

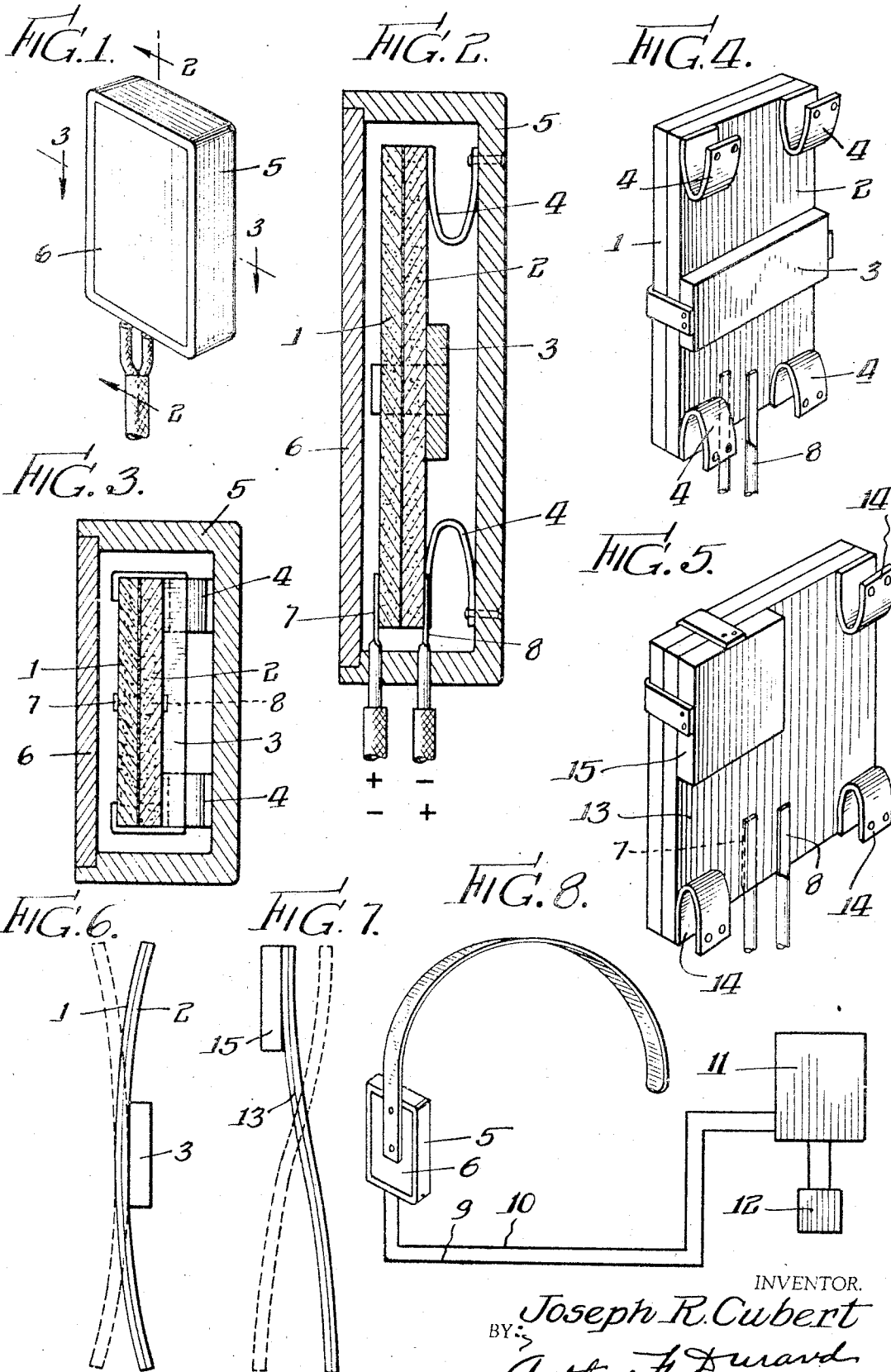
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BONE CONDUCTION HEARING DEVICE

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BONE CONDUCTION HEARING DEVICE

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This invention relates to what are commonly called piezo-electric devices, and more particularly to those that are adapted for use as a hearing aid, by deaf people, by using bone conduction, as by placing the device against the mastoid bone back of the ear.

Generally stated, the object of the invention is to provide a device of this kind in which the crystal, say, of Rochelle salt, is mounted or equipped in a novel and approved manner, thereby to improve the efficiency and effectiveness of the device.

It is also an object to provide certain novel features of construction and combinations tending to increase the general efficiency and desirability of devices of this character.

To the foregoing and other useful ends, the invention consists in matters hereinafter set forth and claimed and shown in the accompanying drawing, in which—

Fig. 1 is a perspective of a hearing aid device embodying the principles of the invention.

Fig. 2 is an enlarged vertical section on line 2-2 in Fig. 1 of the drawing.

Fig. 3 is a transverse horizontal section on line 3-3 in Fig. 1 of the drawing.

Fig. 4 is a perspective of the Rochelle salt crystal employed in said device.

Fig. 5 is a similar perspective view, but showing a different form of the invention.

Fig. 6 is a diagrammatic view illustrating the action of the bender type of crystal shown and employed in Fig. 2.

Fig. 7 is a similar view illustrating the action of the so-called twister type of crystal shown in Fig. 5 of the drawing.

Fig. 8 is a diagrammatic view of the circuits of the apparatus, of which said device is a part.

As thus illustrated, the invention, as shown in Figs. 1 to 4, inclusive, comprises a Rochelle salt crystal composed preferably of two flat sections 1 and 2, held flatwise together in the well known manner. Preferably, this crystal is of less width than length, and has its middle provided with a weight 3, suitably secured thereto. The ends of the crystal have U-shaped springs 4 secured thereto, in any suitable or desired manner, as by cement, and the other ends of these springs are then fastened in any suitable manner to the bottom or back wall 5 of the boxlike housing which encloses the crystal. The top or outer wall 6 may be removable, if desired.

The lower end of the crystal is provided on its opposite surfaces with flat electrode conductors 7 and 8, which are in turn connected with the

wires 9 and 10 leading to a microphone and amplifier 11, of any suitable or desired character, which in turn is connected to the battery 12, of any suitable character, the entire apparatus being made on a small scale, so that it can be carried around by a deaf person, with the bone conduction piezo-electric device on the head, and with the battery and other elements in a coat pocket.

It will be seen that the crystal formed by the flat sections 1 and 2 is of the bender type and that, with its resilient support at its opposite ends, this crystal vibrates at its middle, back and forth, as illustrated in Fig. 6 of the drawing, the weight 3 ensuring the necessary inertia.

As shown in Fig. 5, the crystal 13 is of the so-called twister type, having springs 14 applied to three of its corners, and having a weight 15 applied to the other corner. With this arrangement, the crystal has a twisting action, instead of just a straight bending action, and vibrates in a twisting manner, as illustrated in Fig. 7 of the drawing. The crystal 3 is preferably square, instead of being oblong.

Thus, in each form of the invention, the crystal is, in effect, a floating element, as it is not held stationary at any point thereon, for to the contrary it is free to vibrate or move throughout its entire area, as the result of the resilient support provided. This results in a true and substantially perfect action, so that the vibrations are correct, ensuring proper transmission of the sound, undistorted, to the auditory elements within the head of the user, for very often these inside auditory elements are in normal condition, even though the ear-drum or outside elements have become defective.

Therefore, when an alternating electric current is passed through the crystal, to impose a potential thereon, the vibrations of the crystal are transmitted through the springs to the wall of the box, and through this wall to the bone of the head, and thence to the inside auditory elements.

The characteristics of Rochelle salt crystals are well known and it is quite generally understood that they are distorted when subjected to an alternating electric current, and that they generate the current when subjected to mechanical pressure or distortion. Of course, there are other substances, other than Rochelle salt, that can be used to form the crystal, but in some ways Rochelle salt is preferable.

It will be understood, of course, that these Rochelle salt crystals are sold in the form shown and described with the two sections thereof cemented together, and that the outer flat surfaces

of the opposite sides of the crystal covered with an extremely fine film of metal, and that the electrodes are fastened to the said film of metal. The said metallic film thus found on commercial crystals of this kind is so thin that it cannot be represented by two lines nor even by a very fine line, as it is formed by the thinnest kind of metal foil. It merely puts a metallic surface on the crystal, practically without adding anything to the thickness thereof. This is so well known and understood that it needs no further explanation.

It will be seen, therefore, that in each form of the invention there is something at each corner of the crystal plate that affects the vibration of the crystal, and in each form of the invention there is at least one corner that has such means on only one flat side of the plate, and it is found that this is of advantage in various ways.

It is important to observe that the vibration affecting means at each corner of the crystal plate, in each form of the invention, is unconnected with anything flexible other than the plate itself.

What I claim as my invention is:

1. A piezo-electric bone conduction hearing device having an electric current input and a mechanical vibration output, comprising a crystal plate of rectangular form, and means attached at each of the four corners of the plate, for affecting the vibrations thereof, the means of at least one corner being all on one side of the plate and separate from the means of another corner, and there being at least three corners having practically the same kind of means, in combination with a bone conduction member subject to the vibrations of the crystal and adapted to be placed against the head and forming a support for said crystal, said means comprising spring supports for said three corners, with a weight at the fourth corner.

2. A piezo-electric bone conduction hearing device having an electric current input and a mechanical vibration output, comprising a crystal plate of rectangular form, and means attached at each of the four corners of the plate, for affecting the vibrations thereof, the means of at least one corner being all on one side of the plate and separate from the means of another corner, and there being at least three corners having practically the same kind of means, in combination with a bone conduction member subject to the vibrations of the crystal and adapted to be placed against the head and forming a support for said crystal, the said plate being weighted for vibration.

3. A piezo-electric bone conduction hearing device having an electric current input and a mechanical vibration output, comprising a crystal plate of rectangular form, and means attached at each of the four corners of the plate, for

affecting the vibrations thereof, the means of at least one corner being all on one side of the plate and separate from the means of another corner, and there being at least three corners having practically the same kind of means, in combination with a bone conduction member subject to the vibrations of the crystal and adapted to be placed against the head and forming a support for said crystal, said means comprising a spring support at each of the four corners, and the middle of the plate being weighted for vibration.

4. A piezo-electric bone conduction hearing device having an electric current input and a mechanical vibration output, comprising a crystal plate of rectangular form, and means attached at each of the four corners of the plate, for affecting the vibrations thereof, the means of at least one corner being all on one side of the plate and separate from the means of another corner, and there being at least three corners having practically the same kind of means, in combination with a bone conduction member subject to the vibrations of the crystal and adapted to be placed against the head and forming a support for said crystal, the plate being resiliently supported and weighted for vibration.

5. A structure as specified in claim 4, said plate being a twister with a weight at one corner thereof.

6. A structure as specified in claim 4, said plate being a bender with a supporting spring at each corner thereof and with a weight carried by the middle of the plate.

7. In a piezo-electric device for imparting mechanical vibrations to a load, a vibrator comprising a member of piezo-electric crystal substance, electrode means for impressing electric oscillations on the piezo-electric substance of said member to produce a vibratory motion of said vibrator, and mechanical springs supporting said vibrator in a floating condition and coupling said vibrator to a load to cause transfer of vibratory energy produced by said vibratory motion to said load, said springs being resilient in the direction of the transfer of the energy.

8. A piezo-electric bone conduction hearing device comprising a bone conduction member to be placed against the head, a piezo-electric crystal, electrode means for impressing electric oscillations on a piezo-electric crystal to produce a vibratory motion, and mechanical springs supporting said crystal at opposite edge portions and connected to said bone conduction member for supporting said crystal in a floating condition and coupling said crystal to said bone conduction member to cause transfer of vibratory energy to said member, and a weight attached to said floating crystal.

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