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2,249,933

PIEZOELECTRIC PLATE

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Fig. 1

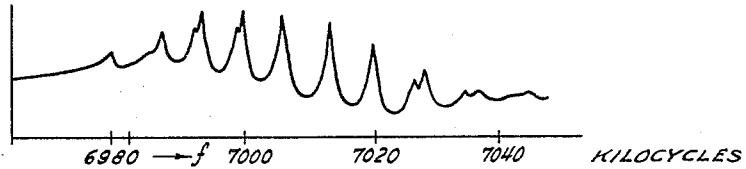


Fig. 1a



Fig. 2

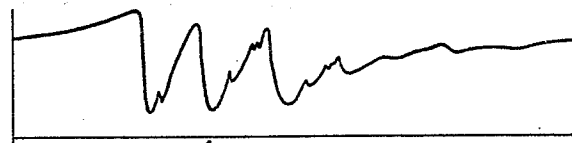


Fig. 2a



Fig. 3



Fig. 3a



Fig. 4

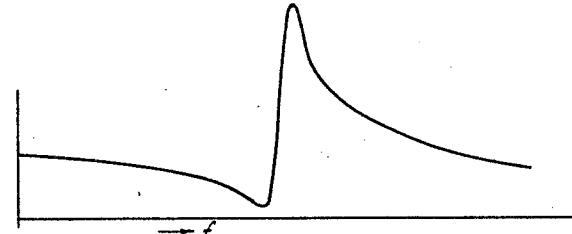


Fig. 4a

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PIEZOELECTRIC PLATE

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5 Claims. (Cl. 171—327)

This invention relates to an electrode arrange-
ment for a piezo-electric quartz crystal plate.

In the use of quartz crystal resonators, more especially as selection means, the single wave performance of the quartz plates plays a decisive part. In the case of shorter waves, the manu-
5 manufacture of single wave plates involves much greater difficulties than in the case of longer waves. In accordance with an earlier proposi-
10 tion, the single wave performance of quartz plates was obtained by a tapering and a round-
ing-off of the edges of the quartz plates.

The multiple wave performance of quartz plates is due primarily to two different condi-
15 tions, one condition being the multiple wave performance and has to do with coupling phenomena between the various degrees of freedom of plate oscillations, such as is the case, for instance, in coupling phenomena between the
20 thickness oscillations and the harmonics of any natural oscillations determined by the trans-
verse dimensions.

These coupling phenomena can be eliminated with the previously described means for working
25 the edges and with the damping by covering the edge regions with an elastic layer. Beyond this, especially in the case of plates whose diameter is large compared with the thickness (larger than 20:1), a further multiple wave performance
30 occurs. This invention will be more clearly understood by referring to the accompanying drawing, in which:

Figure 1 shows a round crystal plate with elec-
trodes having a slightly smaller area than the
crystal plate;

Fig. 1a is a resonance curve obtained by using
electrodes of Fig. 1;

Fig. 2 shows a crystal plate with electrodes
still smaller in area than those of Fig. 1;

Fig. 2a is a resonance curve obtained by using
40 electrodes of Fig. 2;

Fig. 3 shows a crystal with two electrodes, each
one having different areas;

Fig. 3a is a resonance curve obtained by using
electrodes of Fig. 3;

Fig. 4 shows a crystal with two electrodes, each
of different areas but still different from that
shown in Fig. 3;

Fig. 4a is a resonance curve obtained by using
electrodes of Fig. 4.

A resonance curve whose diameter is large
compared with the thickness is shown in Fig. 1a
in which in place of a single resonance spot deter-
mined by the thickness, several adjacent resona-
55 nce places appear having almost the same

values. The physical performance is seen in that
inside the plate whose diameter is assumed to
be large against the thickness, multiple reflec-
tion phenomena appear which entail such
multiple resonators. The plate diameter in the
very thin plates under consideration is chosen
large in view of the fact that the mounting of
small plates entails considerable difficulties. In
the case of large plates which are slightly faceted,
the mounting can be carried out in the known
manner at the circumference without the in-
volvement of substantial damping.

In the invention, such multiple wave phenom-
ena are eliminated more especially in the case of
15 plates in which the diameter is large against
the thickness, by dimensioning in a suitable man-
ner the electrical field which excites the oscilla-
tions, and when utilizing an excitation surface
which is smaller, or small as compared with the
20 surface of the quartz crystal. In this manner,
the oscillation performances at the border
regions are substantially weakened and single
wave resonators are obtained. The use of elec-
trodes having varying sizes was found to be
especially effective. The physical explanation for
this lies in the fact that aside from the electrical
field extending at right angle to the surface of
the plate, a small stray component of the elec-
trical field lies parallel to the surface of the
30 plate when using electrodes of different sizes.
The field parallel to the surface of the plate has
a compensating effect upon coupling phenomena
still existing between the thickness oscillations
and the transversal oscillations.

The idea of the present invention will be
elucidated in reference to the Figs. 1 to 4a, in-
clusive. In these figures, there is shown by the
upper picture of each figure a cross-section
through the crystal and the electrodes and by
40 the lower picture of each figure a curve in which
the abscissa represents the frequency and the
ordinate the apparent conduction value of the
crystal. The curves have been recorded with
an apparatus of the type described in Tele-
funkenzeitung No. 76, July, 1937, page 10. Fig. 1
is concerned with a round disk whose frequency is
7000 kilocycles and whereby the diameter of the
quartz crystal is 25 mm. and its thickness is 0.5
mm. The energizing electrodes likewise had a
round cross-section and both of them had a
diameter of 23 mm. In Fig. 2, the electrodes for
the same plate were reduced to 20 mm. In Fig.
3, the one electrode diameter was 20, the other
one was 12 mm. and in Fig. 4, which finally
55 represents a single wave plate, the one diameter

was 13 mm. and the other one 17 mm. The present invention relates to thickness oscillations of quartz plates which carry out shearing oscillations. In addition to the proper choice of the dimensions of the electrodes also the aforementioned rounding-off or tapering may obviously be resorted to. Furthermore, plates are employed preferably whose temperature coefficient is less than five times 10^{-6} per Celsius degree, such as can be realized by proper cutting.

What is claimed is:

1. A piezo-electric crystal arrangement which will function in the thickness mode of the crystal to give a single frequency response when subjected to high frequencies, comprising a piezo-electric crystal, two electrodes each having an area which is smaller than one-half the area of said crystal and arranged each side thereof, one of said electrodes having a smaller area than the other electrode.
2. A piezo-electric crystal arrangement which will function in the thickness mode of the crystal to give a single frequency response when subjected to high frequencies, comprising a circular piezo-electric crystal, two electrodes each having an area which is smaller than one-half the area of said crystal and arranged each side thereof, one of said electrodes having a smaller area than the electrode.
3. A piezo-electric crystal arrangement which will function in the thickness mode of the crystal

to give a single frequency response when subjected to high frequencies in the order of 7,000 kilocycles, comprising a piezo-electric crystal, two electrodes each having a smaller area than said crystal and arranged each side thereof, one of said electrodes having a diameter of seventeen millimeters and the other electrode having a diameter of thirteen millimeters.

4. A piezo-electric crystal arrangement which will function in the thickness mode of the crystal to give a single frequency response when subjected to high frequencies in the order of 7,000 kilocycles, comprising a piezo-electric crystal, two electrodes each having a smaller area than said crystal and arranged each side thereof, one of said electrodes having a diameter of twenty millimeters and the other electrode having a diameter of twelve millimeters.

5. A piezo-electric crystal arrangement which will function in the thickness mode of the crystal to give a single frequency response when subjected to high frequency comprising a piezo-electric crystal having a high ratio of dimensional difference between its diameter and its thickness, two electrodes arranged each side of said crystal, the area of said electrodes being smaller than one-half the area of said crystal whereby multiple wave phenomena are eliminated.

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