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PIEZO ELECTRIC CRYSTAL

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Fig. 2

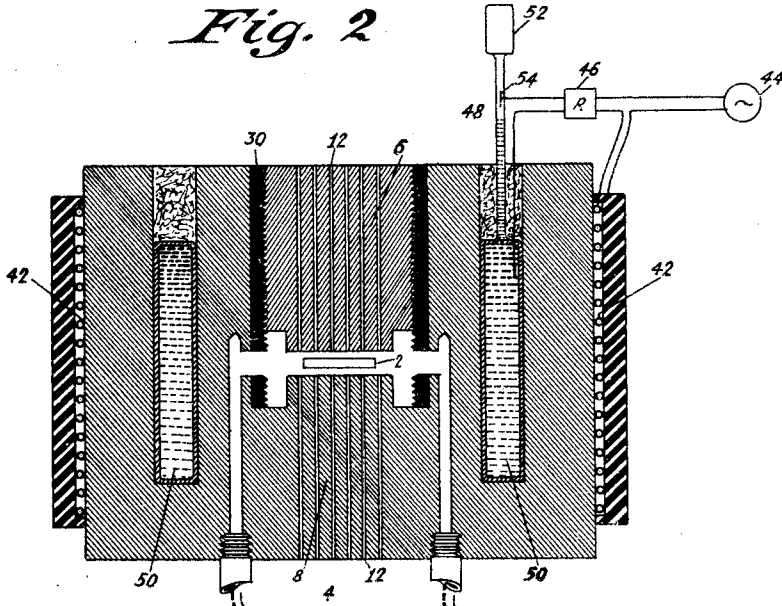
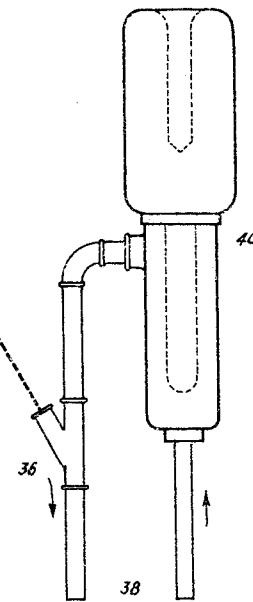
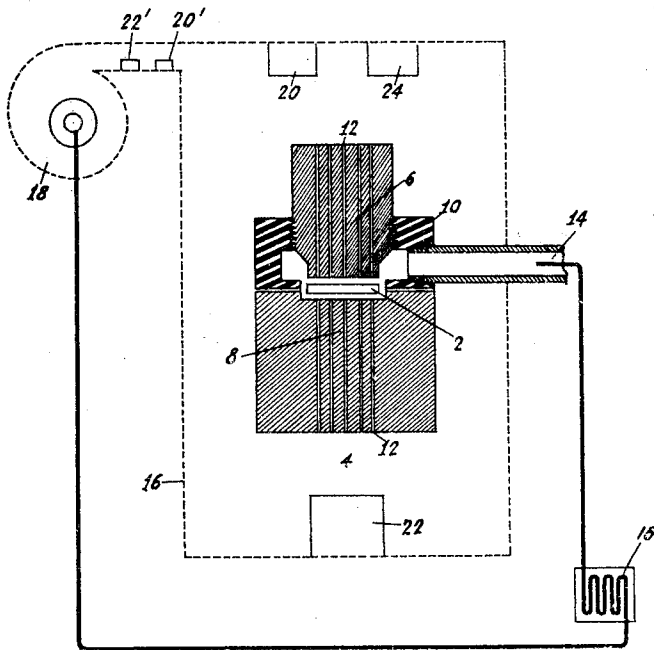


Fig. 1



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PIEZO-ELECTRIC CRYSTAL

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This invention relates to piezo-electric crystals, and more particularly to a method and means for reducing the wear of the crystal as well as controlling the temperature of such crystals.

One difficulty experienced with piezo-electric crystals is the change in resonance frequency caused by the gradual change in thickness resulting from wear of the crystal against its electrodes during vibration. As a practical matter I find that this wear takes place regardless of the quality of the finish of the crystal and the electrodes. It is an object of my invention to reduce such wear, and to this end I keep the crystal from contact with its electrodes by passing a stream of gas between the crystal and the electrodes.

For constant frequency a piezo-electric crystal must be kept at constant temperature, but experience has shown that it is not entirely satisfactory merely to keep the crystal holder, or some larger chamber in which the entire crystal holder is mounted, at a constant temperature, for there is considerable heat insulation between the crystal and the holder, and they do not necessarily remain at the same temperatures, especially owing to the fact that the crystal itself dissipates considerable heat during vibration. A further object of my invention is to provide temperature control of the crystal itself, and this I do by passing a stream of gas around the crystal, and regulating the temperature of the gas. Of course, in practice the same stream of gas may serve for both the reduction of wear and the regulation of the crystal temperature.

The rapid vibration of a crystal against even a gas medium is undesirable, and to reduce this disadvantage is another object of my invention, which I accomplish by moving the aforesaid stream of gas by suction in order to rarify the gas surrounding the crystal. For the sake of economy and simplicity air may be used as the gas circulated around the crystal, but in cases where a closed circulating system is feasible hydrogen or helium may well be used because of the great heat conductivity and the low density of these gases. A further object of my invention is to pro-

vide the desired suction head without resorting to special mechanically driven means. The crystal ordinarily is used for the control of transmitters employing vacuum tubes of sufficient power to be provided with water cooling and a circulating system for the cooling water. I take advantage of this fact by coupling the air circulating system of the crystal to a Y branch in the water circulating system, so that the suction head caused by the flow of cooling water draws the air from around the crystal.

The invention is described more in detail in the following specification, which is accompanied by drawing in which

Figure 1 is one form of my invention; and Figure 2 is a preferred modification.

Referring to Figure 1 there is a crystal 2 which is situated in a crystal holder 4, comprising upper and lower electrodes 6 and 8 respectively. These electrodes are electrically insulated by a suitable insulation portion 10.

The electrodes, it will be seen, are relatively thick, and are pierced by relatively long and constricted air inlet passages 12. To complete the air circuit an air outlet passage 14 is provided, which opens into the crystal chamber between the electrodes.

The entire crystal holder 4 is enclosed within a chamber 16. A blower 18 is provided for increasing the pressure within the chamber, while the conduit 14 leads without the chamber, and, if a gas other than air is employed, it may lead, as shown, to a radiator 15 and thence back to the blower 18. A pressure regulating device 20 is provided for so controlling the blower 18 as to maintain a constant pressure within the chamber. A heating arrangement 22 is provided within the chamber, and responds to a temperature control device 24, in order to maintain the gas in the chamber at a constant temperature. Of course, a suction blower could be used and in such case it would preferably be connected to the outlet pipe 14. Also, a heating device and thermostatic control therefor may be inserted directly in the circulating conduits, as has been indicated by the elements 20' and 22'.

Attention is now directed to Figure 2, in

which there is a crystal 2 situated inside of a crystal holder 4, provided with upper and lower electrodes 6 and 8, electrically insulated by an insulation bushing 30. As before, the electrodes are made massive in thickness, and are pierced by relatively long and constricted air inlet passages 12. Air outlet passages 34 are provided in the body of the crystal holder, which consists essentially of the lower electrode so massively constructed that it encloses the upper electrode.

In this case the air is moved by suction, and the suction is provided by a Y branch 36 inserted in the cooling water circulating system 38 of the water cooled vacuum tube 40, which itself is part of an oscillator, or amplifier, or transmitter, the frequency of which is initially determined by the crystal.

In the arrangement here shown it is possible to obviate the use of a chamber for enclosing the crystal holder, and for this purpose the air inlet passages 12 are made sufficiently long and constricted so that they serve not only the purpose of reducing the pressure in the crystal chamber, but also of insuring that the temperature of the air, when it reaches the crystal chamber, has become substantially that of the electrodes. With such an arrangement the crystal may be kept at a constant temperature by keeping the crystal holder at a constant temperature, and there is no danger of heat insulation between the crystal and the crystal holder spoiling the attempted temperature control.

The crystal holder is heated by a coil of resistance wire indicated in section at 42, and energized from a suitable source of heating current 44 when the relay 46 closes the heating circuit. The relay in turn is actuated in response to an electrical circuit which is itself closed or opened by a thermometer 48. The reservoir of this thermometer consists of a hollow annular ring 50, which is embedded in the body of the crystal holder 4, or the liquid may be directly in contact with the body of the crystal holder, and the latter provided with a thermometer stem. To provide for accidental over heating an overflow bulb 52 is added. When the temperature of the crystal holder rises the mercury in the bulb 50 expands and rises in the tube 48, and, contacting with an electrode 54, actuates the relay 46 to open the heating circuit.

What I claim is:

1. The method of reducing the wear of a piezo-electric crystal which includes keeping the crystal from contact with its electrodes by passing a stream of gas between the crystal and the electrodes.

2. The method of reducing the wear of a piezo-electric crystal which includes passing a stream of gas between the crystal and the electrodes, and moving the stream of gas by suction in order to rarefy the gas surrounding the crystal.

3. The method of reducing the wear of a piezo-electric crystal and governing its temperature which includes keeping the crystal from contact with its electrodes by passing a stream of gas between the crystal and the electrodes, and regulating the temperature of the gas.

4. An arrangement for reducing the wear of a piezo-electric crystal comprising the crystal, a holder, electrodes mounted in said holder and being provided with gas circulating inlet and outlet conduits arranged to direct a stream of gas between the crystal and the electrodes of the crystal holder, a crystal disposed between said electrodes, and suction means coupled to the outlet conduits for moving and rarefying the gas surrounding the crystal.

5. An arrangement for controlling the temperature of a piezo-electric crystal comprising the crystal, a holder, electrodes mounted in said holder and being provided with means for directing a stream of gas against the crystal, a crystal disposed between said electrodes, and means to regulate the temperature of the gas.

6. An arrangement for reducing the wear and controlling the temperature of a piezo-electric crystal comprising a crystal holder, electrodes mounted in said holder and being provided with means to pass a stream of gas between the crystal and the electrodes to prevent the crystal from resting on the electrodes, a crystal disposed between said electrodes and means to control the temperature of the gas.

7. In combination, a crystal holder having electrodes provided with air passages there-through, said holder being provided with other passages opening into the crystal chamber between the electrodes to complete the air circuit, and means for circulating air through the air circuit and a crystal disposed between said electrodes.

8. In combination, a crystal holder having a crystal chamber and electrodes provided with air inlet passages therethrough, air outlet passages opening into the crystal chamber between the electrodes, and means to apply a suction head to the outlet passages in order to cause a stream of rarefied air to flow between the electrodes and the crystal and a crystal disposed between said electrodes.

9. In combination, a crystal holder having relatively thick electrodes pierced by relatively long and constricted air inlet passages, air outlet passages opening into the crystal chamber between the electrodes, a crystal disposed between said electrodes, means for causing air circulation around the crystal from the inlet to the outlet passages, and automatic means for controlling the temperature of the electrodes in order to regulate

the temperature of the air flowing around the crystal.

10. A piezo-electric crystal holder comprising electrodes mounted in said holder, one of said electrodes being removable to permit the insertion and removal of a piezo-electric crystal vibrator in said holder, said electrodes being provided with air passages to permit a flow of air into and out of the said holder, whereby the temperature of the said crystal may be controlled.

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