

Oct. 22, 1940.

A. W. ZIEGLER

2,218,735

PIEZOELECTRIC PLATE HOLDER

Filed March 10, 1939

2 Sheets-Sheet 1

FIG. 1

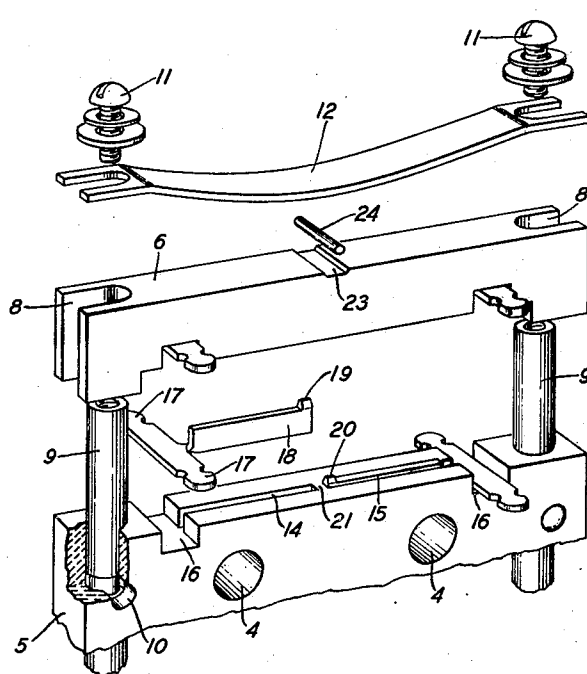
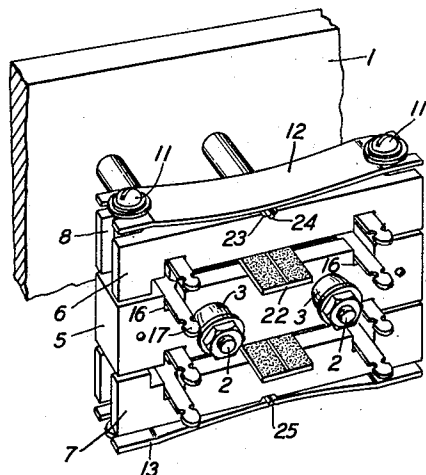


FIG. 2

INVENTOR  
BY A. W. ZIEGLER

*E. V. Snigge*

ATTORNEY

Oct. 22, 1940.

A. W. ZIEGLER

2,218,735

PIEZOELECTRIC PLATE HOLDER

Filed March 10, 1939

2 Sheets-Sheet 2

FIG. 3

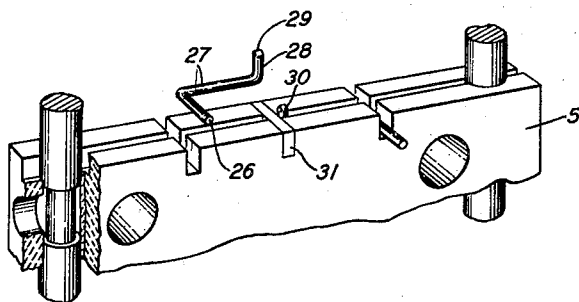


FIG. 4

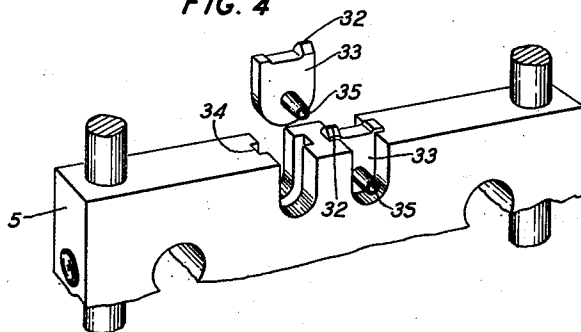
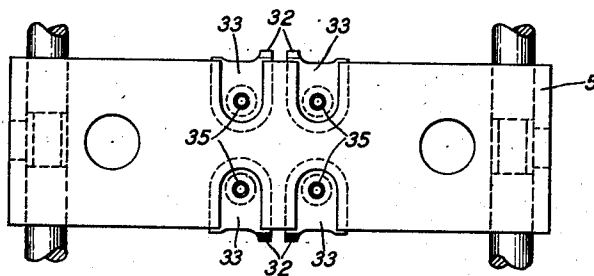


FIG. 5



INVENTOR  
BY A. W. ZIEGLER  
E. V. Briggs  
ATTORNEY

## UNITED STATES PATENT OFFICE

2,218,735

## PIEZOELECTRIC PLATE HOLDER

Arthur W. Ziegler, Short Hills, N. J., assignor to  
Bell Telephone Laboratories, Incorporated, New  
York, N. Y., a corporation of New York

Application March 10, 1939, Serial No. 260,887

9 Claims. (Cl. 171—327)

This invention relates to holders and mountings for piezoelectric plates and more particularly to holders for such plates of the type having divided conductive electrode coatings.

In electric wave filters it is frequently desirable to employ piezoelectric reactances in circuits requiring two equal magnitude reactances. An expedient which has proved most convenient from the standpoints of structural and circuit design involves division of the coating of a single-coated crystal plate in such manner that the individual portions may serve as identically equal but electrically separate piezoelectric elements. It is frequently convenient to provide electrical connections to such coated crystal plates through the devices herein termed "anvils" which mechanically engage the plates to hold them in position. Since a divided coating requires an electrical contact for each portion of the coating it is essential to employ at least four anvils which may conveniently be provided as two pairs of anvils, each pair having two members contacting respectively with opposite sides of the plate and preferably directly aligned with each other. If one pair of anvils exerts a greater pressure than the other, there may be a tendency for warping of the plate with a consequent increase of its damping factor.

An object of the invention is to equalize the pressures exerted by different pairs of anvils gripping the same piezoelectric plate.

Another object of the invention is to enable the parts of a piezoelectric plate holder having a plurality of pairs of anvils to adjust themselves so as to permit the anvils to make uniform contact with the piezoelectric plate.

A further object of the invention is to provide a holder in which a plurality of divided coating piezoelectric plates may be firmly held and in which they may be readily inserted or replaced.

A further object is to provide a holder in which the anvil pairs are so located with respect to the alignment axes of the holder that these anvil pairs with their associated structures are interchangeable.

An additional object of the invention is to provide a multiple plate holder for piezoelectric crystals which will permit electrical circuit connections to be readily made and in which the leakage resistance is so high as not to impair the performance of electric wave filters of which the piezoelectric crystals are elements.

In accordance with the invention, the holder for a plurality of divided coating piezoelectric plates may comprise a plurality of vitreous bars

lying side by side and held together at the ends by rods or bolts fastened thereto. The contiguous sides of the bars have recesses in which are seated members which carry projecting anvils to grip the piezoelectric plates firmly. The extreme outer surfaces of the vitreous bars are each provided with one narrow transverse slot centrally located. In each of these slots a small roller is positioned to serve as a bearing for a leaf spring which operates to press the bars toward engagement with each other.

In the drawings,

Fig. 1 shows a piezoelectric plate holder for two divided coating plates mounting on a panel;

Fig. 2 is a view of a portion of the holder of Fig. 1 disassembled to illustrate the details of its construction;

Figs. 3 and 4 illustrate alternative forms of anvil and anvil supports; and

Fig. 5 shows the central portion of a holder employing the type of anvil illustrated in Fig. 4.

Referring to Fig. 1, a panel 1 is provided with laterally extending rods 2 carrying tubular bushings 3 of long-life rubber which pass through holes 4 in a central vitreous bar 5 to support it resiliently substantially in the manner of the structure of Fig. 10 of U. S. Patent 2,128,420, issued August 30, 1938, to W. G. Laskey. The rods 2 may, if desired, be anchored in the cover of a hermetically sealed container, as in the case of rods 26 of Fig. 1 of U. S. Patent 2,124,596, issued July 26, 1938, to R. A. Sykes. In that event, element 1 of Fig. 1 of the present disclosure may represent the portion of the container cover. Parallel to the central bar 5 are two outer bars 6, 7, also of vitreous material, and each slotted at its ends as indicated at 8 to receive a retaining bolt or aligning rod 9 which is held fixed in position in central bar 5 by a suitable material such as Bakelite cement introduced through a lateral aperture 10 opposite a reduced portion of the bolt. Screws 11 passing through the open slotted ends of springs 12 and 13 into ends of bolt 9 serve to hold the entire assemblage together. Each of the bars 5, 6 and 7 is provided with longitudinal recesses 14 and 15 terminating in lateral apertures 16. A flat strip of nickel-silver preferably annealed to be as soft as possible is stamped to form integral terminal tabs 17 and a central anvil support 18 which carries at one end the pyramidal or tapered anvil 19. Portions 17 and 18 are bent at right angles to each other to permit the tabs 17 to extend from lateral apertures 16. After the annealing which follows the forming processes the central portion 18 is seated

in recess 14 and may be cemented therein by any suitable insulating cement such as Bakelite. A similar anvil support carrying anvil 20 is seated from each other by a dam 21 integral with the vitreous bar 5 to prevent formation of a leakage path by the Bakelite cement between the two anvils 19 and 20. After their supports are cemented in the recesses 14 and 15 the anvils 19 and 20 are carefully machined to present coplanar contact and gripping surfaces to the piezoelectric plate. Moreover, care is taken during the machining operation to insure that the anvil contact surfaces be perpendicular and symmetrical with respect to a plane passing through the centers of the aligning rods and parallel to the adjoining surface of the bar 5 so that corresponding parts of the holder may be interchangeable. Outer vitreous bar 6 is provided with similarly formed and mounted anvils respectively opposite anvils 19 and 20. As an additional precaution to insure interchangeability of the bars 6 and 7 the contact surfaces of their anvils are each formed so as to have their central longitudinal axes in the plane passing through the center of the slots 8 and perpendicular to the anvil contact surfaces. Between the four anvils a piezoelectric plate 22 is held with its coating divided as shown in Fig. 1; one part of the coating in engagement with anvil 19 and its cooperating anvil, the other with anvil 20 and its cooperating anvil. In like manner, a second piezoelectric plate is held firmly between the four cooperating anvils of bars 5 and 7.

In the center portion of the outer surface of bar 6 a shallow centering slot or rollway 23 provides a seat for a hard drill rod roller 24 against which the flat leaf spring 12 of phosphor-bronze or other suitable material bears. A similar roller bearing 25 is provided for spring 13. It will be apparent that the vitreous bars 5, 6 and 7 are maintained in alignment by the guide bolt 9, to insure alignment of the oppositely positioned anvils. Bars 6 and 7 are constrained by the flat springs 12 and 13 to remain in position generally parallel to bar 5. Any tendency toward unequal pressures at the surfaces of the anvils 19 and 20 will be relieved by a rocking motion of the bar 6 about its roller bearing 24. To reduce any possibility of sliding friction the seats of the rollway 23 may be carefully ground to provide a smooth surface and the surface may thereafter be coated with graphite and lacquer or other friction reducing material. The rollway is an especially important feature in the equalization of the anvil pressures as it is wide enough to permit an actual rolling of the roller which thus prevents development of local high pressure regions on the surface of the piezoelectric plate. Any tendencies toward inequality in pressure are relieved and the plane of the faces of the anvils on one side of the piezoelectric plate is permitted to become parallel to that of the faces of the anvils on the opposite side. The rocking motion of the bar 6 requires movement of its ends. Consequently, the guide bolt 9 preferably consists of polished brass with a coating of a friction reducing material, such as chromium. The openings of the slots 8 in the ends of the vitreous bars 6 and 7 are made smooth and held within close tolerance by grinding. After grinding the slots may be made smoother by coating them with lacquer and graphite. This precludes any frictional resistance to adjustment of the position of bars 6 and 7 about their fulcrums 24 and 25.

Fig. 3 illustrates the central vitreous bar 5 of a modified type of holder for piezoelectric plates in which a portion of a wire nickel-silver or hard drawn silver is bent to form a terminal 26, an anvil carrying portion 27, and an anvil projection 28. After the device is cemented in its slot, the anvil 28 is carefully machined to provide a pyramidal portion with a flat contacting surface as shown at 29. An adjacent anvil 30 is similarly cemented in position in its slot at a slight distance from anvil 28. To prevent any possibility of leakage as a consequence of the cement employed to hold the anvil support a cross-slot is provided with a tightly fitting dam 31 to bar passage of the cement between the anvils along the longitudinal slot.

Figs. 4 and 5 show details of a modification in which the anvils 32 are formed as projections on small flat metallic inserts 33 punched from brass or other sheet material and adapted to seat in U-shaped slots 34 in the vitreous bars. A tubular elongated brass eyelet 35 is pressed through a circular opening in insert 33 to constitute a laterally projecting terminal to which electrical connections may be made. The inserts are cemented in position and the plate contacting faces of the anvils are then carefully ground to insure parallelism as in the devices of the previous figures. In other respects the structure is similar to that of Figs. 1 and 2.

It will be noted that these constructions are compact and nevertheless are able to accommodate wide piezoelectric plates. Regardless of the thickness of the piezoelectric element the areas of the contact faces of the anvils engaging the plates are equal and the cooperating juxtaposed members of each pair are aligned in the direction in which pressure is exerted. A minimum of metal is employed to support the anvils and hence the distributed electrical capacitance of the holder is maintained at a low magnitude. This is a very important feature at high frequencies.

What is claimed is:

1. A piezoelectric plate holder comprising a pair of bars each provided with two plate-engaging holding anvils, means for holding the bars in alignment with their anvils respectively opposite each other to clamp a plate therebetween, one of the bars having a wide flat bottomed recess on the side opposite its anvils, a bearing seated in and narrower than the recess to move therein and a spring mechanically connected to the bar holding means pressing upon the bearing to equalize the pressure on the four anvils.

2. A piezoelectric plate holder comprising a pair of bars between which a piezoelectric plate may be clamped, at least one of the bars having slots, aligning means passing through the slots and connected to the other bar, the surfaces of the walls of the slots being ground smooth and the co-acting surfaces of the aligning means being plated with friction reducing material whereby the bars may adjust their relative positions with minimum opposition from the aligning means.

3. A piezoelectric plate holding device comprising a plurality of bars of insulating material, means for holding the bars aligned adjacent each other, each bar having plate holding devices on its side adjacent the other bar for holding a piezoelectric plate, a spring mechanically connected to the bar aligning means and disposed to exert pressure upon the bars to cause the plate holding device to grip a plate, a roller type bearing member upon which the spring pressure member is

exerted and a recess in one of the bars within which the bearing member seats, the recess being sufficiently wide to permit the bearing member to change its position with small frictional opposition whereby the alignment of the bars is not disturbed by the spring pressure.

4. A piezoelectric crystal holder comprising a plurality of vitreous members having slotted sides, metallic strips seated in the walls of the vitreous members and each having a tab projecting at one end to enable an electrical connection thereto to be made, a holding and electrical contact point projecting outward from each strip and means for holding the vitreous members in alignment so that their respective holding and contact points are opposite each other and are pressed resiliently toward each other to firmly hold a piezoelectric plate which may be interposed between them.

5. A piezoelectric holder comprising a plurality of elongated vitreous members, metallic gripping and electric contact-making means carried thereby, the members having apertures through which rods extend to hold the members and their gripping means in alignment, a spring connected with the rods and disposed to exert pressure against one of the members to press the members resiliently together and a bearing element interposed between the spring and the adjacent vitreous member, the vitreous member against which the spring presses having a recessed seat in which the bearing element rests, the seat having a flat bottom portion considerably wider than the bearing element to permit the member to freely adjust its position with respect to the spring.

6. A multielement piezoelectric device comprising a piezoelectric plate having its two principal parallel faces each provided with a plurality of electrically conducting coatings insulated from each other whereby a number of pairs of juxtaposed electrodes are formed, each pair having one electrode coating on each face of the plate, supporting means comprising a plurality of structural elements held in alignment with each other, electrical contact and gripping points mounted on the elements at positions such that

each electrode is in contact with an individual point, means for resiliently pressing the juxtaposed points toward each other and means for so dividing the total pressure exerted on the plate by the points as to assure that the pressures exerted by each pair are substantially equal.

7. A piezoelectric holder comprising a plurality of bars of insulating material each having a slotted side, metallic strips seated in each slot, each strip having a tab projecting at one end for electrical connection and having an integral holding anvil projecting outward from the slot to clamp a piezoelectric plate, the holding anvils comprising tapered portions with flat contacting surfaces at their tips, means for holding the bars of insulating material with their slots adjacent each other in such position as to maintain the contacting surfaces in alignment and means to press the bars resiliently toward each other to cause the anvils to firmly hold an interposed piezoelectric plate.

8. A holder for a piezoelectric plate comprising two bars of insulating material each provided with a plate-engaging holding anvil, the anvils having contact surfaces for engaging a piezoelectric plate which are carefully machined to present parallel plane surfaces when the bars are aligned, means for holding the bars in alignment with their respective anvil contact surfaces opposite each other and means limiting the motion of the bars toward each other to prevent engagement of the anvil contact surfaces with each other.

9. A piezoelectric crystal holder comprising a pair of bars of insulating material, each having a longitudinal slot in one side, two metallic strips seated in the slot each having a holding and electrical contact point formed integral with the strip and projecting outward from the slot beyond the adjacent surface of the side of the bar, the slot and strips each being sufficiently long to permit forming the holding and contact point at such locations along the bar as to enable a desired longitudinal spacing between the contact points to be had.

ARTHUR W. ZIEGLER.