mounting means for piezo electric crystals in which a selection of materials has been made for filling notches formed in opposite peripheral edges of the piezo electric crystals forming a conductive filler over which a coating of electrically conductive material is applied for forming means for establishing electrical connection with the filler and the electrodes of the piezo crystal adjacent thereto for insuring good mechanical and electrical connection with the piezo electric crystal with minimum obstruction to operation due to loading.

Other and further objects of my invention reside in the production of an improved resilient mounting for piezo electric crystals as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Figure 1 is an elevational view of a piezo electric crystal unit enclosed within a protective casing; Fig. 2 is a side elevational view of the enclosed unit shown in Fig. 1; Fig. 3 is a vertical sectional view taken through the piezo electric crystal unit of Figs. 1 and 2 and illustrating the manner of mounting the piezo electric crystal and establishing electrical connection with the electrodes thereof; Fig. 4 is a vertical sectional view taken on line 4-4 of Fig. 3; Fig. 5 is a vertical sectional view taken on line 5-5 of Fig. 3; Fig. 6 is a horizontal sectional view taken on line 6-6 of Fig. 3; Fig. 7 is a horizontal sectional view taken on line 7-7 of Fig. 3; Fig. 8 is an elevational view of the piezo electric crystal with the electrodes applied thereto but prior to the mounting of the crystal on the spring supports; Fig. 9 is a fragmentary elevational view showing the manner of notching one edge of the piezo electric plate and the filling of the notch with electrically conductive material; Fig. 10 is a view similar to the view shown in Fig. 9 but illustrating the addition of an electrically conductive coating to the electrically conductive material, to which coating a mechanical and electrical connection is applied; Fig. 11 is a side elevational view of one of the spring mounts for

2

the piezo electric crystal; and Fig. 12 is a front elevational view of the spring mount illustrated in Fig. 11.

My invention is directed to a method of mounting piezo electric crystals, particularly of low frequency characteristics, over a frequency range, for example, of 500 kc. to 2,000 kc., that is at frequencies below 2,000 kc. The conventional mounting for piezo electric crystals of high frequency cannot be applied satisfactorily to low frequency crystals as the conventional type of spring mounting is too light to support properly the larger and heavier low frequency crystal blank. Moreover, conventional type spring mounts offer too rigid a support for low frequency crystals, and preclude three dimensional movement. Under conditions of shock vibration conventional spring mountings applied to low frequency crystals often resulted in breaking of the crystals away from the mounts and/or the loading of the crystals to such an extent that efficiency in the utilization of the piezo activity thereof has been considerably reduced. The method of my invention involves the notching of the piezo electric plate along the Z axis at opposite spaced positions and the spotting in the notches of Hanover #150 silver paste or Du Pont liquid bright platinum 129. This material is electrically conductive and serves as a partial filler for the notches of the piezo electric plate. When liquid bright platinum filler is used, an electrically conductive silver coating is applied over the platinum to provide a good soldering surface. I provide a pair of spring members formed from resilient electric conductors having a diameter within the range of .012-.018". These electrical conductors are tinned on their surfaces to provide a good soldered connection with the plated silver which extends over the filler of silver paste or liquid bright platinum. Each of the resilient supports are formed into substantially rectangular loops which are resiliently supported by a vertically extending portion of the resilient members carried by a base of insulation material over which the protective casing for the device is fitted. The small, compact size of the unit enables large numbers of these holders to be assembled within small overall physical dimensions.

Referring to the drawings in more detail, reference character 1 designates a base frame which surrounds a base of insulation material represented at 2 and provides a channel in which the depending peripheral edge of housing 3 fits. The housing 3 is provided with an interior lining 4 of insulation material. The base 2 provides a mounting means for a pair of spaced pins 5 and 6. The upper ends of the pins provide means for establishing a soldered connection 5a and 6a with the looped ends 7a and 8a of the resilient wire supports 7 and 8.

The upper ends of the resilient wire supports 7 and 8 are bent upon themselves to form rectangular frames. These rectangular frames are biased inwardly toward each other as shown more clearly in Fig. 3 and provide mechanical mounting means and electric connection means with the piezo electric plate designated at 10. The particular piezo electric plate illustrated is an 833 kc. crystal in the form of a circular disc contoured to a knife edge leaving a flat area of only $\frac{1}{16}$ " diameter at the center. I use a 15 diopter lap to obtain this contour. The surfaces of the piezo electric plate are coated with an electrically conductive covering forming the electrode on each face of the crystal. To secure maximum electrical conductivity I may use a gold coating or an alloy of gold sputtered upon the opposite surfaces of the plate and forming an intimate surface connection with the surface of the piezo electric plate. One such electrode is represented at 11 and the other such electrode is shown at 12. Electrode 11 has a lug extension 11a projected to one edge of the plate. Electrode 12 has a lug extension 12a projected to the opposite edge of the plate 10.

The crystal plate or disc 10 is provided with recesses or notches at the extreme limits of the Z axis as represented at 14 and 15 which have the contour of a curve constituting segments of the disc. These recesses or notches are filled with a layer of Hanover #150 silver paste or with Du Pont liquid bright platinum 129 represented at 16. This layer of material after being introduced into the notches 14 and 15 is fired to secure proper adhesion after which a layer of conducting material such as silver 17

is applied to form the electrode. The piezo crystal may then be aligned with the inwardly biased rectangular frames 7b and 8b of the resilient members 7 and 8 with the lower portions of the rectangular frames 7b and 8b registering with the silver coatings 17 and 18 in the notches 14 and 15 respectively. The lower portions of the rectangular frames 7b and 8b are then soldered to the silver coatings in recesses or notches 14 and 15. The soldered connection between the lower portion of frame 7b and the silver coating 17 is completed to the lug 11a of electrode 11, thus establishing a connection between pin 5 and electrode 11 as represented, for example, at 19 in Fig. 6. Correspondingly, the lower portion of frame 8b is soldered to the silver coating 18 and to the lug 12a of electrode 12 as represented at 20 in Fig. 6. The upper portions of rectangular frames 7b and 8b establish tangential contact with the peripheral edge of disc 10, thus clamping the disc 10 in a position spaced above the base 2 as represented by gap 21 in Fig. 3. The low frequency piezo electric crystal is thus free to move in the X, Y and Z axes without loading and without subjecting the bond between the crystal plate and the spring members to excessive stresses or strains.

The fact that tinned music wire of a gauge extending between .012 and .018" is used in producing the resilient members 7 and 8 insures freedom of motion in all three planes without excessive loading of the crystal. The resiliency of the mounting is such that in extended vibration tests of this mounting the crystals rarely exceeded the frequency tolerance (.00075%). Approximately 60% of the crystals vibrated change less than 10% in resistance and virtually all change less than 15%.

While I have illustrated a preferred form piezo electric crystal housing it is to be understood that other types of housings may be employed and that the housing shown herein is to be considered in the illustrating sense and not in the limiting sense.

I have found the method of mounting low frequency crystals as set forth herein and the structure of low frequency crystal mounting highly efficient and productive of uniform and reliable runs of low frequency crystal units so essential in communication equipment where space and weight limitations are essential, but I realize, however, that modifications in the details of the method and structure of my invention may be made and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

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

1. A mounting for a low frequency piezo electric crystal of circular disc-like contour, comprising a pair of resilient wire members supported in spaced substantially parallel positions, said resilient wire members each being bent to form a substantially rectangular resilient peripheral frame having spaced substantially parallel extending end portions aligned with each other on opposite sides of the peripheral edge of said crystal, one of the aligned end portions of each of the wire members establishing electrical connection with the piezo electric crystal along the Z axis thereof, another of the substantially parallel end portions of each of said frames establishing tangential contact with the peripheral edge of said piezo electric crystal at positions remote from the Z axis of the piezo electric crystal and side portions forming parts of said frames and interconnecting the end portions thereof and extending in planes offset from the faces of said crystal.

2. A mounting for a low frequency piezo electric crystal comprising a base of insulation material, a pair of resilient wire members having supporting portions disposed in spaced positions on said base and extending in directions substantially normal to the plane of said base, said resilient wire members each having an open loop on the free end thereof extending in planes generally transverse to the axis of the supporting portions of said wire members, a piezo electric crystal having its opposite edges projecting through the open loops on said resilient wire members, whereby the crystal is displaceably clamped between said resilient wire members, one end of each of said loops being electrically and mechanically bonded to said piezo electric crystal along the Z axis thereof and the remote end of each of said open loops establishing resilient engagement

with opposite edges of the piezo electric crystal in positions displaced from the Z axis of the piezo electric crystal.

3. A mounting for a low frequency piezo electric crystal as set forth in claim 2 in which the piezo electric crystal is substantially in the form of a circular disc and where the contact between opposite ends of said loops and the peripheral edge of said piezo electric crystal at the positions aligned at the Z axis of the crystal and displaced from the Z axis thereof are substantially tangential.

4. A mounting for a low frequency piezo electric crystal of the circular disc type comprising a piezo electric crystal having an electrode on each face thereof, with the electrode on one face of the piezo electric crystal terminating in a connecting lug extending in the direction of the Z axis of the crystal and the electrode on the opposite face of the crystal terminating in a lug projecting in the opposite direction along the Z axis of the crystal, the periphery of said crystal being notched in diametrically opposite positions along the Z axis of the crystal and in alignment with the aforesaid lugs, an electrically conductive material within each of said notches, an electrically conductive coating extending over said material, electrically conductive resilient wire members disposed adjacent opposite edges of said piezo electric crystal and supported at adjacent ends thereof, the free ends of said resilient wire members terminating in substantially rectangular frames having opposite substantially parallel sides substantially embracing the opposite edges of said piezo electric crystal, one of each of the substantially parallel extending sides of said substantially rectangular frames being aligned with the Z axis of said crystal and electrically bonded to the electrically conductive material disposed in said notches, one of said resilient wires being bonded to the lug formed on one of said electrodes and the other of said resilient wires being bonded to the lug carried by the other of said electrodes and the upper extremities of said substantially rectangular frame members establishing tangential contact with said piezo electric crystal for suspending said crystal.

5. A mounting for a low frequency crystal comprising in combination with a substantially circular disc-like piezo electric crystal plate, a base of insulation material, a pair of resilient wires projecting from said base and extending adjacent opposite peripheral edges of the crystal plate, said wires terminating in substantially rectangular peripheral frames each including a pair of spaced end portions extending substantially normal to the plane of said crystal plate, one of said end portions of each frame being connected with opposite edges of said plate along the Z axis thereof in a position for locating the lower peripheral edge of said crystal plate in spaced relation to said base of insulation material and the other of the end portions of each frame establishing yieldable tangential contact with the peripheral edge of said plate in a position displaced from said Z axis.

6. A mounting for piezo electric crystals having a frequency characteristic below 2,000 kc., comprising in combination with a piezo electric crystal plate having a frequency characteristic below 2,000 kc., a pair of resilient wires each being formed in substantially rectangular peripheral frames for supporting said plate, said wires each including a pair of spaced end portions interconnected by side portions, one of the said end portions of each of said frames establishing contacting relation with the edge of said crystal along the Z axis thereof and the other of the said end portions of each of said frames establishing contacting relation with the edge of said crystal in positions displaced from the Z axis of the crystal and the interconnecting side portions of said frames extending in planes spaced from the plane of said crystal plate.

References Cited in the file of this patent

UNITED STATES PATENTS

2,077,204	Bechmann	Apr. 13, 1937
2,275,122	Ziegler	Mar. 3, 1942
2,443,700	Sylvester	June 22, 1948
2,484,428	Smith	Oct. 11, 1949

FOREIGN PATENTS

985,072	France	July 13, 1951
---------	--------	---------------