.

R-cut Quartz Oscillation Plates and Harmonic Oscillation

by

Issac KOGA

(Tokyo University of Engineering)

1. Introduction

Practical merit of quartz crystal oscillation are (1) easy starting of oscillation, (2) strong oscillation power, (3)small temperature dependence of frequency, etc. Small size compared with wavelength is also convenient. New cutting method which is explained in this paper may satisfy all of above conditions.

2. R-cut plates

Quartz crystal is shown in Fig 1. In this Figure, surface r (and r' backward) displays remarkable characteristics over other surfaces. For example, strong brightness, highly resistant against HF (hydrogen fluoride) corrosion, etc.

I suppose that these merit may be reflected on the characteristics of oscillation. Therefore I tried to cut out thin plates which are parallel in this r-face. I will call them as R-cut plates. These plates exhibit distinguished performance as explained in the following.
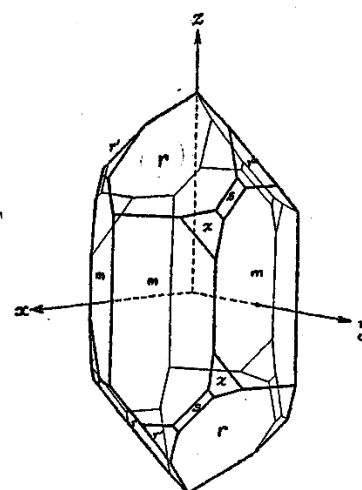

Figure 1

3. Features of R-cut plates

(1)Easier oscillation and strong power.

This means easy handling of quartz plates and holders, therefore not requiring delicate treatment. Strong power of oscillation means oscillation is not affected by the big gap between a crystal plate and holding electrodes. Tested oscillator circuit (Pierce's circuit) and its photograph is shown in Fig 2.

(2) Small temperature coefficients

Recently, request for stable oscillation frequency becomes high. Various ideas are presented (Mason. Nanba, Koga, …), but they have some demerits. Measured temperature coefficients of these R-cut plates are fairly small as shown below.

Size of plates	freq. (kc)	temp. coeff.
0.740 × 23.0 × 31.0	3350	$3.3 \times 10^{-5}/°C$
0.740 × 25.0 × 29.5	3348	$1.2 \times 10^{-5}/°C$

(3) Bigger size

For same oscillation frequency, thickness of R-cut plate is larger than conventional (for example, Y-cut) plates. This means that R-cut plates are mechanically strong even for higher frequency plates.

(4) Cutting angle is just parallel to r-face and the setting of cutting angle is easy.

(5) Strong harmonic oscillation

In R-cut plates, strong harmonic oscillation can be generated by tuning the circuit to the wanted harmonics (ex. 3rd) and can suppress other modes.

We can easily obtain very high frequency wave.

For example,

Figure 2

Size (mm)	1.861 × 27.2 × 30.0	1.563 × 24.9 × 28.1	1.150 × 21.5 × 26.9
Wavelength	75	63	46

4. Conclusion

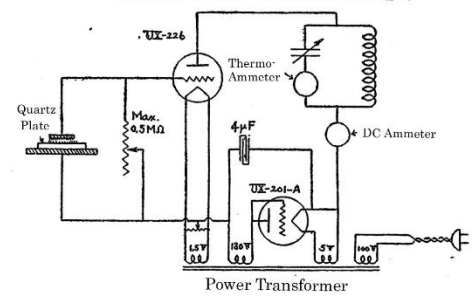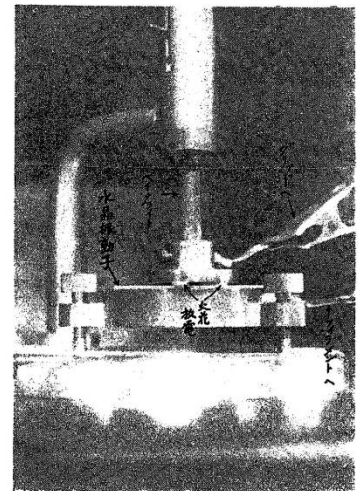As explained above, R-cut plates have various merits compared to the existing conventional cuts (X-cut and Y-cut, etc.) and is practically very useful.