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APPARATUS FOR TRANSFORMING MECHANICAL VIBRATIONS
INTO ELECTRICAL FLUCTUATIONS
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FIG. 1.

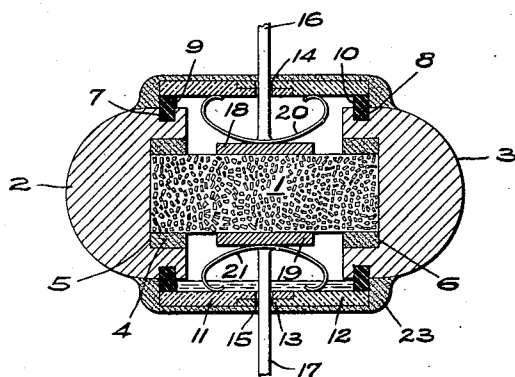
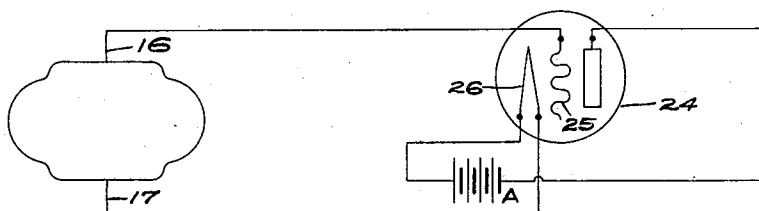


FIG. 2.



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APPARATUS FOR TRANSFORMING MECHANICAL VIBRATIONS INTO ELECTRICAL FLUCTUATIONS

Application filed September 8, 1925. Serial No. 55,202.

My invention relates to apparatus whereby vibratory energy in solids or liquids may be utilized to cause fluctuations in an electric circuit, said fluctuations corresponding accurately to the vibratory excursions of the material.

An object of my invention is to provide apparatus of this character which is responsive to vibrations of relatively low amplitude and in the operation of which forces of relatively high magnitude may be utilized, such as, for example, earth vibrations in connection with geological explorations of the general character described in my co-pending patent applications, Serial No. 15,528, filed March 14, 1925, entitled "Method and means for geological exploration" and Serial No. 55,203, filed September 8, 1925, entitled "Method and means for radiating vibratory mechanical impulses into solids, liquids and the like."

The detection of vibratory impulses, such as sound, when the said impulses occur in air, has been reduced to a state of fairly high efficiency. Vibrations of the same energy content, however, when occurring in solids or liquids, differ from the vibrations in air in a manner which renders the customary air sensitive apparatus incapable of efficient operation for the detection of such vibrations in solids or liquids.

For a given energy content in a sound vibration, the amplitude of excursion of such sound, if occurring in air, will be many times greater than the amplitude of excursion of the same sound if occurring in the solid, on account of the greatly differing densities of the media. Correspondingly, although the amplitude of excursion of a sound in a solid or liquid is smaller than that of a sound of equal energy content in air, the forces which such vibration are capable of exerting are far greater than the corresponding forces of vibration of equal energy in air.

It follows that a sensitive means for detecting vibrations in solids or liquids must be capable of utilizing relatively larger forces, and relatively smaller amplitudes of vibration, than the customary means used

in air. This could obviously be accomplished by the utilization of lever or multiplying means whereby the actual vibration as received from the solid is transformed mechanically into a vibration of much greater amplitude but exerting much less force, and is then applied to any of the customary air sensitive apparatus. However, the employment of such lever or multiplying means always involves losses, and additional vibratory periods in the apparatus itself, tending to destroy its uniform sensitiveness for vibratory incoming energy at various frequencies. The sensitive means embodying my invention has the advantage that it operates more efficiently under the precise conditions existing in solids or liquids when in vibration.

The invention possesses other advantageous features, some of which with the foregoing will be set forth at length in the following description where I shall outline in full that form of the invention which I have selected for illustration in the drawings accompanying and forming part of the present specification. Although I have shown in the drawings but one form of the invention I do not wish to be limited thereto, since the invention as set forth in the claims may be embodied in a plurality of other forms.

Referring to the drawings:

Figure 1 is a sectional view of apparatus embodying my invention; and

Fig. 2 is a diagram illustrating the apparatus connected with a thermionic tube.

In Figure 1 I have shown a bar 1 of material which exhibits the piezo electric effect. Such material may be quartz, tourmaline, or some other natural crystal in which the effect is present, or with greater advantage this bar may be made of Rochelle salts. It is well known that if a slab be sawed out of a crystal of Rochelle salts, along axes with relation to the crystalline axis of the Rochelle salts, a pressure exerted upon this bar between its opposing ends, will result in the liberation of an electric charge on two of its other faces, the axis between these two faces being at right angles to the

direction of pressure applied to the bar. If this pressure is removed, the electric charge disappears. If vibratory pressure is applied, a vibratory electric charge naturally results.

The bar 1 is held at its longitudinal ends between two metal caps 2 and 3, the exterior surfaces of the same preferably being spherical for greater ease in mounting and applying pressure. Preferably, the metal caps 2 and 3 are firmly secured to the bar by a cementing material 4. As shown in the drawing, the caps 2 and 3 are respectively provided with cut-out portions 5 and 6 of larger area than the end surfaces of the bar 1, so that the end faces of the bar may make close contact with the end caps and leave sufficient room in which to apply the cement between the bar and the lateral walls of said cut-out portions. The cementing material may take the form of amalgam, such as is customarily used in dental work, which possesses the required degree of rigidity to transmit vibratory energy without appreciable loss. This layer of amalgam should preferably be introduced between the ends of the crystals and the cap during the mounting process, and the crystal firmly pressed against the layer until the amalgam has solidified in order to maintain perfect mechanical contact throughout the exposed surface of the end of the crystal. The spherical heads or caps 2 and 3 are provided with external grooves 7 and 8 respectively near their inner surfaces, to receive gaskets 9 and 10. These gaskets are preferably of material of low rigidity such as for example a small rubber band. A casing of insulating material comprising two sleeves 11 and 12 is provided for inclosing the crystal bar 1 and other parts. The sleeves 11 and 12 may be made of hard rubber, bakelite, or other suitable material and are provided with a slipping joint as indicated at 13 to facilitate assembly. The sleeves 11 and 12 are provided with two suitable openings 14 and 15 to accommodate conductors or contact bands 16 and 17, which are respectively secured to metal electrodes 18 and 19, and extend out of the casing formed by said sleeves. The electrodes 18 and 19 are in the form of plates whose surfaces respectively are in contact with the surfaces on the crystal bar 1 on which the electric charge is exhibited when pressure is applied on the metal caps 2 and 3. These electrodes 18 and 19 are firmly held against the surfaces of the crystal by springs 20 and 21 respectively, which springs are adapted to exert pressure outwardly against the sleeves 11 and 12 and inwardly against the electrode.

A sealing material 23 of low rigidity, such as celluloid cement, may be used to coat over the exterior of the entire assembly, thereby rendering the same water and vapor tight, without diverting any material part of the

pressure exerted between the end caps 2 and 3 which is preferably to be applied entirely or supplied in a large part to the crystal 1. By this arrangement I maintain an atmosphere within the unit.

By sealing over the entire assembly, a further advantage is made possible, namely, that shellac, in solution in grain or wood alcohol, and as free as possible from water, may be introduced into the casing, and maintained there permanently, thereby providing a surface between the electrode and the crystal which has dielectric capacity, promoting thereby the efficiency with which the electric charge generated on the crystal may be transmitted to external detecting means.

From experiment, I find that the presence of this alcohol, or of other organic liquids of high dielectric constant enhances greatly the sensitiveness and facility of the performance of this crystal. It is possible that this enhancement of sensibility is due to some reaction whereby the sensitizing liquid in question actually enters into the substance of the crystal to some degree producing thereby a new molecular structure which exhibits the electric effects to a greater extent. In actual use, the vibratory force is applied so as alternately to compress and release the crystal between the caps 2 and 3, and electric charges corresponding in direction and magnitude to the compression will be liberated between the conductors 16 and 17 extending from the unit. This charge may be conveyed to operate a thermionic tube 24, as shown in Fig. 2, by creating differences of potential between the grid element 25 and the filament element 26 of said tube in the customary manner, and the electric fluctuations occurring in the circuit of the said tube may be passed on to any suitable detecting or recording apparatus.

I claim:

1. A device of the character described comprising a member exhibiting piezo electric effects, rigid abutments in contact with two opposite ends of said member, said abutments having external spherical surfaces, and electrodes positioned on other surfaces of said members.

2. A device of the character described comprising a member exhibiting piezo electric effects, rigid abutments in contact with two opposite ends of said member having external spherical surfaces, resilient means surrounding the outer surfaces of said abutments adjacent their inner edges, electrodes positioned on opposite surfaces of said member, and an insulated casing surrounding the entire assembly supported on said resilient means.

3. A device of the character described comprising a member exhibiting piezo electric effects, rigid abutments in contact with two opposite ends of said member adapted to receive vibratory energy and transmit same to said member, electrodes in contact with oppo-

site surfaces of said member, and resilient means acting against said electrodes to force the electrodes in firm contact with said member.

5 4. A device of the character described comprising a member exhibiting piezo electric effects, rigid abutments in contact with two
10 opposite ends of said member having external spherical surfaces, electrodes in contact with opposite surfaces of said member, and resilient means acting against said electrodes to force the electrodes in firm contact with said member.

15 5. A piezo electric cell comprising, a crystalline member exhibiting piezo electric effects, and spherical shaped abutments in close physical contact with the ends of said member.

20 6. A piezo electric cell comprising a crystalline member exhibiting piezo electric effects, pressure transmitting abutments adjacent opposite ends of said member, and a metallic amalgam for securing close physical contact between the abutments and said member.

25 7. A piezo electric cell comprising a crystalline member exhibiting piezo electric effects, means for applying mechanical stresses to said crystal, a housing enclosing said crystal, and a sensitizing substance disposed within the housing whereby the piezo electric effects of the crystal are maintained in sensitized condition.

30 8. A piezo electric cell comprising a crystalline member exhibiting piezo electric effects, means for applying mechanical stresses to said crystal, a housing enclosing said crystal, and a volatile sensitizing substance disposed within the housing whereby the piezo electric effects of the crystal are maintained in sensitized condition.

35 9. A piezo electric cell comprising a crystalline member exhibiting piezo electric effects, means for applying mechanical stresses to said member, a housing enclosing said member, and alcohol disposed within said housing for sensitizing said member.

In testimony whereof, I have hereunto set my hand.

50 FRANK RIEBER.