

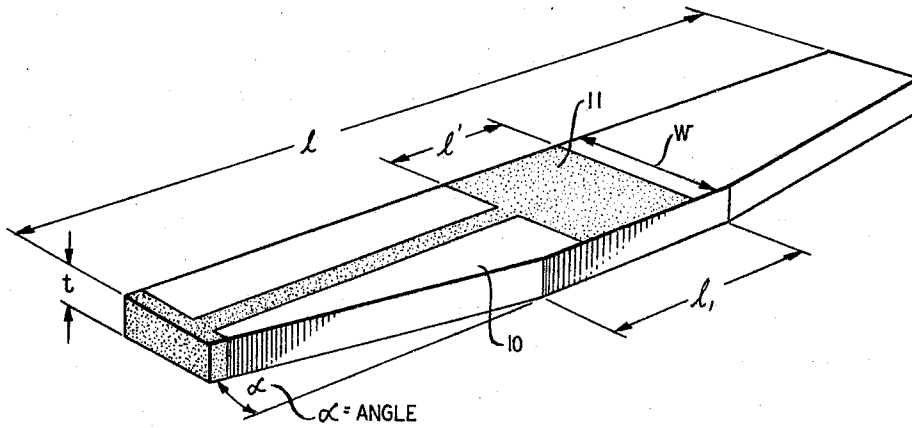
Feb. 24, 1970

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3,497,732

DT-CUT QUARTZ CRYSTAL

Filed July 23, 1968



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DT-CUT QUARTZ CRYSTAL

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Filed July 23, 1968, Ser. No. 746,799
Int. Cl. H01v 7/00

U.S. Cl. 310—9.5

2 Claims

ABSTRACT OF THE DISCLOSURE

The specification describes an improved DT-cut quartz crystal ($yzw = -51^\circ/0^\circ/0^\circ$) which is beveled along the width at both ends of the crystal. The beveling permits high quality resonance most suitable for applications in the frequency range of 800 kHz. to 2.2 mHz. for a crystal having a length-to-width ratio in the range of 23 to 29.

This invention relates to quartz crystals designed for use in filters and oscillators.

The frequency range 800 kHz. to 2200 kHz. is especially awkward from the point of view of quartz crystal design. Known low frequency designs became inconveniently small in this frequency range, and the conventionally used AT-cut becomes excessively large when designed to approximate the performance of an infinite plate; that is, a plate having a diameter-to-thickness ratio greater than about 55. A new DT-cut crystal, designed especially for use in this troublesome frequency range is described and claimed in my application Ser. No. 708,355 filed Feb. 26, 1968 and assigned to the assignee of this application, Bell Telephone Laboratories, Incorporated. While this crystal design is especially effective from several aspects, it requires a length-to-width ratio of the order of 55 and consequently is larger than one may desire.

It has now been found that the DT-cut quartz plate mentioned above can be significantly improved by symmetrically beveling a substantial portion of the width of the crystal at both ends of the plate. By this expedient the overall length of the crystal can be made approximately half that of the prior DT-cut crystal with little or no compromise in the resonator performance.

These and other aspects of the invention are more fully explained in the following detailed description. In the drawing:

The figure is a perspective view of a quartz crystal constructed according to the invention.

The crystal design of the invention is illustrated by the figure. The quartz crystal 10 is DT-cut, i.e., it has an (yzw) orientation of approximately $-51^\circ/0^\circ/0^\circ$. The width dimension w is beveled at both ends along a length ($l-l_1$) and at an angle α . Electrode 11 is shown covering the top surface over that portion of the length indicated by l' . An identical electrode (not shown) is present on the reverse side of the crystal. A series of extensive empirical studies were performed to determine the optimum values of the several dimensions shown. The studies were complicated by the fact that each of the parameters, with the single exception of the thickness, t , are interdependent and all depend on the frequency. However, the studies indicated that good results are obtainable at least within the following ranges.

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Width—(frequency determinant in these studies) 0.0825 inch at 800 kHz. to 0.030 inch at 2.2 mHz.
Length (l)-to-width (w) ratio: 23 to 29
Angle α — 1° to 5° .

The lengths l_1 and l' were not found to be critical parameters although a relationship between l_1 and α has been found. Good results were found with l_1 equal to about 40 to 50 percent of the length, l . This range can be extrapolated to 30 percent to 60 percent in view of the relatively small dependency of the performance characteristics on this parameter. The extent and shape of the electroding on the crystal faces was not found to be important relative to electrical performance as long as an appreciable portion of the region l_1 is covered. As indicated previously the thickness is not interrelated with the other important dimensions. It could therefore be chosen to obtain a desired inductance value. However, it is economical from a consideration of material cost to restrict the thickness, t , to less than the minimum width, or 0.030 inch.

Q values and the suppression of unwanted modes were determined for a considerable number of crystals falling within the limits defined above.

Q values exceeding 50,000 were typical with several crystals evidencing Q values over 200,000. Unwanted resonance suppression in the frequency range from 0 to 1.2 times the main resonance was also obtained. By selective damping, mode suppression up to the third mechanical overtone of the width shear mode was obtained.

Various additional modifications and extensions of this invention will become apparent to those skilled in the art. All such variations and deviations which basically rely on the teachings through which this invention has advanced the art are properly considered within the spirit and scope of this invention.

What is claimed is:

1. A quartz crystal for use in a piezoelectric resonator device comprising a quartz plate having a (yzw) orientation of approximately $-51^\circ/0^\circ/0^\circ$, a length-to-width ratio in the range of 23 to 29, the width of the crystal being symmetrically beveled at both ends of the plate along a substantial portion of its length at an angle in the approximate range of 1° to 5° .

2. The crystal of claim 1 wherein the width of the crystal is in the range of 0.0825 inch to 0.030 inch.

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U.S. Cl. X.R.

310—9.6