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S. C. HIGHT

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PIEZOELECTRIC CRYSTAL ELEMENT

Original Filed Sept. 18, 1940

FIG. 1

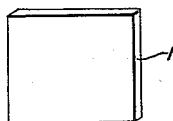
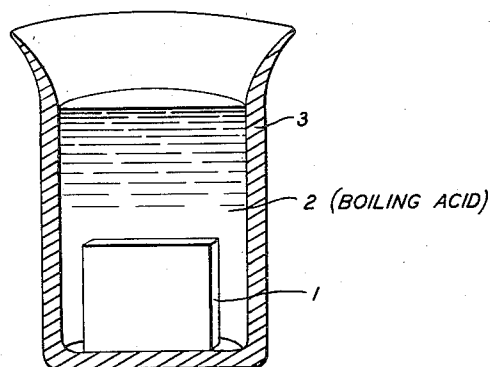


FIG. 2



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PIEZOELECTRIC CRYSTAL ELEMENT

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Original application September 18, 1940, Serial
No. 357,251. Divided and this application Au-
gust 14, 1941, Serial No. 406,793

13 Claims. (Cl. 171-327)

This invention relates to piezoelectric crystal elements, such as for example, quartz or tourmaline piezoelectric crystal elements, and particularly to boiling such crystal elements to reduce frequency changes therein.

This application is a division of my copending application for Piezoelectric crystal apparatus, Serial No. 357,251, filed September 18, 1940.

One of the objects of this invention is to reduce the temporal frequency drift in piezoelectric crystal elements and to increase the frequency stability thereof.

Another object of this invention is to reduce strains in piezoelectric crystal elements.

Another object of this invention is to cleanse the surfaces of piezoelectric crystal elements.

In accordance with this invention, quartz or other piezoelectric crystal elements may be boiled in acid, such as in strong sulphuric or chromic acid, or in other solutions having a relatively high boiling point, in order to prevent or reduce changes in the frequency thereof due to aging effects, and to relieve or reduce strains in the crystal material.

For a clearer understanding of the nature of this invention and the additional advantages, features and objects thereof, reference is made to the following description taken in connection with the accompanying drawing, in which like reference characters represent like or similar parts and in which:

Fig. 1 is a perspective view of a bare piezoelectric crystal element 1 which has been cut and ground to the correct dimensions to give the desired vibrational frequency; and

Fig. 2 is a view showing the crystal element 1 of Fig. 1 immersed in a bath 2 of boiling acid contained in a suitable container or beaker 3.

Newly cut crystal elements such as the crystal element 1 of Figs. 1 and 2 gradually change their frequency slightly and drift in frequency over a period of time of several days, but may be artificially aged by boiling the bare quartz crystal element 1 in a solution of acid 2, such as strong sulphuric acid or chromic acid in order to reduce the period of time that would otherwise be required for the crystal element 1 to acquire frequency stability, and to prevent a possible frequency drift outside of the allowable frequency limits after installation. The frequency of oscillation of untreated quartz crystal elements ordinarily slightly increases for about a week or so before the crystal reaches frequency stability in operation, but the frequency thereof may be increased about the same magnitude by initially

boiling it, in the uncoated state, for a short time in strong chromic or sulphuric acid, thus in effect artificially aging the crystal in a short time. Starting with the unplated crystal 1 immersed in the cold acid bath 2, the acid bath 2 may be gradually brought to a boiling condition and then allowed to cool before removing the crystal plate therefrom. Since the acid bath 2 boils at a temperature of the order of about 300° centigrade, the crystal plate 1 is put through a thermal cycle which tends to relieve or reduce strains in the quartz. Also, the boiling liquid 2 having zero surface tension probably works under and breaks loose minute fragments on the quartz surfaces. Whatever may be the explanation of the action of boiling the quartz plate 1 in acid, there is very little drift or change in frequency during the operation of the quartz plate 1 after being subjected to such treatment. For example, the operating frequency change in an unboiled 10 megacycle per second thickness-mode AT-cut crystal 1 over a period of ten days has been found to be of the order of 300 to 400 cycles per second, whereas the operating frequency change for such a crystal element after being boiled in strong sulphuric or chromic acid, for example, has been reduced to about 10 per cent of the values mentioned, or about 30 cycles per second over the same operating period. The reduction in frequency change occurs mostly during the first boiling in the acid and if boiled again in the acid bath, little further effect is obtained.

Although this invention has been described and illustrated in relation to specific arrangements, it is to be understood that it is capable of application in other organizations and is therefore not to be limited to the particular embodiments disclosed, but only by the scope of the appended claims and the state of the prior art.

What is claimed is:

1. The method of cleaning a piezoelectric crystal element which comprises boiling it in a liquid bath at a temperature in excess of 100° centigrade.

2. The method of cleaning a piezoelectric crystal element which comprises boiling it in a liquid bath of acid at a temperature in excess of 100° centigrade.

3. The method of cleaning a piezoelectric crystal element which comprises boiling it in a liquid bath of sulphuric acid at a temperature in excess of 100° centigrade.

4. The method of cleaning a piezoelectric crystal element which comprises boiling it in a liquid

bath of chromic acid at a temperature in excess of 100° centigrade.

5. The method of treating a piezoelectric crystal element which comprises exposing it to the action of boiling acid at a temperature in excess of 100° centigrade, whereby frequency changes therein are eliminated or diminished.

6. The method of treating a piezoelectric crystal element which comprises exposing it to the action of boiling acid at a temperature of the order of 300° centigrade, whereby frequency changes and strains in the crystal element are eliminated or diminished.

7. The method of treating a piezoelectric crystal element which comprises exposing it to the action of boiling acid including one of the acids sulphuric and chromic at a temperature of the order of 300° centigrade, whereby frequency changes and strains in the crystal element are eliminated or diminished.

8. The method of treating a piezoelectric crystal element which comprises immersing it in a bath of liquid, and bringing the liquid bath to a boiling condition at a temperature in excess of 100° centigrade, whereby the surfaces of the crystal element are cleansed.

9. The method of treating a piezoelectric crystal element which comprises immersing it in a

bath of strong acid, and bringing the acid bath to a boiling condition at a temperature in excess of 100° centigrade, whereby frequency changes in the crystal element are diminished.

10. The method of treating a piezoelectric crystal element which comprises immersing the crystal element in an acid bath having a boiling point temperature in excess of 100° centigrade, bringing the acid bath to a boiling condition at said temperature, and allowing the acid bath to cool before removing the crystal element therefrom, whereby frequency changes and strains in the crystal element are reduced.

11. The method in accordance with claim 10, wherein said bath is strong sulphuric acid.

12. The method in accordance with claim 10, wherein said bath is strong chromic acid.

13. The method of treating a piezoelectric crystal element which comprises immersing the crystal element in a liquid bath having a boiling point temperature of the order of 300° centigrade, bringing the liquid bath to a boiling condition at said temperature, and allowing the liquid bath to cool before removing the crystal element therefrom, whereby frequency changes and strains in the crystal element are reduced.

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