

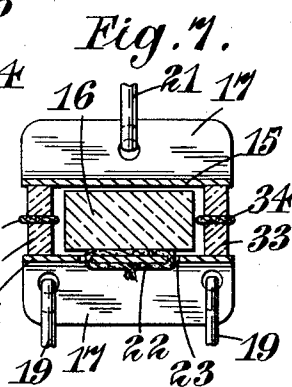
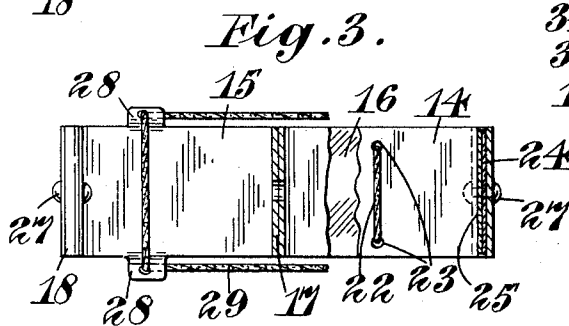
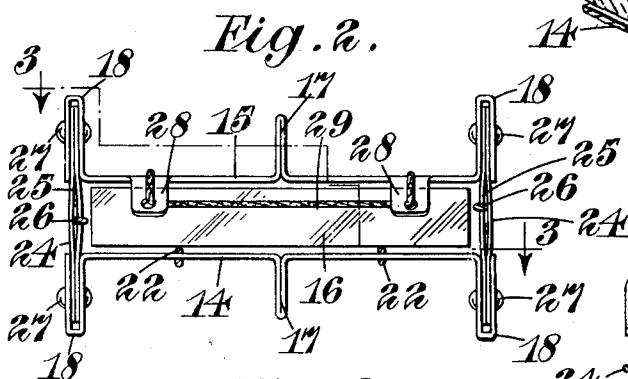
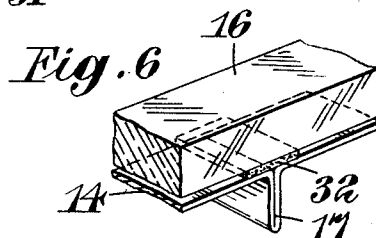
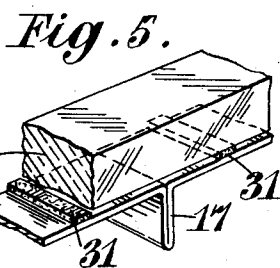
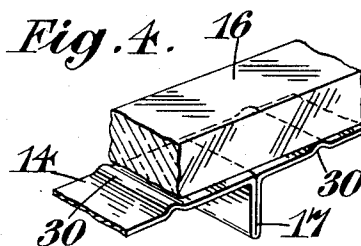
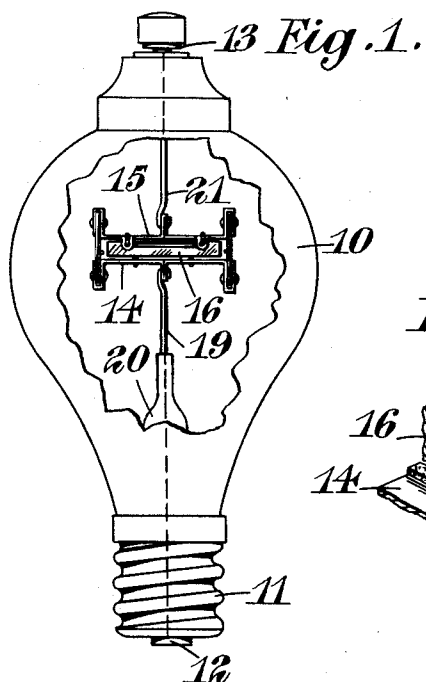
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L. A. LEVY ET AL
PIEZO-ELECTRIC DEVICE

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2 Sheets-Sheet 1



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Fig. 8.

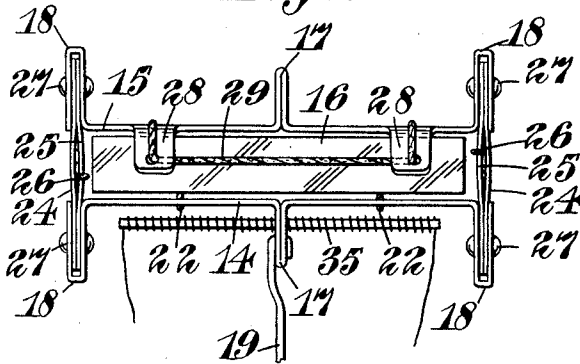
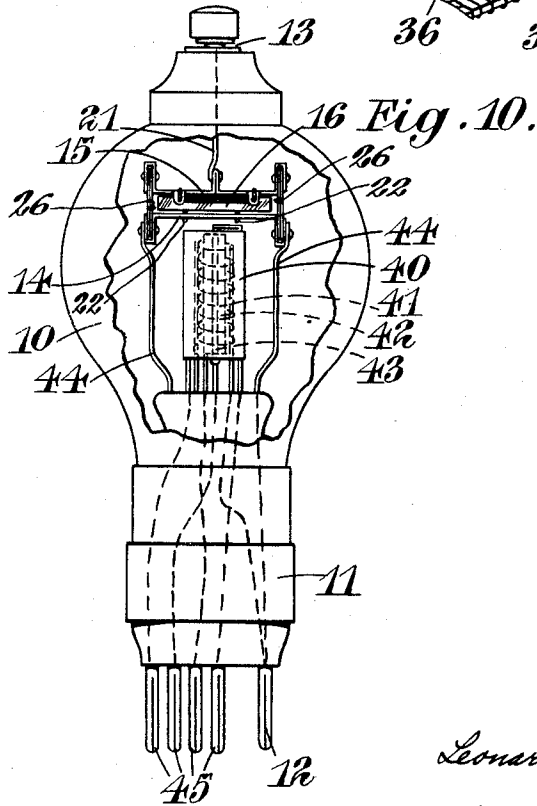
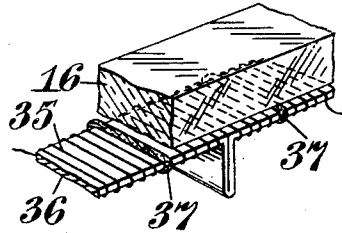


Fig. 9.



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PIEZO-ELECTRIC DEVICE

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and in Great Britain July 26, 1930

11 Claims. (Cl. 171—327)

This invention is for improvements in or relating to piezo-electric devices and is concerned with such devices of the type used in wave signalling systems such as wireless telegraphic and telephonic systems and comprising a quartz crystal arranged between a pair of electrodes.

One general object of the invention is to improve the performance of the quartz piezo-electric device by reducing to a minimum mechanical restraint upon the crystal and at the same time preventing mechanical vibration against the electrodes and accurately retaining the crystal in its proper position between the electrodes.

According to the invention a piezo-electric device of the type described is characterized by the fact that the quartz crystal is mounted freely upon a support or supports of which the area in contact with a surface of the crystal is very small compared with the area of the crystal surface.

In one form of piezo-electric device according to the invention, the crystal support comprises two or more thin filaments, e. g. of metal or silk, upon which filaments the quartz crystal rests. Conveniently the thin filaments may lie upon the surface of one of the electrodes of the device. In an alternative construction one of the electrodes has projections punched-up to form bearing surfaces of small area for the quartz crystal and these punched-up projections may be provided with a layer of soft material, for example a thin coating of rubber or celluloid. Instead of this, one or more resilient soft pads may be provided on an electrode for supporting the quartz crystal.

According to a further feature of the invention, the electrodes may be formed with bent-up lugs to lie along two opposite sides of the crystal, these lugs being faced with a soft material, such as cork, rubber or celluloid.

In one construction, the bent-up lugs are perforated and a cord, for example of asbestos or silk, is threaded through the perforations of the lugs to provide buffers for the quartz crystal. Furthermore opposite edges of the electrodes may be connected by plates (e. g. sheets of mica), and a soft mechanically insulating buffer for the quartz crystal provided on the inner side (e. g. a thread of asbestos or silk looped around the plates).

In a preferred construction of piezo-electric device according to the invention, the quartz crystal and its mounting are enclosed within an evacuated vessel.

These and other subsidiary features of the piezo-electric device according to the invention will now be described with reference to the sev-

eral embodiments shown by way of example in the accompanying drawings in which—

Figure 1 is an elevation of a piezo-electric device mounted in an evacuated glass bulb.

Figure 2 is an enlarged elevation of the quartz crystal and its mounting between the electrodes.

Figure 3 is a section on line 3—3 of Figure 2.

Figures 4, 5 and 6 are detail views of modified supports for the quartz crystal.

Figure 7 is a cross-section of a crystal and its mounting showing modified restraining means for the crystal.

Figure 8 shows a quartz crystal and a mounting therefor as shown in Figure 2 in combination with heating means therefor.

Figure 9 is a detailed view of a modification of the construction shown in Figure 8.

Figure 10 shows an elevation of a quartz crystal and mounting according to the invention, combined with a thermionic valve electrode assembly contained in the single evacuated vessel.

In the drawings, like reference numerals indicate like parts in the several figures.

Referring to the Figures 1, 2 and 3 of the drawings, the piezo-electric crystal and its mounting are contained within an evacuated vessel 10 having a supporting base 11 bearing one electrical contact 12 connecting with one electrode of the piezo-electric device, the other electrode being connected to an exterior terminal 13 at the opposite end of the vessel. By this construction, the stray capacity between the leads to the electrodes of the piezo-electric device is reduced to a minimum.

The piezo-electric device comprises two electrodes, a lower electrode 14 and an upper electrode 15 and the quartz crystal 16 is located between these electrodes. The electrodes 14 and 15 are similarly formed of sheet metal and each has a doubled vertical portion 17 at the centre and vertical U-shaped guides 18 at the ends. The double vertical portions 17 provide means for connecting the supporting wires within the vessel 10, the portion 17 of the lower plate 14 being fixed on one or more wires 19 secured in a glass pinch 20 and connected to the terminal 12, and the portion 17 of the upper electrode 15 being fixed to a wire 21 connected to the terminal 13.

The quartz crystal 16 is supported upon two thin metal wires 22 lying upon the upper surface of the electrode 14 and passing through holes 23 in the electrode and secured on the underside by twisting the ends together. The metal wires 22 are arranged as close together as is possible while

obtaining mechanical stability of the crystal mounted upon them.

At each end of the quartz crystal 16, the U-shaped guides 18 at the corresponding ends of the electrodes provide opposed recesses receiving an end member 24 for limiting the endwise movement of the crystal. The end members each consist of two sheets of mica, 24, 25 secured in the guides by rivets 27 and a thread 26 of asbestos or silk is arranged across the face of the sheet of mica adjacent to the crystal and clamped at its ends between the sheets. The thread 26 of asbestos or silk thus constitutes a soft buffer retaining the quartz crystal in position.

The uppermost electrode 15 is formed with tongues 28 bent to occupy positions along the side of the crystal to limit the sideways movement of the crystal. The tongues 28 are provided on their inner sides with soft buffers for the crystal and as shown in Figures 1 to 3, a cord of silk or asbestos 29 is threaded through apertures in the tongues to provide the soft buffers.

By this construction of support for the quartz electric crystal, the mechanical restraint upon the vibration of the crystal is reduced to an absolute minimum and the electrical selectivity of the device is of a very high order. In particular, the provision of soft resilient buffers for the crystal affords mechanical insulation for the crystal which obviates stray electrical effects due to mechanical vibration of the electrodes and their mounting.

In the modification shown in Figure 4, instead of providing thin filaments 22 upon the upper surface of the electrode 14 for carrying the crystal, this electrode is formed with punched-up projections 30 spaced apart but arranged as close as is possible to obtain mechanical stability of the crystal. In another form of crystal support shown in Figure 5, there is provided two narrow pads 31 of cork, rubber or other soft material spaced apart and mounted upon the upper surface of the electrode 14 and the quartz crystal rests upon these pads. Alternatively, as shown in Figure 6, a single soft pad 32 may be employed for supporting the crystal 16 at its centre.

By providing a soft resilient support of this nature, there is obtained the further advantage of the additional mechanical insulation of the crystal from the electrode 14, thus avoiding to a still further degree any subsidiary piezo-electric effects which may be due to the movement of the crystal or the member supporting it. In order that this further advantage may be obtained in the constructions shown in Figures 1 to 4, filaments of silk or asbestos may be substituted for the metal wires 22 or the wires may be coated with a soft material such as rubber or celluloid. Similarly the projections 30 of the construction shown in Figure 4 may be coated with rubber or celluloid.

In the further modification shown in Figure 7, alternative means for preventing excessive sideways movement of the crystal is shown. In this construction the electrodes 14 and 15 are separated by strips 33 of glass or quartz having a resilient buffer such as a thread 34 of silk or asbestos, engaging the crystal 16. The strips 33 are fixed, for example by means of a cement such as that known under the trade name "Prodrite" to the electrodes 14 and 15 and thus this construction is a particularly robust and permanent one. Moreover the air-gap between the upper electrode 15 and the top of the quartz crystal can

be regulated exactly by the thickness of the strips 33.

It has been found that the sensitivity of the piezo-electric device can in some instances be increased by heating the crystal above ordinary atmospheric temperature. In Figure 8 there is shown a quartz crystal 16 mounted between electrodes 14 and 15 as shown in Figure 1 and beneath the lower electrode 14 there is provided an electric heater 35 which may be electrically connected to additional terminals in the base 11 (Figure 1). The heating device may constitute also one of the electrodes of the piezo-electric device and as shown for example in Figure 9, the heater wire 35 is wound closely upon an insulating strip 36 corresponding to the lower electrode 14 in Figure 2. In this example the quartz crystal is mounted upon two asbestos threads 37 raising the crystal out of contact with the heater.

Since the piezo-electric device according to the invention is largely to be used in conjunction with thermionic valves, it may conveniently be combined with the electrode assembly of a valve and mounted in a single evacuated bulb. Such a construction is shown in Figure 10 in which the piezo-electric crystal 16 and its electrodes 14 and 15 are mounted in a bulb 10 above the electrode assembly comprising in the example shown an anode 40, a grid 41, a cathode 42 and an independent cathode heater 43. The lower electrode 14 is in this case supported upon wires 44 fixed to the ends of the electrode and one of these wires is electrically connected to the terminal 12. The other electrode 15 is connected by means of the wires 21 to the upper terminal 13. The valve electrodes 40 and 42 and the heater 43 are connected in a usual manner to contact pins 45 in the base 11 and the grid electrode 41 is connected to the terminal pin 12 that is also connected to the electrode 14. In this construction the heater 43 in addition to heating the cathode of the valve, also heats the crystal mounted above it.

The quartz crystal employed in the device according to this invention need not be polished since being mounted in an evacuated bulb there is no possibility of dust collecting on it. It is of advantage, however, to polish that part of the crystal that is to bear upon the supporting means, e. g. the filament 22 since in this manner the resistance of the contact to the natural vibration of the crystal is reduced.

It is to be understood that the invention is not restricted to the particular embodiments hereinbefore described with reference to the drawings, and that these constructions may be modified according to the particular application of the device in use.

We claim:

1. A piezo-electric device comprising the combination of a piezo-electric crystal, an electrode on which said crystal is mounted, crystal supporting means on said electrode, said supporting means having an area in contact with the surface of the crystal that is small compared with the area of said crystal surface, a second electrode mounted above and spaced from said crystal, separators bridging the two said electrodes at opposite sides of the crystal, and yielding means on said separators for limiting sideways movement of the crystal.

2. A piezo-electric device comprising the combination of a piezo-electric crystal, an electrode on which said crystal is mounted, crystal supporting means on said electrode, said supporting means having an area in contact with the sur-

face of the crystal that is small compared with the area of said crystal surface, a second electrode mounted above and spaced from said crystal, separators bridging the two said electrodes at opposite sides of the crystal, and a fibrous thread looped around each of said separators and constituting soft buffers for limiting sideways movement of the crystal.

3. A piezo-electric device comprising the combination of a piezo-electric crystal, an electrode on which said crystal is mounted, crystal supporting means on said electrode, said supporting means having an area in contact with the surface of the crystal that is small compared with the area of said crystal surface, a second electrode mounted above and spaced from said crystal, marginal elements forming part of an electrode, said marginal elements overlying opposite sides of the crystal, and yielding means on said marginal elements constituting soft buffers for limiting sideways movement of the crystal.

4. A piezo-electric device comprising the combination of a piezo-electric crystal, an electrode on which said crystal is mounted, crystal supporting means on said electrode, said supporting means having an area in contact with the surface of the crystal that is small compared with the area of said crystal surface, a second electrode mounted above and spaced from said crystal, perforated lugs provided on said second electrode and located at opposite sides of the said crystal, and a fibrous thread passed through the perforations of said lugs to form soft buffers limiting sideways movement of the crystal.

5. A piezo-electric device comprising the combination of a piezo-electric crystal, an electrode on which said crystal is mounted, crystal supporting means on said electrode, said supporting means having an area in contact with the surface of the crystal that is small compared with the area of said crystal surface, a second electrode mounted above and spaced from said crystal, separators bridging the two said electrodes at opposite sides of the crystal and yielding means on said separators, marginal elements provided on said second electrode and overlying two other opposite sides of the crystal, and yielding means on said marginal elements forming soft buffers for limiting sideways movement of the crystal.

6. A piezo-electric device comprising in combination a piezo-electric crystal, an electrode upon which said crystal is supported, said electrode having bearing elements of small area upon which said crystal rests freely, a second electrode mounted above said crystal, insulating strips bridging said electrodes at each of two opposite ends of said crystal, and a soft

thread looped around the inner one of said strips at each end of the crystal for limiting endwise movement thereof.

7. A piezo-electric device comprising the combination of a pair of electrodes, a piezo-electric device mounted between said electrodes, thin wire extending over one of said electrodes and in contact therewith and constituting bearing surface of small area upon which the crystal freely rests.

8. A piezo-electric device comprising the combination of a piezo-electric crystal, an electrode carrying said crystal, a plurality of fine wire strands located on said electrode and constituting bearers of small area upon which the said crystal rests freely, a second electrode mounted above the crystal, and yielding means on opposite sides of said second electrode for limiting sideways movement of the crystal.

9. A piezo-electric device comprising the combination of a piezo-electric crystal, an electrode carrying said crystal, a plurality of fine wire strands located on said electrode and constituting bearers of small area upon which the said crystal rests freely, a second electrode mounted above the crystal, separators bridging said electrodes at two opposite ends of the crystal, yielding means carried by said separators for limiting endwise movement of the crystal, lugs on one of said electrodes overlying opposite sides of the crystal, and yielding means on said lugs for limiting sideways movement of the crystal.

10. A piezo-electric device comprising the combination of a piezo-electric crystal, a supporting means upon which said crystal rests freely, said supporting means having an area in contact with a surface of the crystal that is very small compared with the area of said crystal surface, soft buffers at opposite sides of the crystal for limiting sideways movement thereof, an evacuated bulb enclosing said crystal and supporting means, and heating means in said bulb for raising the temperature of the crystal above atmospheric temperature.

11. A piezo-electric device comprising the combination of an evacuated bulb, a pair of electrodes mounted therein, connecting wires to said electrodes leading out at opposite sides of the said bulb, a piezo-electric crystal mounted between said electrodes, a plurality of supporting elements of small area for the crystal in one of said electrodes, insulating separators bridging the said electrodes at two opposite ends of the crystal, yielding means on said separators for limiting endwise movement of the crystal, and yielding means on opposite sides of said crystal for limiting sideways movement thereof.

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