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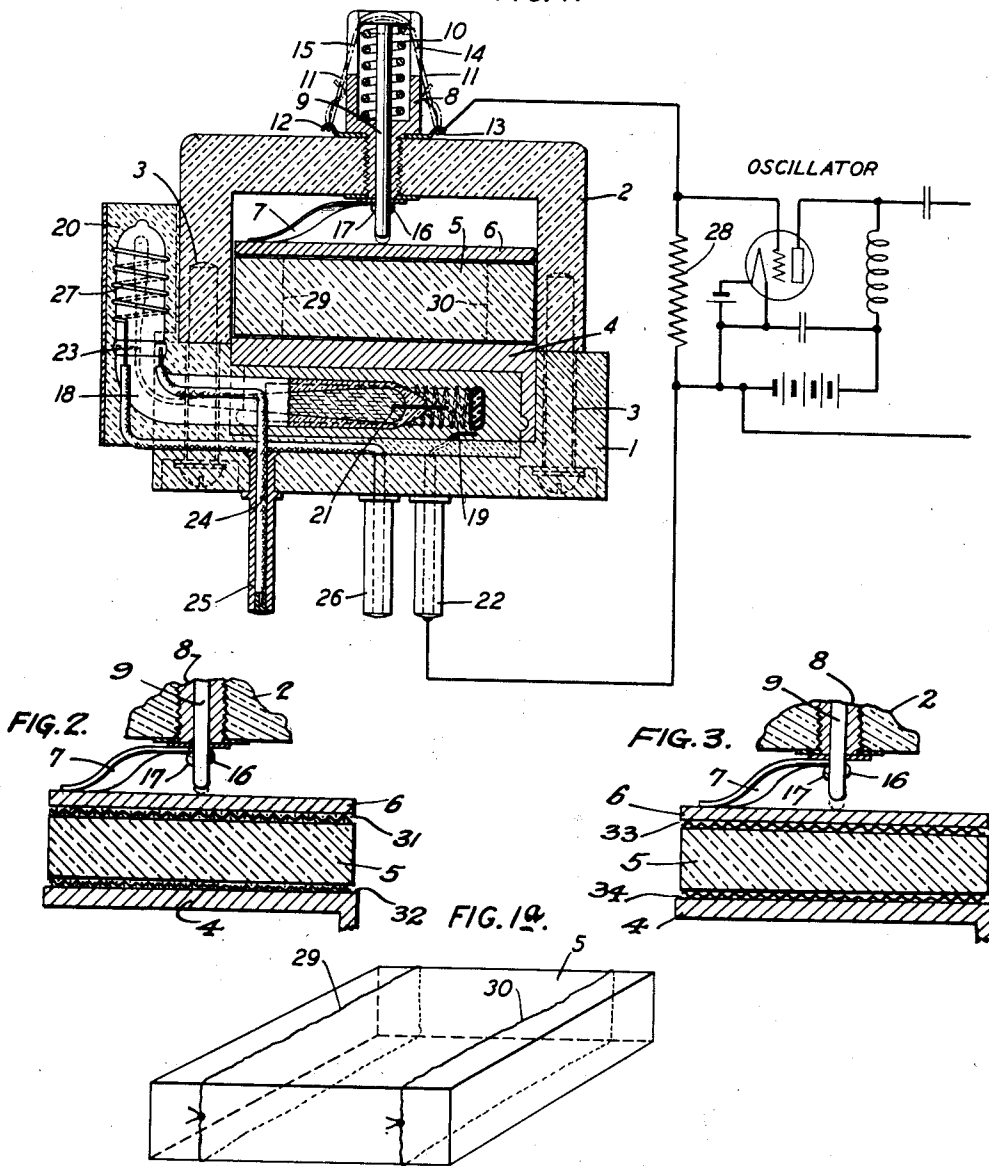
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PIEZO ELECTRIC OSCILLATOR

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FIG. 1.



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PIEZO-ELECTRIC OSCILLATOR

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7 Claims. (Cl. 171—327)

This invention relates to a piezoelectric crystal vibrating element and has for its object the physical control of such an element in its holder in such a manner that it will begin to vibrate more readily when used in an oscillating circuit, and will control more power, than those formerly used.

A feature of the invention is the use of two silk threads or the like arranged to separate a piezoelectric crystal element from its electrodes and to form a cushion for it.

In a specific radio transmitter of 10 watts power output which has been designed in the laboratories of applicant's assignee for use at airports for short distance communication with aircraft, two specific problems were encountered. One was due to the desire to design a transmitter which could be built at minimum cost for this power output. This required that the crystal itself should vibrate with sufficient amplitude to control considerable power, and thereby reduce the number of stages of amplification required. The other problem was due to the frequency at which the crystal was designed to vibrate. The frequencies to be used in the service for which this transmitter is designed are from 230 to 500 kilocycles. It was found that when a crystal was cut with sufficient thickness to enable it to vibrate at these frequencies, there was difficulty in making it start to vibrate immediately when potential was applied to the oscillator. Exhaustive experimentation led to the discovery that if two threads, preferably of silk, were tied loosely around the crystal or otherwise were arranged so that they formed a cushion between the crystal and its electrodes, there was no longer any difficulty about starting, and the power output of the crystal was unusually large. In a life test a crystal was caused to oscillate over 1,500 hours, after which the threads were examined for deterioration. So far as could be determined, the threads were in exactly the same condition as at the start of the test. To determine whether the crystal can be depended on to start vibrating every time the plate voltage is applied to the vacuum tube, a test was made by applying the plate voltage over 10,000 times. The invention was found to be perfectly satisfactory in this respect.

The invention will be more fully understood from the following specification taken with the drawing on which like reference numerals designate elements of similar function and on which:

Fig. 1 is a cross-sectional view of a crystal holder with a crystal in position, tied loosely

with threads according to this invention, and connected in a circuit to form a crystal controlled oscillation generator; and

Fig. 1A is a large view of the crystal and associated threads, which are illustrated in Fig. 1.

Fig. 2 is a partial cross-sectional view of a holder similar to that illustrated in Fig. 1 and containing a crystal, fabric being interposed between the crystal and the electrodes.

Fig. 3 is another partial cross-sectional view of a holder similar to that illustrated in Fig. 1 and containing a crystal, paper being interposed between the crystal and the electrodes.

The crystal holder shown in Fig. 1 is identical in many respects with the crystal holder comprising an inverted cup-shaped bottom electrode, a temperature responsive element embedded in Wood's metal in the cup and a heating element wound around the cup, which holder is disclosed and claimed in Patent 1,921,432, granted August 8, 1933 to Burrell Stallard and the holder having the same design, except that the heating element is embedded in the Wood's metal, which is disclosed and claimed in Patent 1,921,433, granted August 8, 1933 to Ole M. Hovgaard, both patents being assigned to applicant's assignee.

In Fig. 1, a cup-shaped base or mounting member 1, preferably of insulating material, is provided with a cover 2, which is secured to the base by bolts 3. Within said base is an inverted cup 4 which serves as the lower electrode for a piezoelectric crystal 5, preferably of quartz material. An upper electrode 6 is above the crystal. Tied loosely around the crystal are two silk threads 29 and 30. Attached to the upper surface of the upper electrode is a metallic conductor 7 which may be a thin flexible strip of copper. This is attached to a hollow cylindrical metallic member 8 which may serve as a binding post for connection of the upper electrode to the grid of the associated tube. Within the cylindrical member 8 and coaxial therewith is a pin 9 surrounded by a spring 10. A wire 11 may be fastened to hooks 12 and 13 which are fixed to the cover 2, through grooves 14 and 15 in the cylindrical member to compress the spring and put pressure on the upper electrode by the pin, so that the electrode and crystal will not shake about during shipment of the apparatus. Projections 16 and 17 on the pin 9 prevent the pin and spring from coming out of the apparatus after the wire 11 is removed. When the apparatus is put in condition for use, the wire is cut so that the pin may rise

and release the pressure on the upper electrode.

The cup 4 contains a thermostat 18 and a heating coil 19 embedded in a material having a low melting point and good heat conducting properties, such as Wood's metal. The assembly of these elements is accomplished as follows: The cup is placed upright and the thermostat and heating coil are then placed in position, the thermostat protruding through an aperture in the wall of the cup. The aperture surrounding the thermostat is then filled with plastic material such as plaster of Paris, for example, which is allowed to harden, and the cup is filled with molten Wood's metal which is allowed to cool and harden. The cup is then placed in position in the base, the thermostat projecting through an aperture therein. This aperture in the base is then filled with plastic material, which may be the same kind of material as was used before, and the base is ready for assembly with the rest of the structure. A metallic guard 20 surrounds the exposed end of the thermostat and protects it from injury. A contact element 21 in the bottom of the thermostat makes contact with one end of the heating coil. This end of the heating coil is electrically connected with a prong 22 projecting through the base member. The thermostat also has a contact element 23 which is connected by means of a lead 24 to a second prong 25 similarly projecting through the base member. These prongs are provided to facilitate replacement of the holder in case a change of frequency is desired or in case of a breakdown. The lower thermostat contact, the end of the heating coil to which it is connected, and the lower electrode are at a common ground potential so that suitable connections may be made to electrical apparatus to be associated with the device to complete separate circuits through the heating coil, thermostat, and across the electrodes. A third prong 26 may be provided to complete the heater circuit. A heating coil 27 may be wound around the upper end of the thermostat to prevent condensation of mercury on its inner surface. This coil may be in series or parallel with the main heating coil, or in a separate circuit.

The upper and lower electrodes of the crystal are connected across a resistance 28 in the grid circuit of a vacuum tube oscillator which is marked "Oscillator" and is of conventional design, the plate circuit providing an inductive reactance which causes the crystal to oscillate through energy fed back to the crystal through the inter-electrode capacity of the tube.

In a preferred embodiment of the invention the threads used are silk, such as may be pur-

chased in any dry-goods store. However, threads of other material may be used, or thin pieces of woven fabric, or pieces of paper. In Fig. 2, reference numeral 31 designates a piece of fabric which is cushioned between the crystal 5 and the upper electrode 6, and numeral 32 designates a piece of fabric which is included between the crystal 5 and the lower electrode 4. In Fig. 3, numerals 33 and 34 designate pieces of thin corrugated paper which are included between the crystal and the upper and lower electrodes, respectively. The fabric or paper may cover the entire surfaces of the crystal or only a portion thereof, and may be placed loosely in position or affixed to the surfaces of the crystal or to the adjacent electrode surfaces.

The theory of the operation of the invention has not been established. The necessary and sufficient condition seems to be that some resilient spacing means be used between the crystal and its electrodes to overcome the tendency of the crystal to stick to the electrodes. If the threads are tied tightly the results are less favorable than if they are tied loosely.

What is claimed is:

1. A quartz crystal, electrodes therefor, and resilient threads cushioned between said crystal and at least one of said electrodes.
2. A piezoelectrical crystal, electrodes therefor, and silk threads cushioned between said crystal and each of the said electrodes.
3. A piezoelectric crystal, electrodes adjacent thereto and between which the crystal is freely positioned, and resilient fabric interposed between said crystal and each of the said electrodes.
4. A quartz crystal, electrodes adjacent thereto between which the crystal is loosely positioned, and a layer of resilient material interposed between and contacting said crystal and each of the said electrodes.
5. A piezoelectric crystal holder comprising in combination a pair of electrodes, a piezoelectric crystal interposed between said electrodes, and a plurality of silk threads attached to and surrounding said piezoelectric crystal and arranged to contact at least one electrode.
6. A piezoelectric crystal, a plurality of electrodes, one of which supports said crystal and another of which is supported only thereby, and thin material included between said crystal and at least one of the said electrodes.
7. A quartz crystal, electrodes therefor, between which the crystal is freely positioned, and resilient paper interposed between said crystal and each of the electrodes.

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