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2,518,331

PIEZOELECTRIC CRYSTAL MOUNTING

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FIG. 1

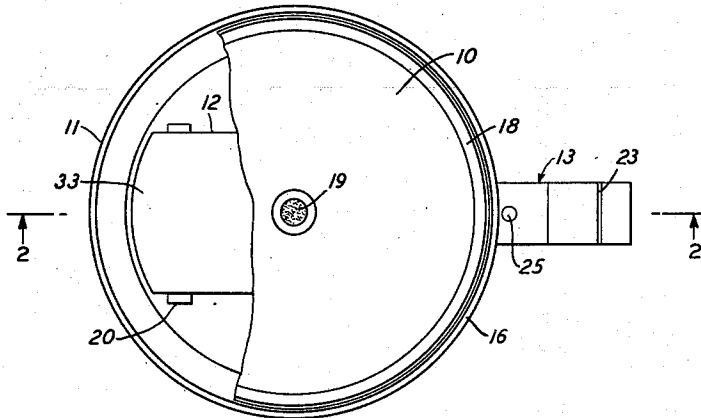


FIG. 2

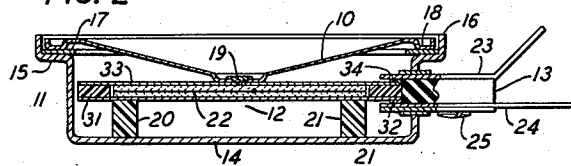


FIG. 3

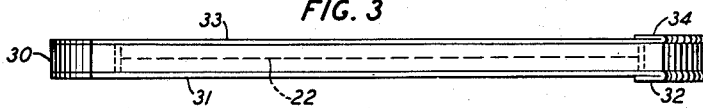
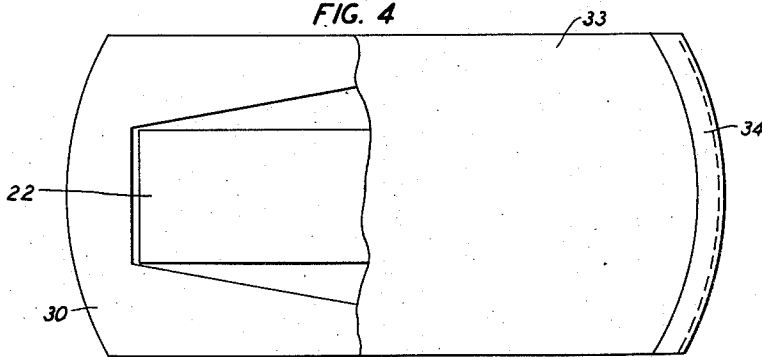


FIG. 4



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PIEZOELECTRIC CRYSTAL MOUNTING

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4 Claims. (Cl. 171—327)

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This invention relates to an improved form of enclosure for piezoelectric crystals, particularly useful in the construction of a crystal microphone.

It is important in such instruments to protect the crystal from moisture and from variations of atmospheric pressure which may produce mechanical damage and change in sensitivity. The invention provides a novel form of hermetically sealed crystal enclosure which excludes moisture and renders the crystal substantially independent of pressure changes. That is the principal object of the invention.

A further object of the invention is to provide a simple and easily assembled hermetically sealed housing enclosing a piezoelectric crystal.

As will appear, the opposite faces of the enclosure serve as electrodes for the enclosed crystal and to provide such a feature is a further object of the invention.

The following description will make clear the nature of the invention, referring to the accompanying drawing, in which:

Fig. 1 is a plan view of a completed microphone using the invention;

Fig. 2 is a diametral section of the microphone taken along the line 2—2 of Fig. 1 and at right angles to the plane of that figure;

Fig. 3 is a lengthwise vertical section on an enlarged scale of the crystal and its housing; and

Fig. 4 is a plan view on the same scale of the assembly shown in Fig. 3.

In all figures, like elements are designated by like numerals.

Referring to Fig. 1, microphone diaphragm 10, loosely fitted in case 11, is partly cut away to show the crystal enclosure 12 in relation to case 11 and to terminal block 13. Block 13 is of methyl methacrylate and electrodes 23 and 24 are secured to it by screw 25 with suitable insulation, as shown in Fig. 2. The outside diameter of case 11, in a particular microphone, is approximately 1.6 inches.

In Fig. 2 the configurations of diaphragm 10 and of case 11 are seen to be as follows:

Case 11, of depth about $\frac{3}{8}$ inch, is a metal cup, preferably of aluminum, spun to have a flat bottom 14 and a cylindrically upturned wall which is turned outward and again upward to provide an annular shelf 15, and outer cylindrical wall 16 within which diaphragm 10 is fitted with a small clearance. Shelf 15 supports rings 17 of impregnated paper on which rests diaphragm 10, crimped around its edge as indicated at 18.

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Rings 17 are suitably constructed and used as taught by H. F. Fruth in United States Patent 1,833,642, November 24, 1931.

Diaphragm 10 may be of Duralumin formed in the shape of a shallow cone, crimped as at 18 around the edge, and flattened at the apex to a circular area 19 in a plane parallel to the bottom of case 11. In the small clearance around the edge of diaphragm 10 there is applied a small quantity of a sealing compound to seal off the space below the diaphragm without restraint of the diaphragm movement.

Cemented to the bottom 14 internally of case 11 are two similar Pyralin blocks 20 and 21, of shape evident from Figs. 1 and 2. By these blocks crystal 22 in enclosure 12 is supported at each end. The lower face of enclosure 12 is cemented to blocks 20 and 21 while the upper face of the enclosure is cemented to the circular flat portion 19 of diaphragm 10; this portion preferably has a central hole through which cement reaches its upper surface.

Crystal 22 is a Rochelle salt bimorph crystal of known construction, consisting of two oppositely oriented crystal elements conductively cemented together at their opposing faces, whereby the voltages generated in the two elements by mechanical stresses are in series. The crystal dimensions are approximately $\frac{3}{64}$ inch by $\frac{1}{4}$ inch by 1 inch.

Referring now to Figs. 3 and 4, crystal 22 is installed within a plastic frame 30 composed of a methyl methacrylate block internally cut out as shown in Fig. 4 to clear the crystal ends by about $\frac{1}{64}$ inch, the side clearance increasing from this amount to about $\frac{3}{32}$ inch on each side at the transverse center line of the crystal. Conveniently, frame 30 has straight sides and rounded ends permitting its location with suitable clearance within microphone case 11 as evident in Figs. 1 and 2. The thickness of frame 30 is that of the crystal itself.

The hermetic sealing of crystal 22 in frame 30 is provided as follows:

A thin sheet of aluminum foil 31, plastic coated on one side to insure good moisture protection, and some .0015 inch thick, including coating, is laid flat on the table with the conducting surface face up. Frame 30 is placed on this face and cemented to it with a suitable waterproof cement such as "vistac." Crystal 22 is lowered into position within frame 30 and is cemented to foil 31 at the two ends of the crystal face with electrically conducting cement. These points of contact between crystal 22 and the foil 31 are

also the points of support between the outer surface of the crystal assembly and the blocks 20 and 21. The foil 31 is then trimmed to the outline of frame 30 except for a narrow transverse strip 32 at one end which is later turned back on the foil sheet of which it is a part.

Frame 30 and crystal 22 are then turned over and a similar foil sheet 33 is cemented into place and similarly trimmed with strip 34 like strip 32. However, there is this exception. This upper crystal face is cemented to the foil 33 with conducting cement at its center so as to establish a firm bond between crystal 22, the composite foil 33 and the circular flat portion 19 of the diaphragm 10. As the exposed surface of enclosure 12 is non-conductive, strips 32 and 34 are turned back on sheets 31 and 33 to expose conducting surfaces to which electrical connections can be made. In Fig. 4, foil sheet 33 is partially cut away.

To blocks 20 and 21, Fig. 2, cemented at the proper locations to the bottom 14 of microphone case 11, is now cemented side 31 of the moisture-proof assembly just described whereby crystal 22 and frame 30 are supported at each end by the blocks 20, 21. At one end, the right in Fig. 2, pressure contacts 23 and 24 seize and make electrical contact with the turned over strips 32 and 34.

Microphone diaphragm 10 is then installed and its central flat portion 19 is cemented to upper foil sheet 33 covering frame 30 and crystal 22. Sound waves incident on diaphragm 10 cause crystal 22 to vibrate correspondingly with a loop at its center and a node at each end.

The purpose of providing increased clearance at the mid-line between crystal and surrounding plastic frame is now obvious. The vibration of the crystal is shared by the portions of the foil sheets between neighboring edges of crystal and frame and the stiffness of these portions is greatly reduced at the line of maximum crystal displacement.

The hermetically sealed enclosure consisting of plastic frame 30 and foil sheets 31 and 33 with the crystal therein enclosed is wholly moisture-proof. The effect on crystal sensitivity of changes in atmospheric pressure is substantially eliminated, inasmuch as the volume of air entrapped between crystal and frame is so minute that static pressure differentials built up between the inside of this frame assembly 12 and the inside of the microphone case 11 are ineffectual towards interference with microphone performance. It will be seen that the invention thus renders the performance of a crystal microphone independent of conditions of weather or altitude above the earth's surface, a result extremely desirable when the instrument is used on board an aircraft.

It will be understood that the type of crystal and the dimensions given in the foregoing description of the invention are solely illustrative.

What is claimed is:

1. A mounting for a piezoelectric crystal, comprising a non-metallic rigid frame of thickness that of the crystal and having upper and lower surfaces coplanar with the corresponding surfaces of the crystal, said frame being internally cut out to clear the crystal by a gap narrow at each end thereof and increasing in width from each such end toward the transverse center line of the crystal on each side, and individual sheets of conducting material conductively cemented to corresponding surfaces of the crystal and hermetically sealed to the frame to cover said surfaces and bridge the gap, whereby the crystal is held between the conducting sheets clear of the inner wall of the frame.

2. A mounting as in claim 1 wherein each sheet is externally coated with a plastic film and is at one of its ends returned upon itself to expose a conducting surface adapted to receive an electrical connection.

3. For a piezoelectric crystal in the form of a slab, a moisture-proof housing comprising a non-metallic flat-surfaced rigid frame having the same thickness as the crystal and cut out internally to receive the crystal with circumscribing clearance and a pair of sheets of conducting material each coated over one surface with a plastic film, the uncoated surface of one of said sheets being hermetically sealed to one side of the frame while the uncoated surface of the other of said sheets is hermetically sealed to the opposite side of the frame, the crystal being located within the frame freely thereof and conductively cemented on each side to the sheet adjacent thereto.

4. A mounting for a piezoelectric crystal comprising a rigid plastic frame of the same thickness as the crystal and surrounding the crystal with clearance therefrom at all points on the perimeter thereof, the frame having upper and lower surfaces each in the same plane as the corresponding surface of the crystal, and sheets of electrically conducting material individually connected to the surfaces of the crystal and hermetically sealed to the corresponding surfaces of the frame, each sheet being coated with a plastic film on its outer surface and extending beyond the frame at one end thereof, the extended portion of the sheet being returned upon itself to expose a portion of its inner surface.

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