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J. G. BEARD

2,018,246

QUARTZ CRYSTAL MANUFACTURE

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Fig. 1.

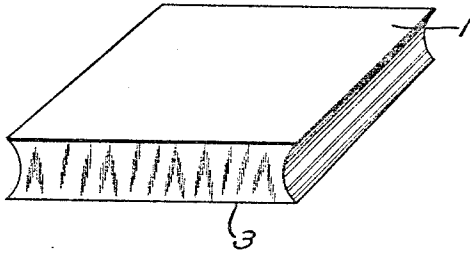


Fig. 2.

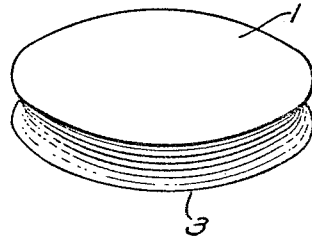


Fig. 3.

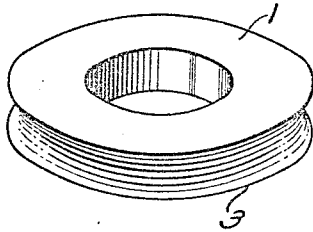
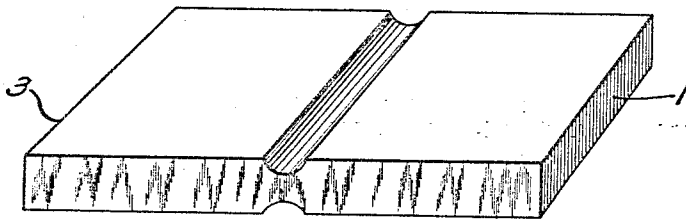


Fig. 4.



WITNESSES:

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## UNITED STATES PATENT OFFICE

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## QUARTZ CRYSTAL MANUFACTURE

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Application October 9, 1934, Serial No. 747,650

4 Claims. (Cl. 171—327)

My invention relates to crystals of the type employed in the stabilization of frequency generators for radio and analogous purposes, and, more particularly, pertains to a method of preparing such crystals for use in these circuits.

Crystals employed for frequency control in radio and other fields are usually cut from the natural or mother crystal to a size approximately that which will resonate at the frequency desired. The crystal is thereafter ground down with a grinding or polishing compound, first with a coarse material and in the later stages with a very finely pulverized material such as rouge. In the last stages of polishing, when the finishing touches are put on the crystal, extreme care and precaution must be taken and frequent tests must be made to determine when the crystal has acquired the proper dimensions, which will cause it to resonate at the frequency intended.

It is not unusual, therefore, that in many cases a crystal is overground causing its dimensions to be slightly less than intended, and thereby raising its frequency above the frequency desired.

It has been the customary practice to either discard such crystals or accumulate them to be subsequently ground to higher frequencies when crystals adapted to resonate at such higher frequencies are needed for other apparatus. Crystals which have been overground could not however be used in the apparatus for which they were originally intended, and an entirely new crystal had to be prepared.

I have discovered a means whereby crystals which have been overground may be modified, whereby these same crystals may be lowered in frequency, and again adapted for use in the apparatus for which they were intended. This result I have accomplished by removing a very small portion of the crystal, such as by grooving one or more of the walls of the crystal, the depth and size of the grooves having a bearing on the resultant frequency of the crystal. This is probably explainable by the fact that the altered surface is enlarged in area and the surface or surfaces so chosen are those which when grooved will effectively increase the frequency determining dimension. In X-cut crystals the important frequency determining dimension is usually measurable directly between the electrode faces along the surface joining them, wherein in Y-cut crystals, the frequency determining dimension is usually measurable along the length of an electrode face of the crystal. With anything but a continuous perpendicular surface, the fre-

quency determining dimension will always be greater than the perpendicular distance between the electrode faces of an X-cut crystal, and greater than the corresponding distance in a Y-cut crystal.

This method of adjusting the frequency of a crystal renders it possible to standardize on a predetermined crystal size for a wide range of frequencies, utilizing, therefor, a crystal adapted to resonate at approximately the highest frequency of this range of frequencies. Then, when it is desired to prepare a crystal to resonate at any frequency within this range, it will not be necessary to cut crystals of different sizes, as has been the practice previously, but, in lieu thereof, one can utilize the standard crystal and adjust its frequency by grooving its walls sufficiently to obtain the desired frequency.

The advantages to be derived from a standardized method of this kind would permit of uniform and standardized crystal holders, since the overall dimensions of the crystals will remain the same regardless of the frequency of resonance thereof.

It is accordingly an object of my invention to provide means whereby the frequency of a crystal may be adjusted without altering its over-all dimensions.

It is a further object of my invention to provide means whereby a crystal, which has been overground in the process of preparation, may be so treated as to adapt the same for operation at the desired frequency.

A further object of my invention is to provide means for lowering the frequency response of a crystal.

Additional objects of my invention will be disclosed in the following description thereof, taken in connection with the accompanying drawing, wherein

Figures 1, 2, 3 and 4 illustrate, in perspective, crystals of various standard shapes, as modified in accordance with my invention.

Referring to these figures, the crystal of Fig. 1 is of the rectangular plate type, that of Fig. 2, the circular plate type, that of Fig. 3 is of the type known as the ring-shaped plate, whereas the crystal disclosed in Fig. 4 is known as the bar type. In each of these figures, the customary frequency determining dimension is designated by the reference numerals 1 and 3. If the electrodes, not shown, are placed in operative relationship to the upper and lower faces of the crystals, as shown then those of Figs. 1, 2 and 3 would be indicated as being of the X-cut type and that

of Fig. 4 would be of the Y-cut type. It will be noted that the side walls of the X-cut type, that is the surfaces joining the electrode faces, have been grooved and in the Y-cut crystal it is the electrode surface which is grooved. This modification of the crystal causes the crystal to resonate at a frequency lower than previously, and it is desired to point out that in modifying the crystal, as disclosed, the general shape of the crystal has not been changed nor has the overall dimensions, that is the length, width and thickness of the crystal been altered.

From a practical standpoint, this means that the same crystal can be utilized in the same holder for which it was originally intended and the spacing between the electrodes need not be modified, since the thickness of the crystal remains the same. Furthermore, crystals adjusted as to frequency in accordance with my invention retain substantially unchanged the area of the electrode surfaces exposed to the electrodes. This is important, particularly in connection with crystals having contact type electrodes, since the pressure per unit area does not change as would be the case should the electrode surfaces of the crystal be altered, in which case, undesirable damping of the crystal would occur.

Thus, in grinding crystals for a given frequency, the crystal need not be discarded nor rendered useless for the purpose intended should the crystal happen to be overground to a frequency higher than desired for, according to my invention, a slight grooving of the crystal walls will bring the frequency of the crystal down to the desired value.

Where it may be desired to standardize on crystal sizes by utilizing crystal blanks for any one of a range of frequencies, this may easily be accomplished in accordance with the teachings of my invention. Assuming, for example, that the blanks be of the dimensions disclosed in the crystal of Fig. 1. Then, without changing the length, width, or thickness dimensions of the blank, one can adjust its frequency resonance to any frequency within a desired range by merely grinding into the sides of the crystal as shown until the desired frequency has been obtained, and the same procedure may be followed with crystals of other shapes, such as shown in the other figures of the drawing.

I have also found that the frequency of a crystal may be varied as by providing a convex instead of a concave surface on a frequency dimensioning surface of the crystal. From a practical standpoint, however, this manner of changing the frequency is not considered as feasible as the method involving grooving or concaving a surface or surfaces of the crystal, although in special cases, it may be preferable to utilize the convex construction.

While I have disclosed my invention in detail, it should be apparent to one skilled in the art that it may be subject to minor changes without departing from the scope of my invention. My invention, for example, is not necessarily limited to grooving an edge or side of a crystal without altering the area of the surfaces exposed to the electrodes, since it is apparent that the advantage of lowering the crystal frequency will be secured even should the electrode exposed surfaces be reduced, although certain of the other advantages of my invention will not be attained.

I, accordingly, do not desire to be limited to the specific embodiments or specific steps outlined by me except as may be limited by the appended claims and the prior art.

I claim as my invention:

1. A resonator of the crystal type having a pair of flat parallel electrode faces and a surface joining said electrode faces, the shortest distance between said electrode faces as measured on said joining surface being longer than the perpendicular distance between said electrode faces.

2. A resonator of the crystal type having a pair of flat parallel electrode faces and a surface joining said electrode faces, the shortest distance between said electrode faces as measured on a portion of said joining surface being longer than the perpendicular distance between said electrode faces.

3. A resonator of the crystal type having a pair of substantially flat parallel faces, and a surface joining said faces, said surface being so shaped as to deviate from the perpendicular between said parallel faces.

4. A resonator of the crystal type having a pair of substantially flat parallel faces, a surface extending between said parallel faces, and a groove in said surface.

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