July 10, 1934. L. A. GEBHARD 1,965,591

PIEZO ELECTRIC CRYSTAL HOLDER

Filed March 29, 1933 2 Sheets-Sheet 1

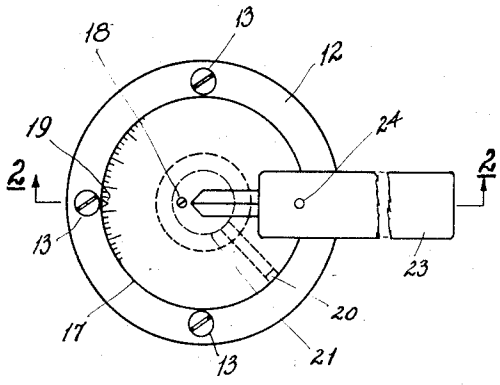


FIG. 1.

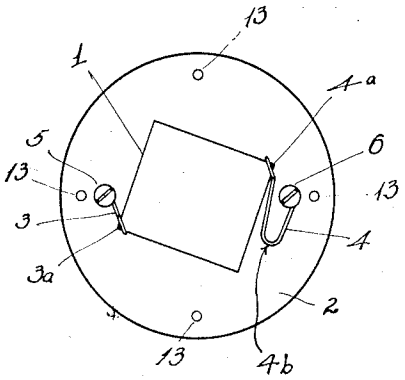


FIG. 3.

FIG. 2.

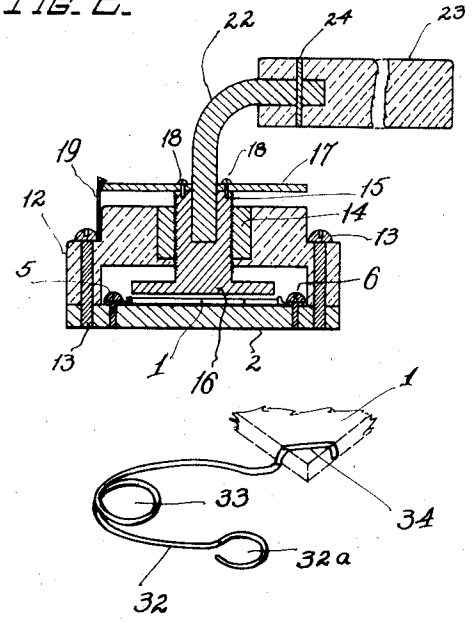
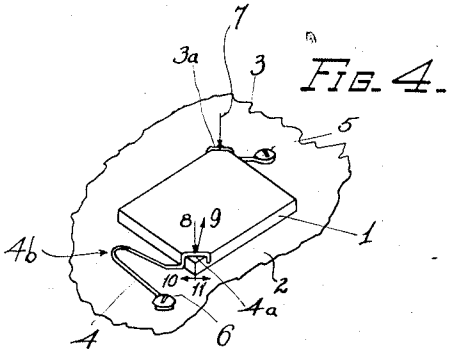


FIG. 9.

FIG. 4.



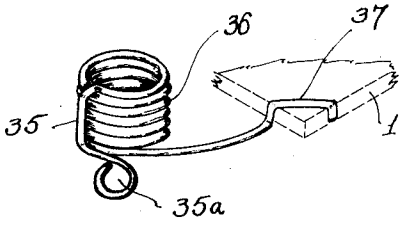


FIG. 10.

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PIEZO ELECTRIC CRYSTAL HOLDER

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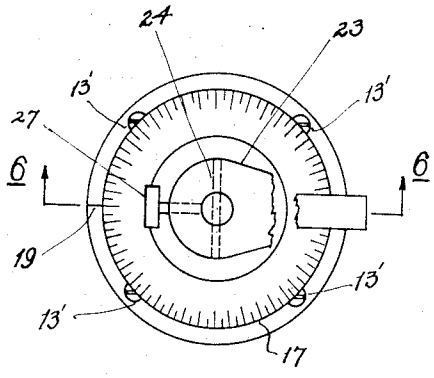


FIG. 5.

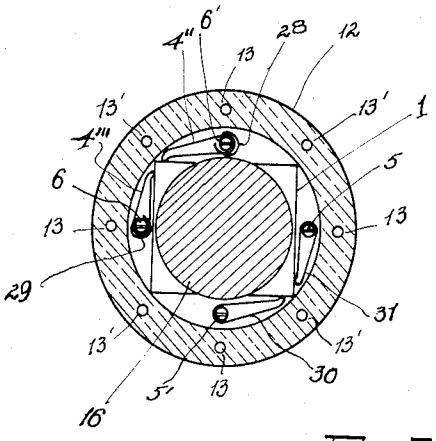


FIG. 7.

FIG. 6.

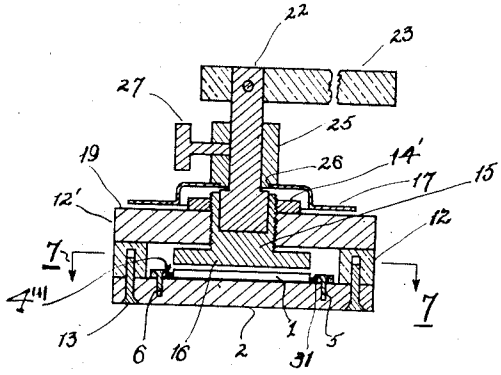
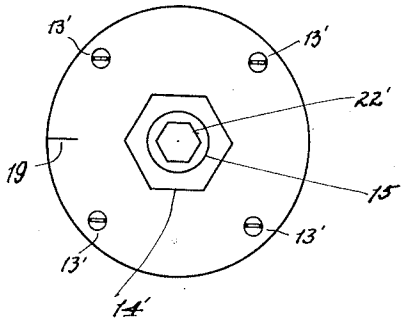


FIG. 8.



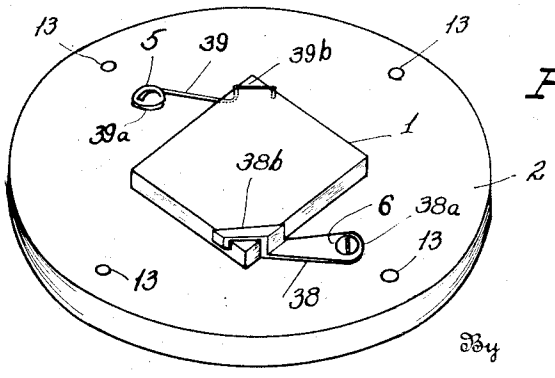


FIG. 11.

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UNITED STATES PATENT OFFICE

1,965,591

PIEZO-ELECTRIC CRYSTAL HOLDER

Louis A. Gebhard, Washington, D. C.

Application March 29, 1933, Serial No. 663,380

6 Claims. (Cl. 171—327)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

My invention relates broadly to frequency control devices and more particularly to a holder for a piezo electric crystal element.

One of the objects of my invention is to provide a construction of precision type piezo electric crystal holder for piezo electric crystal elements which is simple in its manufacture and production and efficient in its operation.

Another object of my invention is to provide a construction of piezo electric crystal holder having means for protecting the piezo electric crystal element against displacement due to excessive shock or undesired vibration during shipment or operation.

Still another object of my invention is to provide a construction of piezo electric crystal holder having an air gap between the upper surface of the piezo crystal element and an upper electrode with means for accurately adjusting the position of the upper electrode with respect to the upper surface of the piezo electric crystal element.

A further object of my invention is to provide an improved construction of piezo electric crystal holder in which the setting of the upper electrode with respect to the piezo electric crystal may be fixed according to a calibrated scale for insuring precision operation of the frequency control device constituted by the piezo electric crystal element.

Other and further objects of my invention reside in the construction of piezo electric crystal mounting as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Figure 1 is a top plan view of the crystal holder embodying my invention; Fig. 2 is a cross-sectional view taken through the piezo electric crystal holder of Fig. 1 on line 2—2 thereof; Fig. 3 is a top plan view of the piezo electric crystal mounted in position on the bottom plate of the piezo electric crystal holder with the upper portion of the piezo electric crystal holder removed; Fig. 4 is a perspective view showing the piezo electric crystal mounted in its retaining means; Fig. 5 is a plan view of a modified construction of piezo electric crystal holder; Fig. 6 is a cross-sectional view taken through the piezo electric crystal holder of Fig. 5 on line 6—6 thereof; Fig. 7 is a transverse cross-sectional view taken through the piezo electric crystal holder on line 7—7 of Fig. 6; Fig. 8 is a plan view showing a further modified form of crystal mounting embodying my invention wherein the adjustment means has been eliminated and the position of the upper electrode permanently fixed in the crystal holder; Figs. 9 and 10 show modified forms of resilient members which may be provided for securing a corner of a piezo electric crystal in position; and Fig. 11 is a perspective view illustrating a further modification of the rigid and resilient elements which are employed for maintaining the piezo electric plate in position in the crystal holder.

It is becoming highly important to obtain extreme accuracy of the emitted frequency of radio transmitters. One of the limitations in securing a high degree of accuracy in radio transmitters using quartz crystals for frequency control is the movement of the crystal inside of the crystal holder. Slight motion of the crystal in the holder produces changes of frequency of the order of .0003%. The crystal is usually held in the holder by means of limiting surfaces such as pins or a retaining ring or by the use of strings. All these various means have proven unsatisfactory for one reason or another. The improved construction of my invention provides means for holding the piezo electric crystal in position in a crystal holder which insures proper stability of the crystal by providing the required resiliency necessary to prevent injury to the crystal when the crystal holder is shipped from place to place.

Referring to the drawings in detail, the piezo electric crystal is shown at 1 mounted on a substantial plate 2. The crystal is held in place by means of resilient members 3 and 4. Members 3 and 4 are secured to plate 2 by means of screws 5 and 6 respectively. Resilient member 3 is relatively stiff whereas resilient member 4 is relatively springy. These members hold the crystal by means of bent portions 3*a* and 4*a* which embrace diagonally opposite corners of the crystal. By making member 3 rather stiff, movement of the one side of the crystal is prevented in any horizontal or vertical direction except in the case of excessive shock. Excessive shock will possibly occur only when the crystal is shipped. In this case the position of the crystal is only shifted momentarily since it is returned immediately to its adjusted position. Member 3 is so adjusted that it bears down slightly on the crystal in the direction illustrated at 7. Member 4 is adjusted so as to bear against the crystal in directions shown at 8 and 9. Thus the crystal is forced against 7 and at the same time held down upon plate 2. The force 7 caused by member 3 holds the other end of the crystal down upon plate 2. Member 4 is so shaped that it possesses great stiffness in the directions 10 and 11. This prevents movement except for shock in any horizontal di-

rection. Various shapes may be imparted to spring member 4.

The casing of the crystal holder comprises an insulating body 12 secured to plate 2 by means of screws 13. The upper portion of this body contains a bearing 14 supporting a screw 15 having a disc member 16 as part of its lower end. By adjusting the screw 15, a control of the air gap above the crystal 1 is obtained. The adjustment of the air gap is indicated by the use of a dial 17 which is held by means of screws 13 upon member 15. Indications are obtained by means of a pointer 19 held by screw 13'. The screw member 15 is held in position after adjustment has been made by set screw 20. A piece of soft material 21 prevents injury to the screw. The adjustment may be made by means of a wrench 22 which passes into a recess in member 15. A handle 23 is provided on wrench 22 which is made of insulating material and held to wrench 22 by means of pin 24.

Figs. 5 and 6 show another method of arranging the indication of the air gap. In this case the dial 17 is secured to member 25 by means of a pressed joint 26. A set screw 27 fastens member 25 to wrench 22, which has been turned down so as to permit member 25 to rotate about it. The particular position of the dial may be selected and then the set screw 27 located so as to hold the dial in position. In Figs. 5, 6, 7 and 8, the pointer 19 is eliminated and a line made on the surface of the insulating member 12. Fig. 7 is a view taken of the top of the crystal holder with the adjusting means removed. In this arrangement resilient means are provided at 28 and 29 so as to hold the crystal against permanently fastened members 30 and 31. This prevents movement of the crystal in a horizontal direction. No means are provided to retain the crystal on the plate other than its weight and the air cushion between the upper surface of the crystal and the lower surface of member 16.

The principle involved in the construction of the piezo electric crystal holder illustrated in Figs. 6 and 7 is the same as that illustrated in Figs. 3 and 4, in that two edges of the piezo electric crystal rests against the more rigid abutment than is the case with respect to the two edges of the piezo electric crystal. The springs 28 and 29 which act on the arms 4'' and 4''' provide a resilient abutment at diagonally opposite edges of the piezo electric crystal as compared with the firmer abutment provided by arms 30 and 31 illustrated in Fig. 7 as bearing against the opposite edges of the piezo electric crystal 1. It will be observed that the arms 4'' and 4''' and 30 and 31 terminate in abutting fingers which strike the edges of the piezo electric crystal immediately adjacent diagonally opposite corners thereof. This insures minimum frictional drag upon the vibratory action of the crystal at the same time that the crystal is properly centered and prevented from displacement under conditions of mechanical shock. The arms 4'' and 4''' under the action of springs 28 and 29 respectively (Fig. 7) or the resilient action of arm 4 due to the bowed portion 4b (Figs. 3 and 4) insure a yieldable mounting for the piezo electric crystal insuring against undesirable displacement, at the same time permitting the maximum piezo electric effect to be obtained from the piezo electric crystal.

I may employ retaining means for the piezo electric plate of a still further modified construction as illustrated in Figs. 9, 10 and 11. In Fig. 9, a resilient device is illustrated consisting of the wire element 32 having a coil 33 looped therein and having the end 34 thereof bent to shape to engage the corner of the crystal. The arm at 32 is secured to the base 2 by a screw device extending through the eyelet 32a. Where increased resiliency is required in the spring device, a structure such as illustrated in Fig. 10 is provided. In this arrangement, the wire element 35, having an eyelet 35a formed on the end thereof, is bent in the form illustrated and extends to the top of a coil 36. The wire element projects from the base of the coil 36 to the position shown for providing a shaped wrapping end 37 which engages the corner of the crystal. In some instances, I have found it more desirable to construct the retaining means as represented in Fig. 11. In this arrangement, the lower plate 2 has been represented in perspective view providing a mounting means for piezo electric plate 1. A flat metallic strip 38 which is yieldable in a vertical direction but rigid in a lateral direction is secured at the end 38a to the base 2 by screw member 6. The flat strip 38 is bent to shape at the end 38b and directly engages the corner of the piezo electric plate 1. Strip 38 provides a rigid abutment against which the piezo electric plate 1 is seated. The diagonally opposite corner of piezo electric plate 1 is gripped by means of resilient wire element 39, the end 39a of which is anchored beneath the screw head 5. The extremity of the resilient wire element 39 is shaped as represented at 39b to embrace the corner of the piezo electric plate in a yieldable manner. That is, the wire element 39 is yieldable both vertically and laterally for preventing displacement of the piezo electric plate due to mechanical shock while permitting free vibratory movement thereof.

The structure of my invention has proven highly efficient and while I have described certain of the preferred embodiments of my invention, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalty thereon or therefor.

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

1. A piezo electric crystal holder comprising a conductive base, a housing of insulating material carried by said base, an electrode adjustable with respect to said housing, a piezo electric plate, and means for mounting said piezo electric plate on said base in a position immediately below said electrode comprising a relatively firm abutment at one corner of said piezo electric plate and a yieldable abutment at the other corner of said plate.

2. A piezo electric crystal holder comprising a conductive base, a housing of insulating material carried by said base, an electrode adjustable with respect to said housing, a piezo electric plate, and means for mounting said piezo electric plate on said base in a position immediately below said electrode comprising a relatively stationary abutment at one corner of said piezo electric plate and a yieldable abutment at the diagonally opposite corner of said piezo electric plate.

3. A piezo electric crystal holder comprising a conductive base, a housing of insulating material carried by said base, an electrode adjustable with

respect to said housing, a piezo electric plate, and means for mounting said piezo electric plate on said base in a position immediately below said electrode comprising a relatively rigid wire-like member embracing one corner of said piezo electric plate and a yieldable wire-like member embracing the diagonally opposite corner of said piezo electric plate.

4. A piezo electric crystal holder comprising a conductive base, a housing of insulating material carried by said base, an electrode adjustable with respect to said housing, a piezo electric plate, and means for mounting said piezo electric plate on said base in a position immediately below said electrode, comprising a straight wire-like member secured to said base and having a hook shaped end engaging one corner of said piezo electric plate, and a resilient looped wire carried by said base and having a hook shaped end embracing the diagonally opposite corner of said piezo electric plate.

5. A piezo electric crystal holder comprising a conductive base, means for insulatingly supporting an adjustable electrode in variable spacial relation to said base, a piezo electric plate, and metallic members connected to said base and embracing diagonally opposite corners of said piezo electric plate for maintaining said piezo electric plate in a central position beneath said adjustable electrode, one of said members comprising a relatively stiff wire element and the other of said members comprising a relatively resilient wire element.

6. A piezo electric crystal holder comprising a conductive base, means for insulatingly supporting an adjustable electrode in variable spacial relation to said base, a piezo electric plate, and a pair of metallic members carried by said base and engaging the edges of diagonally opposite corners of said piezo electric plate, means for rigidly fixing the position of one of said pair of said metallic members, and means for resiliently controlling the movement of the other of said pair of metallic members in engagement with the edges of said plate.

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