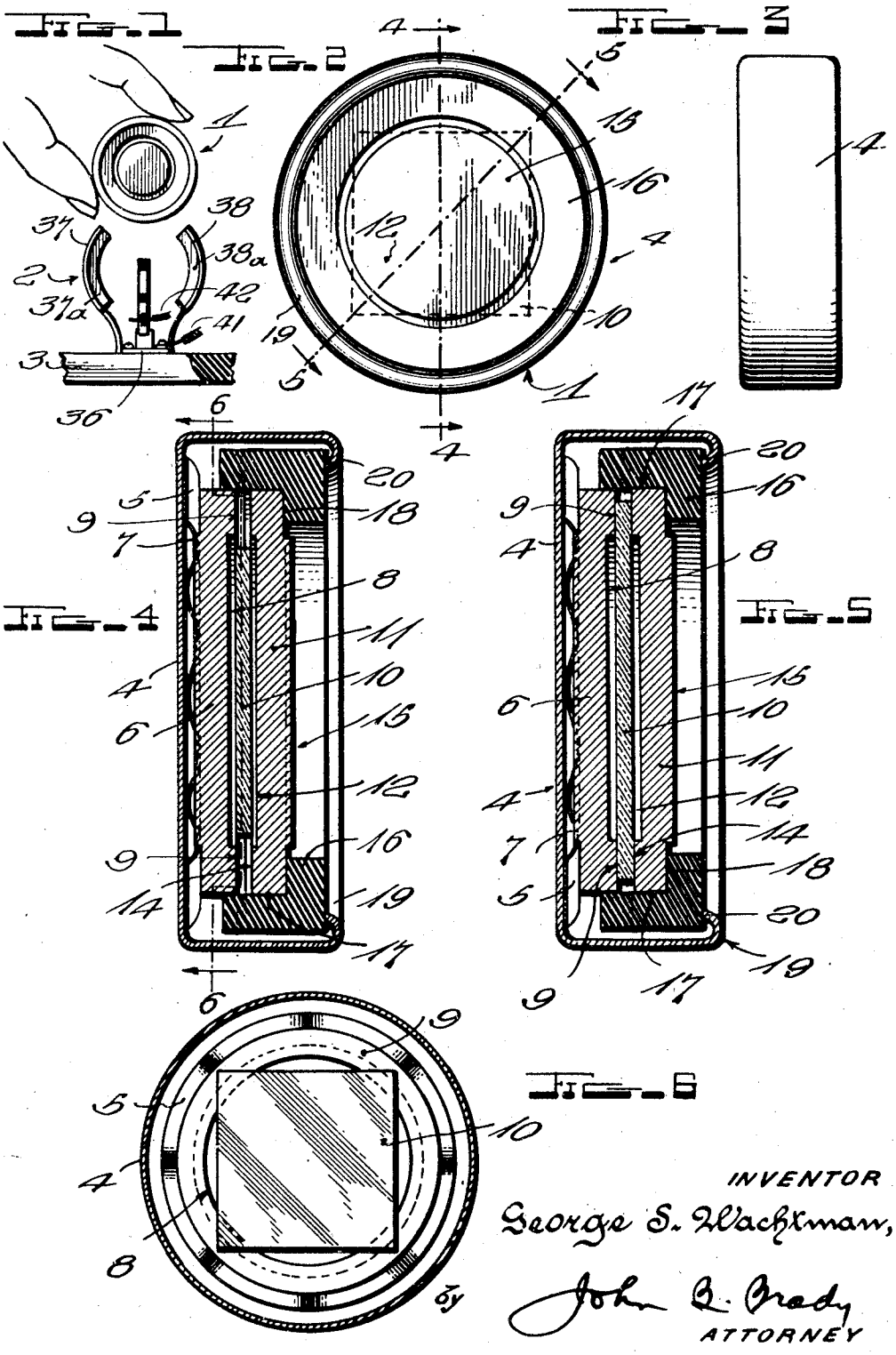
April 8, 1947. G. S. WACHTMAN 2,418,491

PIEZO CRYSTAL UNIT ASSEMBLY

Filed June 5, 1945 2 Sheets-Sheet 1

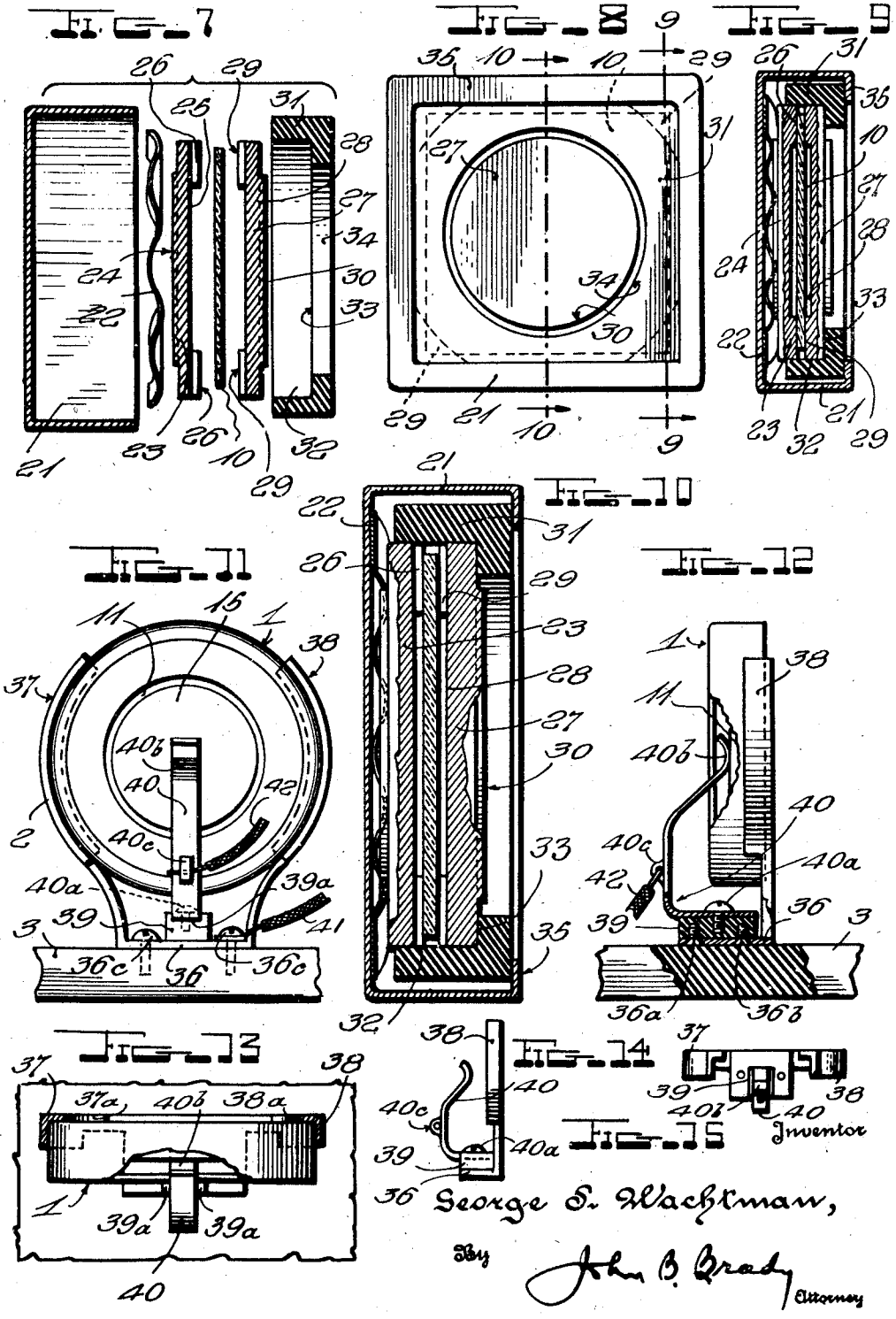


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PIEZO CRYSTAL UNIT ASSEMBLY

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9 Claims. (Cl. 171—327)

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My invention relates broadly to piezo electric crystal apparatus and more particularly to an improved construction of piezo crystal unit assembly.

One of the objects of my invention is to provide a construction of piezo electric crystal unit assembly which is relatively inexpensive for mass production and which has a high electrical efficiency.

Another object of my invention is to provide an improved construction of piezo electric crystal unit assembly having a minimum number of parts and low electrical capacity for efficient operation in piezo electric crystal control and oscillator circuits.

Still another object of my invention is to provide a construction of piezo electric crystal unit assembly which is extremely small in size and which may be readily detachably mounted in a circuit terminal assembly of low cost.

Still another object of my invention is to provide a construction of relatively flat holder for a piezo electric crystal of a depth which is only slightly greater than the thickness of the electrode and crystal assembly and yet which provides adequate electrical insulation and mechanical resiliency for the mounting of a piezo electric crystal element for normal vibration in its course of operation in an electrical circuit.

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

Figure 1 is a view illustrating the piezo electric crystal unit assembly of my invention about to be placed in the circuit terminal device or holder; Fig. 2 is a front elevational view of the piezo electric crystal unit assembly of my invention; Fig. 3 is a side elevational view of the piezo electric crystal unit assembly; Fig. 4 is a vertical sectional view through the piezo electric crystal unit assembly taken on line 4—4 of Fig. 2; Fig. 5 is a cross sectional view taken on line 5—5 of Fig. 2; Fig. 6 is a transverse sectional view taken substantially on line 6—6 of Fig. 4; Fig. 7 illustrates the parts employed in a piezo electric crystal unit assembly of a modified form embodying my invention in superimposed relation previous to the crimping of the shell; Fig. 8 is a front elevational view of the modified form of piezo electric crystal unit assembly the parts of which are shown in Fig. 7; Fig. 9 is a vertical sectional view of the structure of Fig. 8 taken substantially on line 9—9 of Fig. 8; Fig. 10 is an enlarged vertical sectional

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view through the piezo electric crystal unit assembly taken substantially on line 10—10 of Fig. 8, the view being enlarged in order to more clearly illustrate the coaction of the several parts; Fig. 11 is a front elevational view of the piezo electric crystal unit assembly of my invention mounted in the circuit terminal assembly; Fig. 12 is a side elevational view of the piezo electric crystal apparatus of my invention with certain parts broken away to more clearly illustrate the manner of detachably mounting the piezo electric crystal unit assembly in the circuit terminal assembly of my invention; Fig. 13 is a top plan view of the piezo electric crystal apparatus of my invention partially broken away to show the piezo crystal unit assembly detachably mounted in position in the circuit terminal assembly; Fig. 14 is a side elevational view of the circuit terminal assembly employed for mounting the piezo electric crystal unit of my invention; and Fig. 15 is a top plan view of the electric circuit terminal assembly illustrated in Fig. 14.

With the allocation of many additional frequencies in the frequency spectrum for various services in which the public interest is paramount, the matter of controlling the frequency of operation of signalling circuits has assumed enormous proportions. The construction of frequency control apparatus on a mass production scale at low cost is important for the adequate development of the art. The piezo electric crystal unit assembly of my invention has been developed with a view of meeting requirements of the art from the viewpoint of quantity production at low cost. I provide a shell-like container into which a spring device may be inserted as a resilient support for the electrode and piezo electric plate assembly of the piezo electric crystal unit. The piezo electric plate assembly is arranged with respect to the electrodes to permit free vibration thereof. The spring device serves both as a centering means for one of the electrodes as well as to provide a yieldable support for the electrode assembly. A retaining ring of insulation material embraces the other of the electrodes and serves as a centering means therefor within the enclosing shell. The enclosing shell is rolled to a position engaging the retaining ring thereby completing the piezo electric unit assembly. An inexpensive and compact form of spring clip holder is provided for detachably mounting the piezo electric crystal unit assembly.

The assembly may be manufactured either in the form of a rectangular shell-like encased unit or as a circular shell-like encased unit. I have

found the construction highly practical for inexpensive mass production and as having low electrical capacity and a high degree of electrical efficiency.

Referring to the drawings in detail Figure 1 shows one form of piezo electric crystal unit assembly designated by reference character 1 about to be inserted or removed from the cup-like support designated at 2 as mounted upon supporting base 3. The piezo electric crystal unit assembly 1 comprises the shell-like metallic cup 4 in which there is inserted the ring-like spring member 5. The ring-like spring member 5 is sinusoidally shaped about its periphery and has an external diameter which substantially conforms with the internal diameter of the sheet-like cup 4. The ring-like spring member 5 thus serves as a centering means for the circular electrode 6. Electrode 6 has a central projection 7 thereon which has an external diameter conforming with the internal diameter of the ring-like spring member 5 so that the ring-like spring member 5 fits over the projection 7 of the electrode 6 sufficiently to center the electrode 6 within the shell-like cup 4. The electrode 6 is centrally recessed on its opposite face as represented at 8 leaving the peripheral annular land portion 9 which provides a mechanical support and an electrical contact for the corners of the piezo electric plate represented at 10.

The opposite electrode of the piezo electric crystal unit assembly is shown at 11 as having a recessed central portion 12 and an annular peripheral portion 14. The annular peripheral portion 14 serves to mechanically and electrically engage the corners of the opposite face of the piezo electric crystal plate 10. The opposite side of the electrode 11 has central projection 15 thereon which extends into the internal diametrical portion of the retaining ring 16 and serves as an electrical terminal. Retaining ring 16 is formed from insulation material and is provided with a circular recess 17 in one side thereof terminating in an annular shoulder 18 which receives and forms a seat for the circular peripheral portion of the circular electrode 11. The circular recess 17 in retaining ring 16 is of sufficient depth and diameter to receive the circular electrodes 11 and 9 in loose filling relation and allow vibratory movement thereof. The retaining ring 16 has an external diameter substantially conforming with the internal diameter of the cup or shell-like metallic casing 4 for thereby centering electrodes 11 and 6 within the casing. Thus electrode 6 is centered by its entry into circular recess 17 in retaining ring 16 against ring-like spring member 5 while electrode 11 is centered wholly within recess 17 of retaining ring 16 for thereby assembling the electrodes with respect to the piezo electric plate 10 in stacked arrangement within the shell-like container 4 under the yieldable control of ring-like spring member 5. Electrical connection is completed from electrode 6 to metallic casing 4 through spring 5. The assembly thus described is maintained in position by rolling over the extremity of the skirt of the shell-like casing 4 as represented at 19. The rolled over extremity 19 presents a circular edge 20 thereof in contacting relation to the retaining ring 16 of insulation material for maintaining the piezo electric crystal unit in assembled relation. The depth of the shell-like container 4 only slightly exceeds the combined effective thickness of the assembly constituted by retaining ring 16, electrodes 6 and 11, considered in conjunction with the thickness of the piezo electric plate 10 and the effective depth of ring-like spring member 5. Thus the piezo electric crystal unit assembly is free to vibrate in the generation of piezo electric current at maximum efficiency.

In Figs. 1–6 I have explained my invention as directed particularly to a circular construction of piezo electric crystal unit assembly. Certain mass production procedures may be carried out more expeditiously with a rectangular or square construction of piezo electric crystal unit assembly. Figs. 7–10 illustrate my invention as applied to a rectangular or square type of piezo electric crystal unit assembly. In this arrangement the metallic container or shell is pressed from sheet-like material to form a substantially square container represented at 21 which receives the spring-like device 22 of peripheral outline substantially conforming with the internal shape of the sheet-like container 21, the spring-like device being of sinusoidal shape for presenting one bearing surface directly against the end wall of the container 21 and the alternating bearing surface against the periphery of the electrode represented at 23. The electrode 23 has a peripheral contour corresponding in shape to the internal shape of container 21 with a central projection 24 thereon extending through the interior of the rectangularly shaped strip-like member constituting the spring-like device 22. Electrode 23 is centered within the sheet-like container 21 by its loose fitting entry into the recess 32 in rectangular retaining ring 31. Electrode 23 is provided with lands at each of the corners thereof shown at 26 projecting from the central portion represented at 25 and providing supports for the corners of the piezo electric plate 10. The fact that the piezo electric plate is contacted at the corners only by electrode 23 insures free vibration of the crystal throughout its area.

The opposite electrode 27 has lands 29 at the opposite corners thereof projecting from the central circular portion 28 thereof to establish mechanical and electrical contact with the corners of the opposite face of piezo electric plate 10. A central projection 30 of circular shape extends from the opposite side of electrode 27 as shown. A rectangular or square retaining ring of insulation material shown at 31 serves to mount the electrodes 27 and 23 in position with respect to shell 21 in insulated spaced relation thereto. Retaining ring 31 of insulation material has a recess 32 formed therein conforming in contour to the peripheral shape of electrodes 27 and 23 whereby electrode 27 may be seated against shoulder 33 of retaining ring 31 with the central portion 30 thereof partially projecting through the circular aperture 34 in the opposite face of retaining ring 31. The dimensions of retaining ring 31 are such that retaining ring 31 substantially conforms to the interior cross section of container 21 thereby centering electrodes 27 and 23 within the unit assembly and in coaction with spring member 22 centering the unit assembly with respect to the interior walls of the container 21. The length of the skirt or wall of container 21 is such that the peripheral extremity of the skirt or wall 21 may be rolled over as represented at 35 for retaining the piezo electric crystal unit assembly in position within the shell-like container 21. The depth of the container 21 is such that when the peripheral extremity is rolled over

as represented at 35 the combined thickness of retaining ring 31, electrodes 27 and 28 and piezo electric crystal 10 in association with spring member 22 allows free vibration of the piezo electric crystal within the container.

The circuit terminal assembly for mounting the piezo crystal unit assembly 1 comprises cup-like support 2 in the form of a bracket having a central portion 36 mounted upon supporting base 3 and a pair of side portions 37 and 38 which are shaped to conform with the contour of the piezo electric crystal unit assembly 1. The side portions 37 and 38 have inwardly directed plane-like portions 37a and 38a which serve as abutments against which the piezo electric crystal unit assembly 1 may be centered and maintained as shown. The portion 36 of the bracket serves as a mounting means for the block 39 of insulation material which is secured thereto in any suitable manner such as by means of screws 36a and 36b. The upper portion of the block 39 of insulation material is grooved at 39a and into this groove the resilient strip-like member 40 is secured by means of screw 40a. Resilient strip-like member 40 has a contacting portion 40b directed inwardly through the open end of the button or disc-like piezo crystal unit assembly for establishing connection with the projecting face 15 of the electrode 11. Strip-like member 40 tends to continuously urge the piezo electric crystal unit into supporting relation with the abutment portions 37 and 38 of the cup-like support 2. The resiliency of the strip-like member 40 is such that the button or disc-like piezo crystal unit assembly may be readily inserted or removed from the support for facilitating the change of the associated electrical circuit from one frequency to another. The electric circuit connections are made to the terminal assembly through conductors, one of which I have indicated at 41 connected to one of the securing screws 36c and the other of which I have shown connected at 42 as connected to a lug 40c struck from the resilient strip-like member 40. The manner of supporting the square or rectangular shape of piezo electric crystal unit of Figs. 7–10 is the same as the method of mounting the circular piezo electric unit assembly of Figs. 1–6 except that the cup-like support 2 has the abutment portions thereof differently shaped to conform with the shape of the container constituting the piezo crystal unit assembly.

I have found the embodiments of my invention herein highly practical in construction for mass production at low cost, but I realize that modifications in detail 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 and desire to secure by Letters Patent of the United States is as follows:

1. A piezo electric crystal unit assembly comprising a metallic shell-like container, a spring member mounted in said container, an electrode supported by said spring member, a piezo electric crystal plate establishing surface contact with said electrode, a second electrode establishing surface contact with the opposite side of said piezo electric crystal plate, a ring-like member of insulation material spacially relating said second mentioned electrode with respect to said shell-like container and a confining peripheral edge portion on said shell-like container establishing binding connection with said ring-like member.

2. A piezo electric crystal unit assembly comprising a metallic shell-like container, a strip-like yieldable member substantially conforming in shape with the interior contour of said shell-like container, an electrode supported by said strip-like yieldable member, a piezo electric crystal plate having one of its surfaces establish surface connection with said electrode, a second electrode establishing connection with the other surface of said piezo electric crystal plate, a retaining ring of insulation material engaging said last mentioned electrode and a confining connection between the peripheral edge of said shell-like container and said retaining ring.

3. A piezo electric crystal unit assembly comprising a shell-like metallic container, a relatively flat strip-like spring member disposed against the end wall of said shell-like container, an electrode supported by said strip-like spring member, a piezo electric plate, a land formed on said electrode for establishing surface connection adjacent opposite corners of said piezo electric crystal plate, a second electrode, a land formed on said second electrode and establishing connection with the opposite surface of said piezo electric plate adjacent the corners thereof, a retaining ring embracing said second electrode and centering said electrode within said shell-like container and a binding connection between said retaining ring and the peripheral edge of said shell-like container.

4. A piezo electric crystal unit assembly comprising a pair of parallel extending electrodes each being recessed centrally of the face thereof providing peripheral lands thereon, a piezo electric crystal plate mounted between the lands of said electrodes and free to vibrate in the recesses provided in said electrodes, a shell-like metallic casing, means for yieldably supporting one of said electrodes with respect to the interior end wall of said shell-like metallic casing, a retaining ring of insulation material peripherally embracing the other of said electrodes and a peripheral connection between said retaining ring and the opposite end of said shell-like container.

5. A piezo electric crystal unit assembly comprising a pair of parallel extending electrodes each being recessed centrally of the face thereof providing peripheral lands thereon, a piezo electric crytsal plate mounted between the lands of said electrodes and free to vibrate in the recesses provided in said electrodes, a shell-like metallic casing, a strip-like spring member disposed in substantially co-planar relation to the interior end wall of said container and one of said electrodes, said strip-like spring member being sinusoidally shaped with the opposite alternate faces contacting the internal end wall of said shell-like container and said first mentioned electrode for resiliently spacing said electrode from the interior end wall of said container, a retaining ring of insulation material peripherally embracing the other of said electrodes and a peripheral connection between said retaining ring and the opposite end of said shell-like container.

6. A piezo electric crystal apparatus comprising in combination a bracket member having a pair of arms with laterally disposed abutments thereon, a disc-like piezo crystal unit assembly engageable by said arms, said assembly including a metallic shell-like container closed at one end and open at the other end, an electrode member supported in insulated relation thereto and accessible through the open end of said shell-like container, said arms being shaped to conform

with the contour of said disc-like piezo crystal unit assembly and establish electrical connection with the shell thereof and engaging the same and a resilient arm supported in insulated relation to said bracket member and establishing both electrical and mechanical connection with one of the electrodes of said piezo electric crystal unit assembly.

7. A piezo electric crystal apparatus, comprising in combination a bracket member having a pair of arms with laterally disposed abutments thereon, a piezo electric crystal unit assembly included within a metallic shell-like container closed at one end and open at the other end, electrode members and a piezo electric plate arranged within said container, one of said electrode members being supported in insulated relation to said shell-like container and accessible through the open end of said shell-like container, said arms being shaped to conform with the contour of said piezo electric crystal unit assembly and engaging the same, and a third arm insulatingly mounted with respect to said pair of arms and projectible through the open end of said metallic shell-like container for establishing mechanical and electrical connection with the electrode accessible through the open end of said metallic shell-like container and maintaining said piezo electric crystal unit assembly in detachable engagement with the laterally disposed abutments on said pair of arms.

8. A piezo electric crystal apparatus, comprising in combination a bracket member having a pair of arms with laterally disposed abutments thereon, a third arm insulatingly supported with respect to said bracket member intermediate said pair of arms and resiliently tensioned in the direction of said pair of arms, a piezo electric crystal unit assembly including a metallic shell-like container closed at one end and open at the other end, a piezo electric plate and electrode assembly disposed within said container, one of the electrodes of the electrode assembly being insulatingly supported with respect to said container and accessible through the open end of said container, said piezo electric crystal unit assembly being detachably engaged against the laterally disposed abutments of said pair of arms with said third arm projecting through the open end of said container and establishing detachable electrical and mechanical connection with the electrode accessible through the open end of said container.

9. A piezo electric crystal apparatus, comprising in combination a supporting member having a pair of arms with laterally disposed abutments thereon extending in a common plane, a third arm insulatingly mounted on said supporting member intermediate said pair of arms and terminating in a contact device, said third arm being tensioned for normally urging said contact device toward the plane of the laterally disposed abutments on said pair of arms and a piezo electric crystal unit assembly comprising a metallic shell-like container closed at one end and open at the other end, a pair of electrodes, a piezo electric plate disposed between said electrodes, one of said electrodes being resiliently supported with respect to the closed end of said metallic shell-like container and the other of said electrodes being accessible through the open end of said shell-like container, said piezo electric crystal unit assembly being detachably engaged against the laterally disposed abutments of said pair of arms when the contact device on said third arm is resiliently engageable against the other electrode through the open end of said metallic shell-like container.

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