July 17, 1934. J. K. CLAPP ET AL 1,967,184

VIBRATOR APPARATUS

Filed Oct. 29, 1931

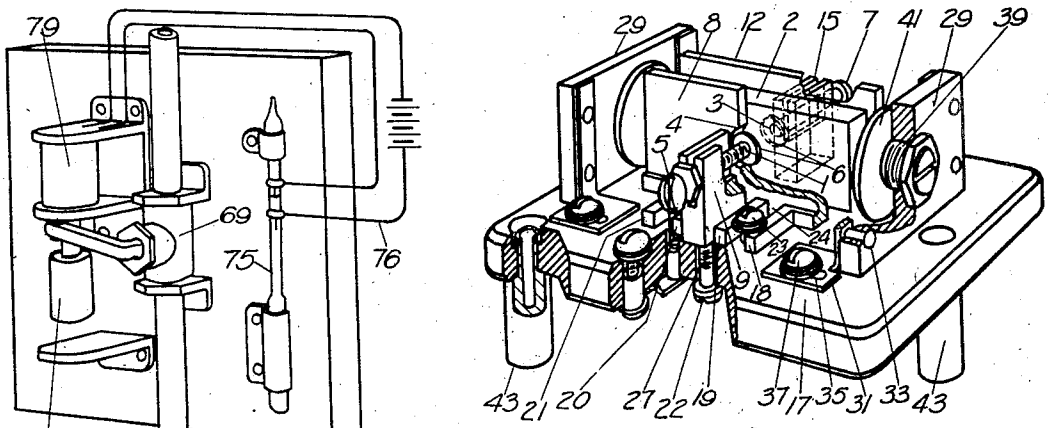

Fig. 2

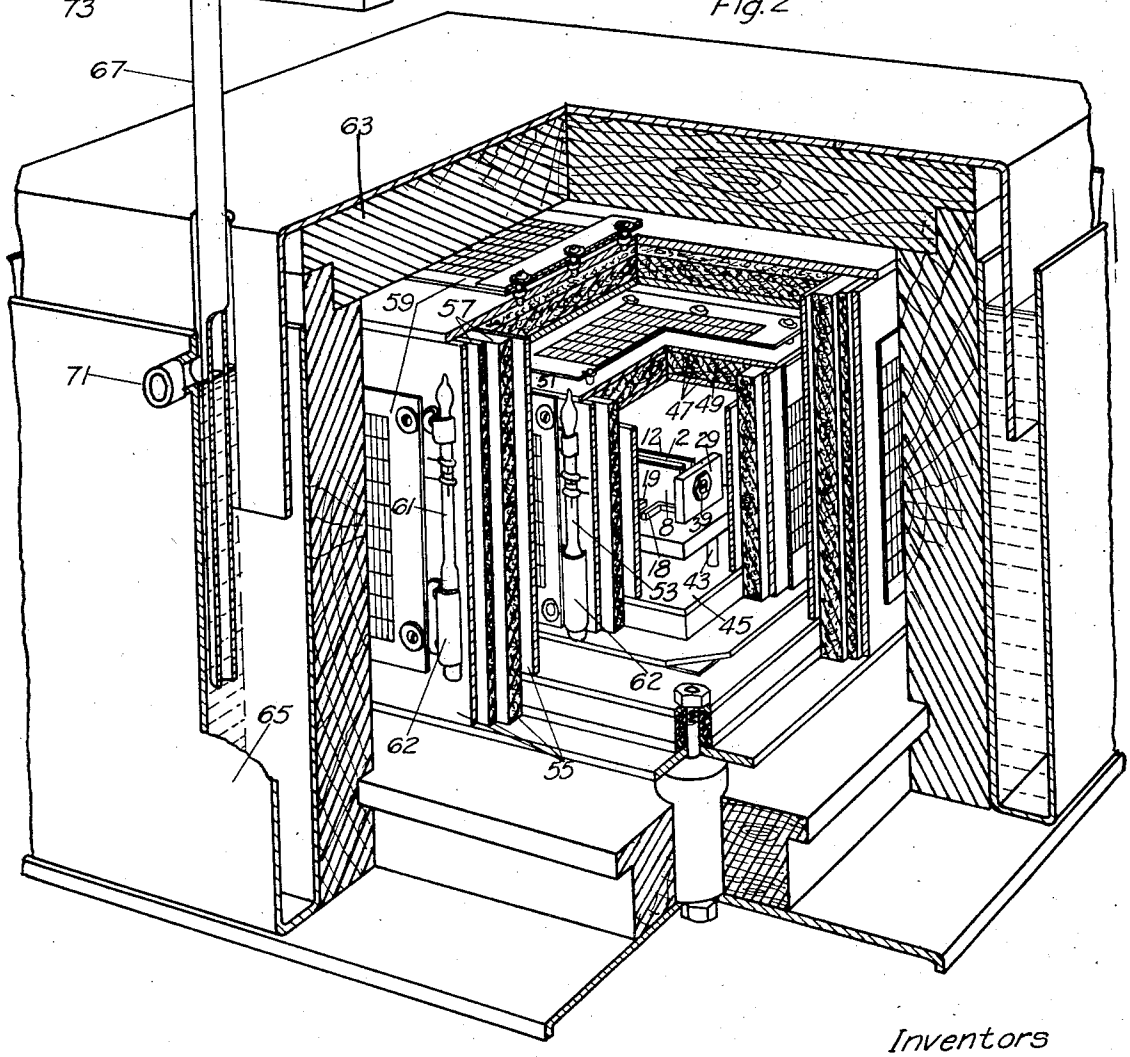

Fig. 1

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Patented July 17, 1934 1,967,184

UNITED STATES PATENT OFFICE

1,967,184

VIBRATOR APPARATUS

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Application October 29, 1931, Serial No. 571,930

12 Claims. (Cl. 171—327)

The present invention relates to electromechanical vibrators, and more particularly to piezo-electric crystals, and to supports and holders therefor.

Piezo-electric crystals, while vibrating, have a tendency to move bodily from side to side between their electrodes. This is undesirable, because tending to cause erratic changes in frequency. Attempts to center the crystal by engagement with its periphery are not wholly satisfactory, because the dimensions of the periphery change periodically with the vibratory expansions and contractions of the crystal. Attempts to clamp the crystal against movement, on the other hand, might interfere with its free vibration.

An object of the invention is to provide a new and improved holding device for an electromechanical vibrator of the above-described character.

Another object is to provide a new and improved holding device that, while positively preventing the vibrator from moving bodily, permits it to vibrate freely.

Even if the crystal were to be held against bodily movement, the friction of its bodily contact with an adjacent surface of relatively large area also tends to introduce frequency changes, and a further object of the invention, therefore, is to obviate such friction, particularly at the vibrating portions of the crystal.

With the above ends in view, a feature of the invention contemplates a new and improved device for holding the vibrator nodally and, in particular, at points along the electric axis of the piezo-electric crystal. The vibrator may thus be held at the said points entirely out of contact with any other points or surfaces. The holding members may be adjustable. The crystal electrodes may be adjustable independently of the holding members.

The vibrations of the crystal are accompanied by air vibrations that, in turn, react upon the crystal after reflection from such objects as the walls of the crystal mounting. It is accordingly a further object of the invention to provide a new and improved baffle-plate mechanism for minimizing the undesirable effects of such air reflections.

Other and further objects will be explained hereinafter and will be particularly pointed out in the appended claims.

The invention will now be explained in connection with the accompanying drawing, in which Fig. 1 is a perspective illustrating a preferred embodiment of the invention, parts being broken away, for clearness; and Fig. 2 is a similar perspective of the crystal holder illustrated in Fig. 1.

A rectangular quartz plate 2 is illustrated in Fig. 2 inserted between parallel conducting electrodes 8 and 12, suitably connected in an electric circuit (not shown). If it rests freely between the electrodes 8 and 12, it has a tendency to slide from side to side during its vibrations; and, if it is clamped carelessly, its vibrations will be interfered with. According to a feature of the present invention, a new and improved construction is provided for holding the crystal plate against bodily movement out of the position in which it is fixed, without interfering with its vibrations.

The electrodes 8 and 12 constitute one arm each of two right-angular members, the other arms of which are disposed in contact with the insulating base 17. The said other arms are each constituted of projections 18, 19, 20 and 21, corresponding projections of the electrodes being alined with each other. In the alined slots thus formed between the projections 19 and 20 are disposed two blocks 9 and 15, adjustably secured to the base 17 in any desired manner, as by screws 22 disposed in elongated slots 27 of the insulating base 17. Screws 5 and 7, threaded in the blocks 9 and 15, extend toward each other through alined openings 4 in the electrodes 8 and 12. The crystal plate 2 is clamped at opposite points 1 and 3 by the ends of the screws along small medial areas corresponding, for example, to nodes of movement; or the points 1 and 3 may be disposed along the electric axis of the crystal where there is likewise small vibratory movement. Being thus supported at the stationary points 1 and 3, and spaced freely from the electrodes, the crystal is free to vibrate, without restriction, according to the desired mode of vibration which may, for example, be along the direction of the longitudinal axis of the crystal plate, that is, along a mechanical axis of the quartz crystal. Indeed, the invention is particularly adapted for use with crystal bars or rods vibrating in the transverse mode at the lowest frequency. It is thus impossible to introduce frequency errors caused either by friction or by changes in position of the crystal with relation to its electrodes.

The degree of nodal pressure may be adjusted by threading the screws in the blocks 9 and 15 so as to hold the crystal with any desired degree of tightness, and yet so as to introduce the least energy loss from the vibrating crystal to its supports. Damping of the vibrating crystal is thus reduced to the minimum. Pads 6 may be inter-

posed between the ends of the screws and the crystal.

Provision is made for adjusting the excitation of the crystal by adjusting the electrodes 8 and 12 towards and from the vibrator along a line parallel to the line joining the points or small areas 1 and 3. To this end, screws 23 are disposed in the slots 24 between the projections 18 and 19 and between the projections 20 and 21, respectively. The screws 23 extend through the alined slots formed between these projections and into the base 17. The adjustment of the electrodes is thus effected without disturbing the supporting screws 5 and 7 or the crystal held thereby.

Supports 29 are disposed on the base 17 near the ends of the crystal and are adapted to be adjusted towards and from the crystal ends by angle plates 31 fixed to the supports 29 at 33 and having elongated openings 35 adapted to receive screws 37 that are threaded into the base 17.

The supports 29 each carries a threaded shaft 39 the end of which supports a baffle plate 41. The baffle plates 41 are disposed parallel and near to the end faces of the crystal, where the amplitude of vibration is greatest, and where the consequent production of air or other gas supersonic waves is correspondingly greatest. The baffle plates 41 may be adjustably threaded on the shafts 39 or, as shown, they may be integral with these threaded shafts. In either case, the baffle plates may be adjusted toward and from, and parallel to, the end faces of the crystal to adjust the air or other gas gaps between the baffle plates and the crystal ends. In practice, the distance between the ends of the crystal and baffle plates will preferably be a quarter wave-length of the radiation in the atmosphere, or an odd multiple thereof.

It is thus rendered possible to adjust the electrodes 8 and 12 toward and from the sides of the crystal, and the baffles 41 towards and from the end faces of the crystal, and all without disturbing the crystal or its independently supported clamping screws 5 and 7. The crystal clamping is wholly independent of the electrode spacing and the electrode adjustment.

The described movements of the baffle plates has the following advantages, among others. It results in reducing the energy radiated in supersonic air waves from the ends of the bar, with consequent important reduction in the effective damping of the bar. A greater frequency stability is obtained from the operation of the bar at the preferred spacings, as the frequency changes caused by supersonic waves reflected from nearby surfaces and impinging on the ends of the bars are eliminated. There is a substantial reduction in the effects of air pressure on the frequency of the bar, since the baffle air gaps remain in suitable adjustment, when once properly fixed, for varying air pressures. There is a substantial reduction in the effects of temperature on the frequency of the oscillator controlled by the vibrator because of the prevention of reaction from surrounding objects through supersonic air waves reflected back from the crystal in varying phase as the wave length of the air waves alters with the temperature. Finally, there is a substantial reduction in the changes in frequency of the said oscillator due to the lowered decrement of the crystal which is the prime frequency controlling element.

It is found, in practice, that this crystal mounting results in an exceedingly high degree of crystal stability.

The insulating base may be provided with legs 43 adapted to rest freely upon a felt layer 45 or the floor of a housing or container 47 which entirely encloses the crystal. If desired, of course, the legs may be firmly fixed to the floor of the housing. The housing 47 may contain also other apparatus, such as the vacuum tubes of the crystal oscillator. The baffles 41, it will be noted, are separate from the housing and may be adjusted independently of the housing. It is thus possible freely to adjust the baffles to fit the requirements of any crystal frequency without regard to any housing in which the crystal and its holder may be contained. The effects on the crystal performance that would otherwise be produced by the reflected supersonic air or other gas waves may thus be wholly eliminated, irrespective of the geometrical shape or size of the housing walls or other surrounding objects. The crystal operates wholly independently of the housing in which it is placed.

The walls 49 of the housing may be of heat-insulating or attenuating material, like asbestos, disposed between layers or walls of heat-distributing material, like aluminum, having a relatively low heat capacity and high conductivity, and may carry heating resistors 51, adapted to be connected into and out of an electric circuit (not shown) by a mercury switch 53.

The housing 47 is disposed in a second or outer housing 55 the walls 57 of which are likewise constituted of one or more layers of heat-insulating material carrying heating resistors 59. The temperature of the second housing is similarly maintained within predetermined limits by a second mercury switch 61.

It will be noted that the thermostatic switches 53 and 61 are disposed outside the spaces the temperatures of which they regulate, though preferably in intimate contact with the aluminum walls of the corresponding housings, preferably in aluminum pockets 62 secured to the aluminum walls.

An outermost housing 63 is provided, also of heat-insulating material, such as balsa wood. The housing 63 is surrounded by a water tank 65 into which water may be supplied by a water pipe 67 through a valve 69. An overflow is shown at 71. A weight 73 normally keeps the valve 69 closed. When the temperature gets high enough, a mercury switch 75 will close a circuit 76 to energize a solenoid coil 79, thereby acting to open the water valve 69. The mercury switch 75 may be set for an air temperature just below that at which the temperature-control unit fails to function,—say, 95° F. The water will naturally be at lower temperature than the air and will thus allow sufficient loss of heat from the unit to permit the thermostatic switches 53 and 61 to effect their contact.

Access to the units may be obtained in any desired way, as by hinging the tops to the side walls of the respective housings, or arranging the tops to be completely removable.

The present application is directed to the oscillator-holder assembly. The temperature-controlled, enclosing structure illustrated herein is covered by a divisional application, Serial No. 615,213, filed June 3, 1932.

It will, of course, be understood that the invention is not restricted to the exact embodiment thereof that is illustrated and described herein, as modifications may be made by persons skilled

in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. Apparatus of the character described comprising a piezo-electric crystal, electrodes for the crystal, means independent of the electrodes for supporting the crystal at two points, and means for adjusting the electrodes along a line parallel to the line joining the points.

2. Apparatus of the character described comprising a piezo-electric crystal, two supports having portions of relatively small area for holding the crystal at two oppositely disposed points, electrodes for the crystal having portions through which the supports extend, and means for adjusting the electrodes without disturbing the supports.

3. Apparatus of the character described comprising a base, two right-angular electrodes having one arm each in contact with the base and the other arms parallel to each other, means for adjusting the electrodes toward and from each other on the base, the first-named arms having alined slots, two blocks carried by the base in the slots, the other arms having alined openings, a rod threaded in each block and extending through one of the openings toward the other rod, and a piezo-electric crystal supported by the ends of the rods.

4. Apparatus of the character described comprising a vibrator, means for suppressing super-sonics including a pair of baffles for the vibrator, and means for adjusting the baffles.

5. Apparatus of the character described comprising a vibrator, means for suppressing super-sonics including a baffle near each end of the vibrator, and means for adjusting the gaps between the vibrator and the baffles.

6. Apparatus of the character described comprising a vibrator, a threaded support, a threaded shaft adjustably threaded in the support, and means for suppressing super-sonics including a baffle for the vibrator mounted on the shaft whereby the baffle may be adjusted by threadedly adjusting the shaft.

7. An electromechanical vibrator comprising a freely vibratory body, means for holding the body against bodily movement out of a predetermined position, and means for suppressing super-sonics including a baffle plate for the vibrator, and means for adjusting the baffle plate.

8. Apparatus of the character described comprising a piezo-electric crystal, electrodes adjacent to the sides of the crystal, means for suppressing super-sonics including baffles adjacent to the ends of the crystal, and means for adjusting the baffles.

9. Apparatus of the character described comprising a piezo-electric crystal, electrodes adjacent to the sides of the crystal, means for suppressing super-sonics including baffles adjacent to the ends of the crystal, and means for holding the crystal out of contact with the electrodes.

10. Apparatus of the character described comprising a housing, a vibrator in the housing, and means for suppressing super-sonics including a pair of baffles for the vibrator in the housing and separate from the housing.

11. Apparatus of the character described comprising a housing, a vibrator in the housing, means for suppressing super-sonics including a pair of baffles for the vibrator in the housing, and means for adjusting the baffles in the housing.

12. Apparatus of the character described comprising a piezo-electric crystal, electrodes for the crystal, two rigid supports independent of the electrodes having portions of relatively small area for holding the crystal at two oppositely disposed nodal points of the crystal, and pads between the crystal and the rigid supports.

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