Oct. 31, 1939. W. F. DIEHL 2,178,224

PIEZOELECTRIC CRYSTAL HOLDER

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Fig. 2.

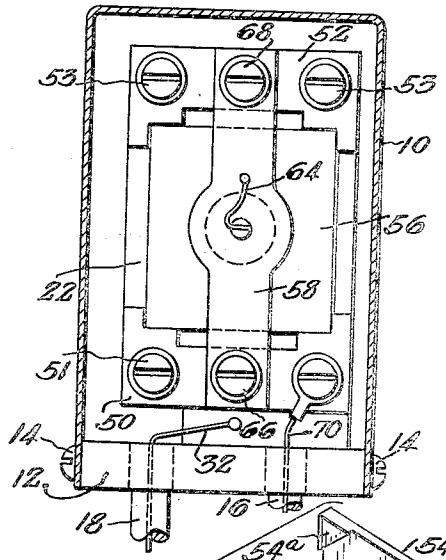


Fig. 1.

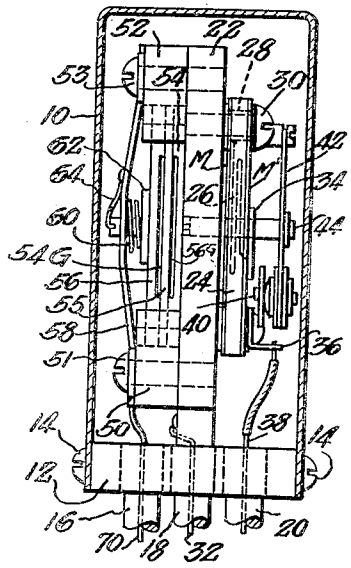


Fig. 3.

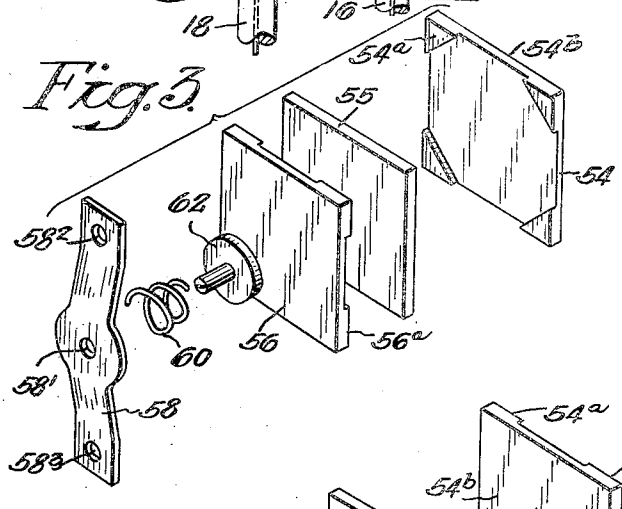
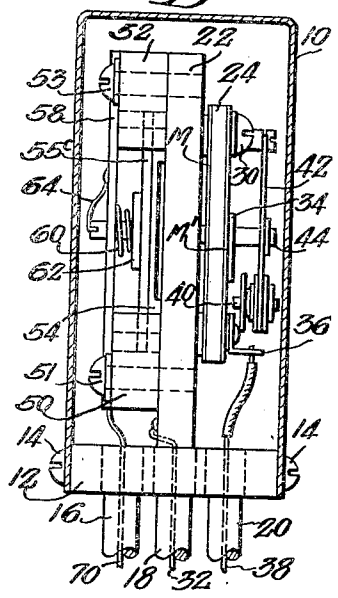


Fig. 5.



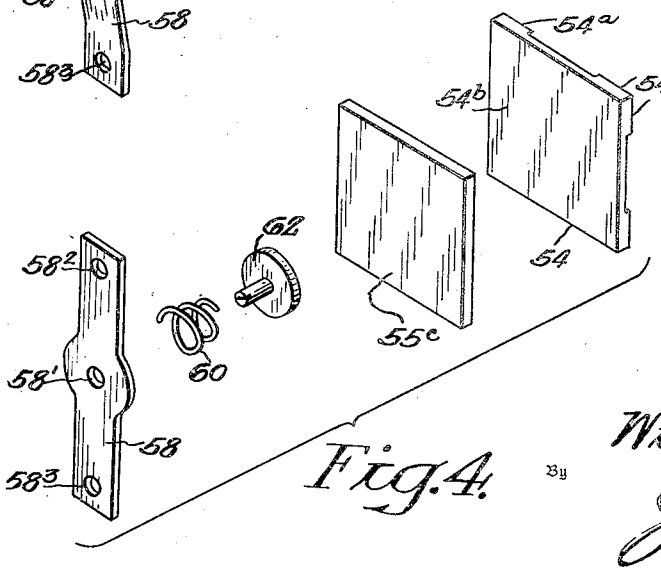


Fig. 4.

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Fig. 8.

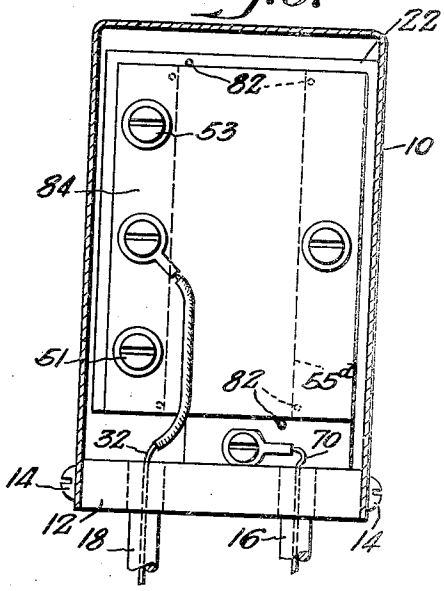


Fig. 7.

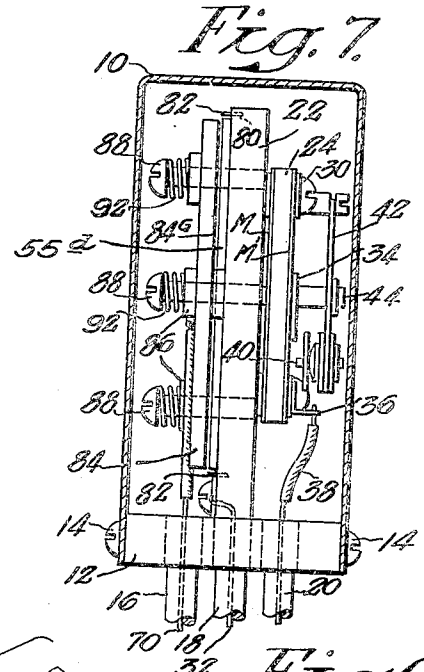


Fig. 9.

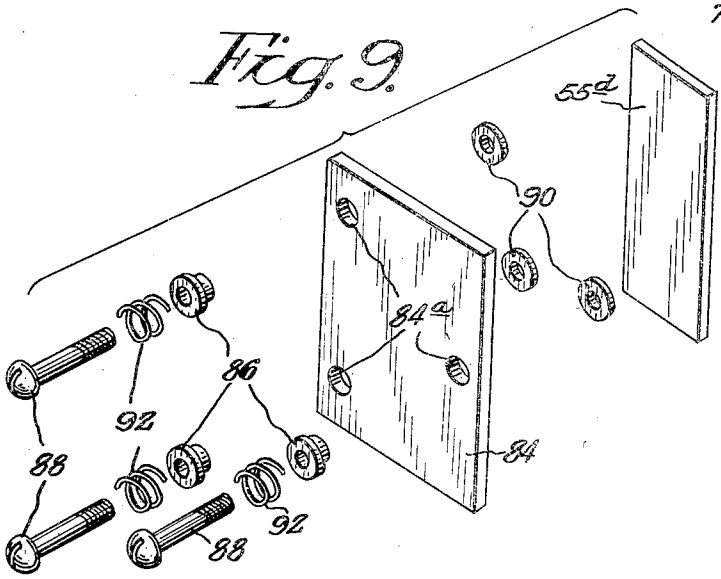
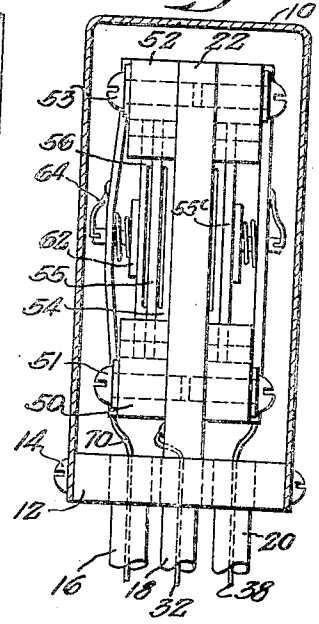


Fig. 6.



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PIEZOELECTRIC CRYSTAL HOLDER

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Application October 31, 1936, Serial No. 108,513

6 Claims. (Cl. 171—327)

This invention relates to the piezo-electric art and particularly to apparatus for mounting piezo-electric crystal elements.

A piezo-electric crystal may be mounted in various ways. It is now appreciated by those skilled in the art that, to ensure optimum performance, a piezo-electric crystal designed to oscillate at a given frequency will require a mounting of one type, whereas one designed to oscillate at a different frequency may require quite another type mounting. Thus, it may be said generally that crystals cut to oscillate at a frequency of between, say, 150 kc. and 2,000 kc. will perform most efficiently when placed without clamping pressure between two spaced electrode plates. Such mountings are usually referred to as being of the "simple air-gap type".

Crystals cut to oscillate at a frequency of between, say, 2,000 kc. and 7,500 kc. will oscillate most efficiently when supported in a "pressure air-gap type" mounting, wherein the crystal is clamped between two plates, each having risers which contact the crystal at spaced points on opposite sides of its electrode surfaces.

Crystals cut to oscillate at a frequency of between, say, 7,500 kc. to 20,000 kc. will oscillate most efficiently when clamped between two flat-surfaced electrode plates, one of which preferably has a surface area somewhat less than that of the crystal. Such mountings are usually referred to as being of the "pressure type".

Modern communication practice, particularly in air-craft governmental and amateur radio systems, dictate the use of crystal holders adapted to permit of transmission at any of the frequencies allotted to such services.

Accordingly, a principal object of the invention is to provide a "universal" holder having interchangeable parts for supporting one or more crystals in the manner best adapted to achieve optimum performance at a given frequency of oscillation.

Another object of the invention is to provide a simple, compact, inexpensive, trouble-free "universal" crystal-holder and one which lends itself readily to mass production methods.

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 drawings, wherein:

Fig. 1 is an end elevation and Fig. 2 a side elevation of a crystal holder constructed in accordance with the principle of the invention and having its parts so assembled as to constitute a "pressure air-gap holder",

Fig. 3 is an exploded view of the crystal and crystal retaining members of Figs. 1 and 2,

Fig. 4 is an exploded view of certain of the members of Fig. 3 rearranged to constitute the elements of a "pressure-type" crystal mounting,

Fig. 5 is an end elevation of a complete holder with the parts of Fig. 4 assembled,

Fig. 6 is an end elevation of a holder containing two crystals, one contained in a "pressure-type" mounting and the other in a "pressure air-gap type" mounting,

Fig. 7 is an end elevation and Fig. 8 is a side elevation of a crystal holder having its parts assembled to constitute a "simple air-gap type" mounting, and

Fig. 9 is an exploded view of the crystal and crystal retaining members of Figs. 7 and 8.

Like reference characters represent the same or corresponding parts in all figures.

Referring to Figs. 1 and 2, 10 designates a metal casing or hood fitted over a base plate 12 of Bakelite or the like and secured thereto as by means of screws 14 which fit into preformed screw holes about the side edges of the base. In a preferred embodiment the dimensions of the casing are 2½" x 1½" x 1¼" and the base ¼" thick. Three triangularly disposed dependent prongs 16, 18 and 20 fixed to the base provide conductive connections to the interior of the casing. The base 12 supports an upstanding metal plate 22 which is disposed on the central long axis of the base and is secured thereon as by screws (not shown) fitted in countersunk holes in the underside of the base.

The thermo-regulator may be constituted by a metal housing 24 having strips of mica M, M' on its inner and outer surfaces, respectively, and containing a heating coil 26 which terminates at one end in a metal eyelet 28 through which a metal attaching screw 30 passes. This end of the coil is thus electrically connected by screw 30 and eyelet 28 to the central upstanding plate 22 which, in turn, is connected by lead 32 to prong 18. The other end of the coil 26 passes through the outer layer of mica M' and terminates in a small metal plate 34. A second metal terminal member 36, spaced from member 34, is connected by lead 38 to prong 20. The space between members 34 and 36 is spanned by a contact 40 mounted adjacent the periphery of a Spencer disc 42. The snap-action of the disc thus controls the energization of the heating coil 26. The disc is mounted on one end of an adjustable metal rod or screw 44 which passes through the housing 24 and terminates within an orifice in the central

plate 22. This screw serves not only to center the thermo-regulator on plate 22 but also provides means for adjusting the tension and hence the thermal response of the Spencer disc.

The side of the plate 22 opposite to that on which the thermo-regulator unit is fixed supports a pair of oppositely located U-shape electrode retaining members 50 and 52, attached to the plate as by screws 51 and 53, respectively. Members 50 and 52 are formed of insulating material and preferably extend the full width of the plate 22.

The electrodes of Figs. 1, 2 and 3 are designed, positioned and arranged to constitute a pressure air-gap mounting. For this purpose the electrodes, designated 54 and 56 have a plurality of crystal supporting risers 54^a, 56^a thereon. There is thus an air-gap 54G, 56G intermediate the crystal 55 and each plate surface, except at the several immediate points of contact. In the embodiment shown there are four risers on each plate, one adjacent each corner. If desired, however, the number of risers on each plate may correspond to the minimum number of points required to define the plane of the crystal 55, i. e., three.

The upper and lower edges of the electrodes 54 and 56 fit snugly in the U-portion of the insulating supporting members 50 and 52. The back surface 54^b of the inner electrode 54 is substantially optically flat, as is the surface of the central plate 22 against which it abuts. The crystal is maintained between the electrodes by the force exerted by the retaining strip 58 and spring 60 through a pressure transfer member 62 which contacts the outer surface of electrode plate 56. Member 62 has a rod-like extension on its back surface about which spring 60 is wrapped. The outer extremity of the rod extends through an orifice 58^1 in the metal retaining-strip 58 and has a short lead 64 attached between it and the strip. The opposite ends of strip 58 are provided with holes 58^2 and 58^3 of a diameter somewhat larger than the screws 66 and 68 which retain it to the U-shape insulating members 50 and 52 whereby to permit the strip to be flexed, if necessary, to regulate the force exerted by spring 60 against member 62. A conductive connection between strip 58 and prong 16 is provided by wire 70 connected therebetween. Prong 18, which is connected to the central upstanding plate 72, by lead 32 constitutes a common return for both the crystal assembly and the thermo-regulator.

As previously indicated the pressure air-gap mounting of Figs. 1, 2 and 3 will ensure optimum performance for crystals cut to oscillate at a frequency of between, say, 2,000 and 7,500 kilocycles. To convert the holder of these figures into a "pressure" holder for 6,500 to 20,000 kilocycles crystals, it is merely necessary (*a*) to remove the outer casing 10, (*b*) remove one of the screws, say 68, and loosen the other screw 66, to permit lateral movement of the retaining strip 58, (*c*) remove the outer electrode 56 and crystal 55, (*d*) reverse the inner electrode 54 so that the risers 54^a are adjacent the central plate 22. The crystal, designated 55C in Fig. 5, is then placed contiguous the flat surface 54^b of electrode 54. The other electrode 56, Figs. 1, 2 and 3 is not used; its place is taken by the flat-surfaced disc 62 which now serves as the second electrode. During the changeover it is not necessary to disturb the electrical connection 70 between the prong 16 and the retaining conductive strip 58. The strip 58 may be flexed as before to adjust the pressure upon the crystal.

Referring now to Fig. 6. When a thermo-regulator is not required (as in the case of piezo-electric crystals enjoying a zero temperature coefficient of frequency) the unit 24 (Figs. 1 and 5) may be detached and a second crystal mounted on the plate 22. This central plate 22 is provided with screw threaded orifices arranged in a universal pattern to permit of such substitution. The mounting on the left side of the central plate 22 in Fig. 6 will be understood to be a pressure air-gap type mounting similar to that shown in Figs. 1, 2 and 3, and that on the right side of the plate 22 to be a pressure type mounting similar to that shown and described in connection with Figs. 4 and 5. Obviously, mountings of the same type may be employed if desired. Lead 38 which, in Figs. 1, 2 and 5 supplies the current for the heater unit, serves in the embodiment of Fig. 6 to energize the second crystal, here designed 55C. Lead 32 connecting the central plate 22 to prong 18 serves as a common return for both crystals. An appropriate switch (not shown) is employed in the apparatus associated with the holder for selectively energizing the crystals 55, 55C.

Figs. 7, 8 and 9 show the device arranged to constitute a "simple air-gap type" holder for crystals cut to oscillate a frequency between, say, 150 kc. and 2,000 kc. Here the central plate 22 itself constitutes one of the electrodes. Plate 22 is provided with a plurality of pin holes 80 which accommodate removable pins 82 which project beyond the surface of the plate and confine a crystal 55^a, adjacent its four corners to the space intermediate the central plate 22 and the outer electrode 84. The outer electrode 84 preferably has a surface area appreciably greater than the crystal and is provided adjacent its outer edges with a plurality of holes 84^a which accommodate insulating bushings 86 through which pass retaining screws 88. The central plate is provided with screw threaded holes positioned to engage screws 88. Insulating washers 90 about the body of the screws intermediate the electrodes 84, 22 provide a suitable air gap therebetween and prevent the application of clamping force to the crystal. Springs 92 adjacent the free ends of the screws serve to maintain the outer electrode 84 against the insulating spacers 90. The crystal is free to move in the air gap 84^G intermediate the electrodes 22 and 84.

A thermo-regulator 24 which is similar in all respects to that shown and described in connection with Fig. 1 is affixed to the opposite side of the central plate. If desired, the regulator may be removed and a second crystal, of any desired type and mounting, fixed in its place.

In mounting the thermo-regulator unit, it is preferable to utilize orifices in the plate not occupied by the retaining members for the crystal. The universal pattern in which these orifices are arranged permits the thermo-regulator to be arranged vertically or horizontally on the plate, as determined by the size and mode of mounting the crystal element.

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

What is claimed is:

1. In a device of the character described, a base of insulating material, an upstanding metal plate

fixed to said base, means including at least one electrode and a plurality of electrode retaining members for maintaining a piezo-electric crystal element adjacent said plate, said electrode being of a size and type dictated by the physical and operating characteristics of the crystal element with which it is to be associated, and means for removably securing said electrode retaining members to said plate in any one of a plurality of patterns determined by the size and type of the electrode to be retained thereby.

2. The invention as set forth in claim 1 wherein said upstanding plate has a substantially optically-flat surface and constitutes a second electrode for the piezo-electric crystal element supported adjacent thereto.

3. The invention as set forth in claim 1 wherein said electrode is constituted by a metal plate having a plurality of risers on one surface thereof, the other of its surfaces being substantially optically-flat.

4. In a device of the character described, a base of insulating material, an upstanding metal plate fixed to said base and having opposite major faces, means including at least one electrode and a plurality of electrode retaining members for mounting a piezo-electric crystal element adjacent each major surface of said plate, said electrodes each being of a size and type dictated by the physical and operating characteristics of the crystal element with which it is to be associated, and means for removably securing said electrode retaining members to said plate in any of a plurality of patterns determined by the size and type of the electrodes to be retained thereby.

5. The invention as set forth in claim 4 wherein a conductive lead extends through said base to said upstanding plate, said lead constituting a common electrical connection for the crystal element on each side of said plate.

6. In a device of the character described, a base of insulating material, a casing removably fixed to said base, an upstanding metal plate mounted centrally on said base, a piezo-electric crystal and at least one electrode therefor mounted on one side of said plate, a thermo-regulator unit mounted on the opposite side of said plate, means comprising separate conductive connections to the exterior of said device for applying operating currents to said unit and through said electrode to said crystal element, and a conductive connection from the exterior of said device to said upstanding plate, said last mentioned connection constituting a common return for said operating currents.

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