

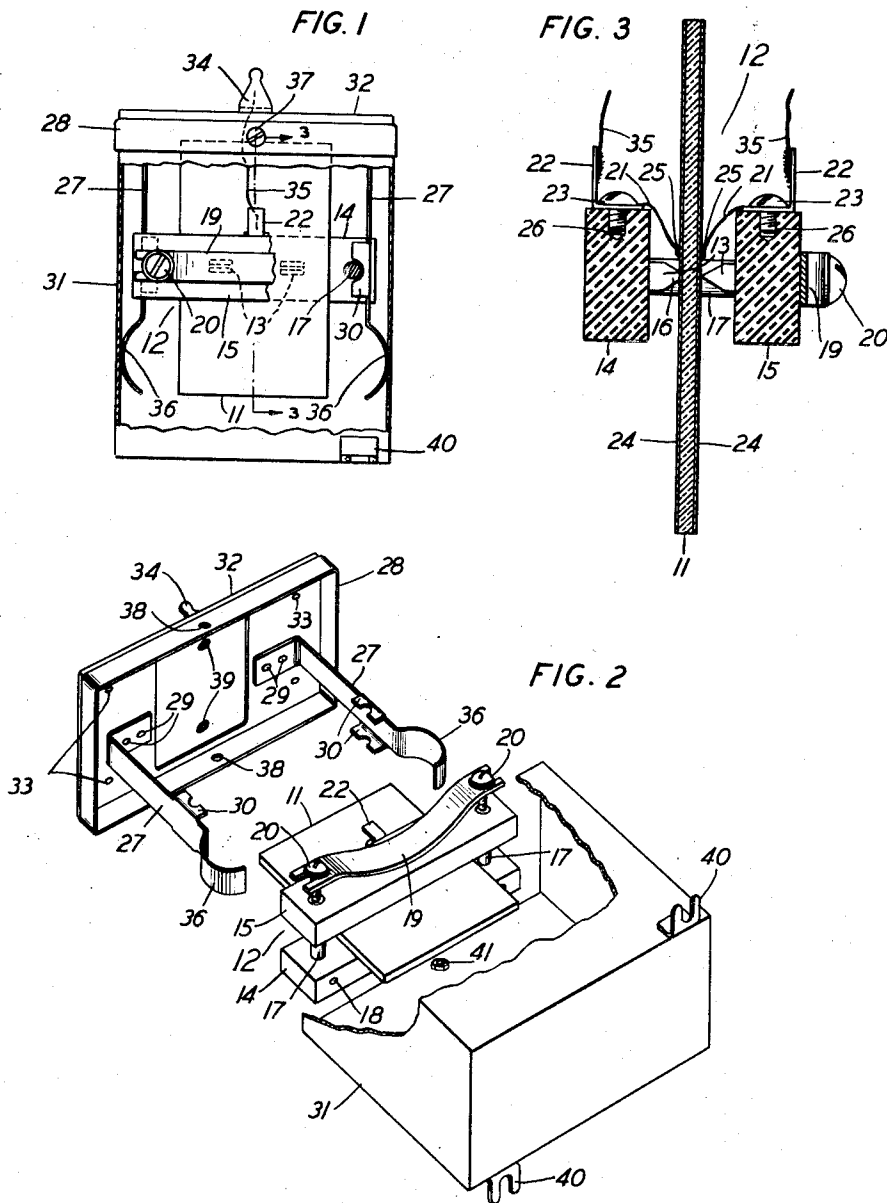
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PIEZO ELECTRIC CRYSTAL APPARATUS

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PIEZOELECTRIC CRYSTAL APPARATUS

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This invention relates broadly to piezoelectric crystal apparatus and more particularly to an improved holder and shield for piezoelectric crystal elements used in electrical circuits.

5 One object of the invention is to house a piezoelectric crystal for substantially unrestricted vibration and in such a manner that it will be protected from dust, dirt and other foreign matter, and also from accidental blows which might cause
10 chipping or destruction of the crystal.

Another object is to mount piezoelectric crystals in such a way that they are firmly and rigidly held in place but so that the crystal may be easily replaced or changed.

15 Another object is to minimize the frictional losses due to the contact between the faces of a piezoelectric crystal and its holder, thereby obtaining the maximum piezoelectric effect from the crystal.

20 A further object is to shield piezoelectric crystals both electrostatically and electromagnetically.

Still another object is so to mount a piezoelectric crystal that it may be transported successfully without impairment of the adjustment of
25 the crystal.

A feature of the invention is a pair of spring clips into which the crystal holder may readily be inserted. When in place the holder is firmly gripped and held, but it may easily be removed
30 when necessary to replace a crystal.

Another feature of the invention is a piezoelectric crystal holder which rigidly clamps a piezoelectric crystal between a pair of knife-edge members, the crystal being gripped along a line
35 which substantially falls within a nodal zone of the vibrating crystal.

Another feature is a metal can which entirely surrounds the crystal holder, protecting the crystal from chipping and also acting as an electrostatic and electromagnetic shield. The can is
40 provided with mounting lugs and also with terminals for connecting the crystal element into the electrical circuit.

Piezoelectric crystals have found a wide variety
45 of uses as reactance elements in transmission networks such, for example, as wave filters. When so used it is desirable to house the crystals in such a way that they will be fully protected both physically and electrically and yet at the
50 same time so that they are easily accessible when a crystal is to be changed or replaced. It is also a requisite that there should be a minimum damping effect due to the frictional contact between the crystal holder and the faces of the vibrating
55 crystal. In accordance with the present inven-

tion, the piezoelectric crystal is clamped in a holder which is clipped in place between a pair of springs depending from the removable cover of a can which entirely surrounds and shields the crystal. Thus, the crystal is protected from dirt
60 and from chipping, yet it may be changed quickly and conveniently when necessary. The housing is rugged enough to withstand any ordinary handling and the jars which are incident to transporting the apparatus from place to place, without
65 disturbing the adjustment of the crystal, and yet the crystal is permitted substantially unrestricted vibration, thereby reducing the frictional losses to a minimum.

The piezoelectric crystal apparatus of the invention is also well adapted for use in controlling
70 the frequency of an oscillator, where stability of the frequency of vibration of the crystal is of great importance. A crystal mounted as hereinafter described has been kept in continuous
75 vibration for months at a time without an appreciable shift of frequency.

The invention will be more fully understood by reference to the following detailed description when taken in connection with the accompanying
80 drawing in which:

Fig. 1 is an elevation view, partly broken away, of the crystal holder and shield of the invention;

Fig. 2 shows an exploded view of the holder and shield of Fig. 1; and

Fig. 3 represents an enlarged cross-sectional view of the holder taken along the line 3—3 shown in Fig. 1.

Referring to Figs. 1, 2 and 3, in which like reference numerals refer to the same parts in all of the views, the piezo-electric crystal 11 is mounted
90 in the holder 12 in such a way as to provide rigid support and still allow maximum freedom of vibration. The crystal 11 may, for example, be quartz of the so-called Curie or perpendicular cut
95 type, that is, it is so cut that its major surfaces are parallel to the optic axis and perpendicular to an electric axis. If the length of the crystal, that is, its dimension parallel to the mechanical axis, which is mutually perpendicular to the optic
100 and electric axes, is made large compared with its other two dimensions, then the crystal will have a major mode of vibration in a direction parallel to the mechanical axis. This is the frequency which is utilized in the electrical circuit
105 in which the apparatus of the invention is employed. Reference is made to Fig. 2 of an article by F. R. Lack in the Bell System Technical Journal, Vol. VIII, No. 3, July 1929, page 515, for an illustration showing the orientation of the
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plate with respect to the crystal axes. An expression for this frequency of vibration in terms of the length of the crystal is given in Equation (1) of the same article. The two major faces of the crystal plate are covered with a conductive material which is closely united with the faces of the crystal, providing a metallic covering of film over the area of the faces of the crystal. These plated surfaces of the crystal form the electrodes 24. The crystal 11 is rigidly clamped between two pairs of knife-edge projections 13 formed along the center line of the two blocks 14, 15. The blocks 14 and 15 may be made of an insulating material such as is produced by the condensation of phenol or a phenol derivative in the presence of formaldehyde. Or, alternatively, the material used may be lavite, isolantite or glass. The crystal 11 is clamped along a line which is approximately perpendicular to the mechanical axis and is midway between the two ends of the crystal. This line coincides substantially with a nodal zone of the crystal when it is vibrating in the mode indicated above, and the damping effect caused by clamping the crystal is, therefore, a minimum. The maximum piezoelectric effect of the crystal is thus obtained in the associated electrical circuit. The blocks may be milled to shape or they may be moulded, with a final milling operation to true up the knife-edge projections 13. The projections from the block 14 are milled off slightly, as shown at the reference number 16, Fig. 3, in order to form small bearing areas, instead of line contacts with the crystal 11. The blocks 14 and 15 are held together by two sleeve bolts 17 which fit into four holes drilled through the blocks. The bolts 17 are made to have a driving fit in the holes in the block 14 and are held in place by the pins 18. The block 15 is given a sliding fit over the bolts 17, so that the pressure of the projections 13 against the crystal 11 may be regulated by adjusting the compression of the spring 19, under the control of the screws 20 which thread into tapped holes in the ends of the bolts 17. The screws 20 are tightened until the crystal 11 is held firmly in place by the projections 13, as determined by a manual test. In an alternative form of the crystal holder the blocks 14, 15 may be made of metal, such as brass, in which case the sleeve bolts 17 may be made of insulating material. Electrical connection is made to each of the crystal electrodes 24 by the flexible wire 21, which at one end is soldered to the crystal coating as shown at 25, and at the other end is soldered to the inner terminal 22. The terminals 22 are held in place by the screws 23 which thread into tapped holes 26 in the blocks 14 and 15, respectively.

As an alternative means for providing an electrical connection to the crystal electrodes, a metallic coating such as gold may be deposited on the knife edges or the knife edges may be covered with a strip of very thin metal such as platinum sheet.

The shield for the crystal and holder is made of metal and comprises a can 31 and a cover 28, the lugs 40 being provided for mounting the apparatus. The can 31 and cover 28 form an electrostatic and electromagnetic shield for the enclosed crystal and holder. The material from which the can and cover are made should be a metal having high conductivity, as, for example, copper. The shield may be effectively grounded through the lugs 40 or it may be otherwise fixed in potential, thereby preventing direct capacity effects between the crystal holder and external apparatus. The crystal holder 12 is supported

by two springs 27 which depend from the cover 28 and are secured thereto by the rivets 29. Fig. 1 illustrates the holder 12 clipped into place between the two springs 27 and shows how the retaining shoulders 30 engage the bolts 17 and prevent any relative movement between the holder and the shield. The flared portions 36 of the springs 27 bear against the sides of the can 31. A terminal strip 32 of insulating material is fastened to the cover 28 by the rivets 33, and two terminals 34 are secured to the terminal strip 32 by the eyelets 39. A portion of the cover 28 is cut out, as shown in Fig. 2. Electrical connection is made from the inner terminals 22 to the external terminals 34 by means of the conductors 35, which pass through the eyelets 39. After the holder 12 has been clipped into place between the springs 27, the cover 28 is placed in position on the can 31 and secured by the screws 37 which pass through the holes 38 and thread into the nuts 41 soldered to the inside of the can 31. The two lugs 40 are provided for mounting the container on a panel or other base, if desired.

When it is desired to replace a crystal this is easily accomplished by removing the cover 28, unsoldering the connectors 25, releasing the screws 20 and removing the crystal 11. A new or different crystal may then be inserted between the blocks 14 and 15 and the apparatus reassembled. Or, if desired, the entire crystal holder 12 may be replaced by a different holder and crystal by unsoldering the connectors 35, removing the holder from the spring clips 27 and substituting the new holder. Also, with the type of crystal holder shown, it is possible to make a final frequency adjustment of the crystal 11 by grinding off its ends, without removing the crystal from its holder 12. In this way the crystal may be adjusted very accurately as to frequency of vibration, while the crystal remains clamped in its holder.

The crystal holder and shield described have been found to be very satisfactory for mounting crystals which have frequencies ranging from 20 kilocycles to 250 kilocycles, the length of the required crystals ranging from about five inches to less than half an inch. For a 50 kilocycle crystal, convenient dimensions of the can are 1.3 inches by 2 inches by 2.5 inches. If crystals of other frequencies are used, the dimensions of the can and holder may be varied, if necessary, in proportion to the length of the crystal.

What is claimed is:

1. In a piezoelectric crystal apparatus, the combination of a piezoelectric crystal holder, an electrostatic and electromagnetic shield of conductive material which completely surrounds said holder, said shield comprising a portion readily separable from the remaining part of said shield, and means for detachably mounting said holder upon the inner side of said separable portion of said shield.
2. A piezoelectric crystal apparatus comprising a crystal holder, a container for said holder and a cover for said container, said holder being detachably inserted between a pair of spring clips which depend from said cover.
3. A piezoelectric crystal apparatus comprising a metallic can, a removable cover for said can, and a piezoelectric crystal holder mounted within said can, said holder being supported from said cover by spring clips.
4. A piezoelectric crystal apparatus comprising in combination a pair of clips, a piezoelectric crystal holder detachably carried by said clips,

a piezoelectric crystal disposed within said holder, an electrostatic and electromagnetic shield surrounding said holder, and a pair of external terminals electrically connected to said crystal.

5 5. A piezoelectric crystal apparatus comprising a housing, a removable cover for said housing, a pair of spring clips depending from said cover, said spring clips having retaining shoulders, a piezoelectric crystal holder inserted between said
10 spring clips and held in position by said retaining shoulders, a piezoelectric crystal in said holder, a pair of terminals mounted externally on said cover and electrical connections from said crystal to said terminals.

15 6. A piezoelectric crystal apparatus comprising a casing, a removable cover for said casing and a pair of spring clips depending from said cover, said clips being adapted to receive one of a plurality of interchangeable piezoelectric crystal
20 holders whereby piezoelectric crystals of different frequency characteristic may be readily inserted or removed from an electrical circuit.

7. A piezoelectric crystal apparatus comprising a metallic receptacle, means for mounting a piezo-
25 electric crystal for substantially free vibration in its own natural period, and a pair of spring clips interior of said receptacle, said clips being adapted to engage said means whereby said means are detachably supported within said receptacle.

30 8. In a piezoelectric crystal apparatus, a metallic cover plate, means for detachably mounting a piezoelectric crystal holder on said cover plate, said means comprising a pair of clips adapted to retain the crystal holder firmly in place, a crystal
35 holder inserted between said clips, a piezoelectric crystal disposed within said holder, an electrostatic and electromagnetic shield surrounding said crystal holder, and electrical connections between the electrodes of said crystal and external
40 terminals.

9. A piezoelectric crystal apparatus comprising a metal can, a removable cover for said can and a piezoelectric crystal holder interior of said can, said holder being retained in position by means
45 of two spring clips which depend from said cover, said clips having retaining shoulders which detachably engage said holder, and said clips having portions which yieldingly bear against the sides of said can, whereby said holder is firmly
50 held in place but may readily be removed.

10. In a piezoelectric crystal apparatus, a container, an interchangeable piezoelectric crystal holder, a piezoelectric crystal disposed within said holder, electrical connections from the electrodes
55 of the piezoelectric crystal to external terminals, and means for detachably mounting said holder within said container, said means comprising a

pair of spring clips having retaining shoulders adapted to receive said holder, and said spring clips having portions which bear against the sides of said container, whereby any one of a plurality of interchangeable crystal holders may be readily
80 mounted between said spring clips.

11. In a piezoelectric crystal device, a metallic receptacle, a removable cover therefor, external terminals and mounting lugs associated with said receptacle, a piezoelectric crystal holder adapted
85 to mount a piezoelectric crystal for substantially free vibration in its own natural period, a piezoelectric crystal disposed within said holder, said crystal being plated on two sides with a layer of conducting material to form electrodes for said
90 crystal, inner terminals associated with said holder, spring clips depending from said cover, said clips having retaining shoulders and portions of said clips being adapted to bear against the sides of said receptacle, said holder being detachably
95 engaged with said retaining shoulders, electrical connections from the electrodes of said crystal to said inner terminals and additional electrical connections between said inner terminals and said outer terminals.

12. A container for completely surrounding and fully shielding a piezoelectric crystal, said container comprising a wall readily separable from the remaining part of said container, and means
105 comprising a pair of spring clips wholly supported by said wall for mounting said crystal, whereby upon the separation of said wall said crystal with its mounting intact is removed from the said remaining part of said container.

13. A container for completely surrounding and fully shielding a piezoelectric crystal, said container comprising a portion which may be readily separated from the remainder of said container, means comprising a pair of spring clips wholly
110 supported by said separable portion for mounting said crystal, and external electrical connections carried by said separable portion for connecting said crystal into circuit, whereby upon the separation of said portion said crystal with its mounting intact may be removed from said container.

14. A container for completely surrounding and fully shielding a piezoelectric crystal, said container comprising a wall readily separable from the remainder of said container, and means comprising a pair of spring clips wholly supported
115 by said wall for mounting said crystal, whereby upon the separation of said wall said crystal with its mounting intact may be removed from said container, said mounting means permitting said crystal to be withdrawn therefrom and another
120 crystal to be inserted in place thereof.

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