July 26, 1932. W. A. MARRISON 1,869,160

PIEZO ELECTRIC RESONATOR

Filed May 11, 1928

Fig. 1.

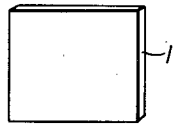


Fig. 2.

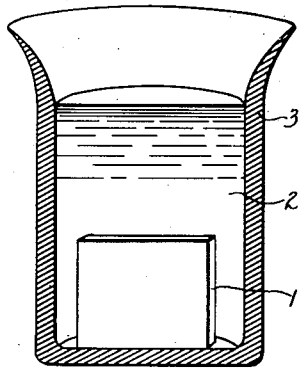
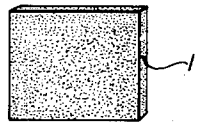


Fig. 3.



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UNITED STATES PATENT OFFICE

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PIEZO-ELECTRIC RESONATOR

Application filed May 11, 1928. Serial No. 277,017.

This invention relates to piezo-electric crystal resonators and more particularly to a method of adjusting them to operate at a desired frequency.

An object of the invention is to secure a very high degree of precision in the adjustment of piezo-electric crystals, so that they will oscillate at a desired frequency.

Another object is to produce crystals having uniform contact surfaces, thereby avoiding irregularities in their activity and in the frequency at which they will oscillate.

A further object of the invention is to provide means for facilitating the selection of good resonators.

At present, piezo-electric resonators such as quartz resonators, for example, are adjusted for frequency by lapping, i. e., by slowly grinding one surface of the resonator with a fine abrasive. In the use of this method abrupt variations in the surface of the crystal frequently occur. These variations affect its activity and the frequency at which it oscillates.

In accordance with the present invention a chemical solvent, for example, hydrofluoric acid, is used to dissolve material from the surface of a crystal to produce an etched surface which is free from irregularities. Commercial hydrofluoric acid may be used and the length of exposure depends on the change in the crystal necessary to render it resonant to the desired frequency. The change in frequency, obtained for a given shape of resonator and given temperature and concentration of the solvent is believed to be approximately directly proportional to the length of exposure.

In the drawing:

Fig. 1 is a piezo-electric resonator which has been cut from a natural crystal to such dimensions as to have approximately the desired resonance frequency.

Fig. 2 illustrates the process disclosed herein and shows the resonator 1 immersed in hydrofluoric acid 2 contained in a suitable container or beaker 3, as of lead.

Fig. 3 is a view of the resonator after being adjusted to the desired frequency by exposure to the acid.

Advantages of chemical treatment of crystals are that material is removed from the entire surface of the crystal to render it uniform, and the crystal may be very precisely adjusted to oscillate at a selected frequency.

As in the past, the resonating element is cut from the natural crystal, its dimensions being slightly greater than those necessary to its vibration at the desired frequency. In cutting from the natural crystal, irregularities are likely to occur in the surfaces. The chemical solvent, to which the element is exposed, serves to dissolve the irregularities and if necessary to its reduction to the proper dimensions, a uniform layer is dissolved from the surfaces of the element. The dimensions of the element are precisely adjusted to a value such that it will vibrate at the desired frequency.

In order to determine whether a crystal was free from twinning when prepared by the method heretofore practiced, it has been necessary to cut the resonator to the size desired for use, polish the resonator, and to examine it with special optical apparatus.

With the present method the crude crystal is cut into slabs of large dimensions from which a number of resonators may be cut. The slab is then exposed to the action of a chemical solvent to produce an etched surface, whereby defects, notably twinning, are rendered visible to the unaided sight. A section of the slab is then selected which is free from defects, and from this section a resonator is cut which has slightly greater dimensions than those desired. This resonator is then exposed to the action of the chemical solvent until it is reduced to such dimensions that it will vibrate at exactly the frequency desired.

The present invention permits the slabs to be selected into different classes depending on the degree of twinning, those showing no twinning being the most suitable from which to make resonators. Consequently it provides a method for selecting crystals before they have been brought to the finished state.

What is claimed is:

1. The method of producing a quartz crys-

tal element which comprises cutting the crystal element to the approximate size and dissolving a portion of said crystal element with hydrofluoric acid.

2. The method of adjusting a quartz crystal element to a desired size which comprises treating said crystal element with hydrofluoric acid.

3. A quartz crystal resonator having a substantially uniform chemically etched surface.

4. The method of producing a quartz crystal element having uniform contact surfaces, which comprises treating a quartz crystal element with a substance which is a chemical solvent for the crystal.

5. The method of producing a piezo-electrically active quartz element which comprises cutting a slab from a natural quartz crystal having piezo-electric properties, exposing the slab to the action of a chemical solvent whereby defects in the slab are readily detectable and cutting a resonator from a section which is free from defects.

6. The method of producing a piezo-electrically active quartz element which comprises cutting a slab from a natural quartz crystal having piezo-electric properties and exposing said slab to the action of hydrofluoric acid.

In witness whereof, I hereunto subscribe my name this 10th day of May, 1928.

WARREN A. MARRISON.