Ref.erence 6 English Translation

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Quartz Oscillating Plates with Small Temperature Coefficients for Short-wave

by
Issac Koga and Koji Ichinose
(Faculty of Electrical Engineering, Tokyo University of Engineering)

Frequencies of oscillators using quartz oscillating plates are very stable. However, for the purpose of short-wave transmitters or frequency measurement standards, temperature dependence of vibration frequency of plates should be carefully considered. At present time, thermostats are normally used for such purposes, but, several authors presented ideas for decreasing the effect of temperature to oscillating frequencies[(1)-(5)]. However, these ideas have several inconveniences such as difficulty of oscillation, difficulty of production and no suitability for high frequency.

In this report, we propose oscillating plates based on new cutting method. We can say that those drawbacks mentioned above are almost overcome with our plates. One of our authors has already reported that the vibration mode of thin plates, which are cut in parallel to X-axis and whose size is large enough compared to the thickness of the plate, is the displacement in the direction of the electric axis (X- axis). Recently this vibration mode was assured by experiment [(7)]. Furthermore, he clarified that the frequency of oscillation is given as follows.

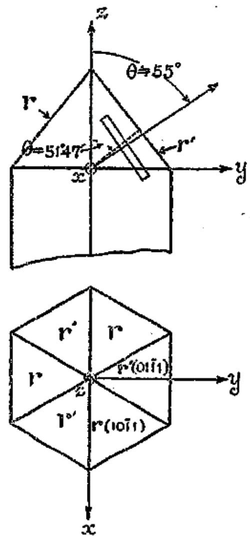

Figure 1

$$f = \frac{1}{2a}\sqrt{\frac{c}{\rho}} \qquad \text{---------- (1)}$$

where

$$c = \frac{1}{2}(c_{11} - c_{12})\sin^2\theta + c_{44}\cos^2\theta + c_{14}\sin 2\theta$$

ρ ---- density of quartz
a ---- thickness of plate
θ ---- angle (see Fig. 1)

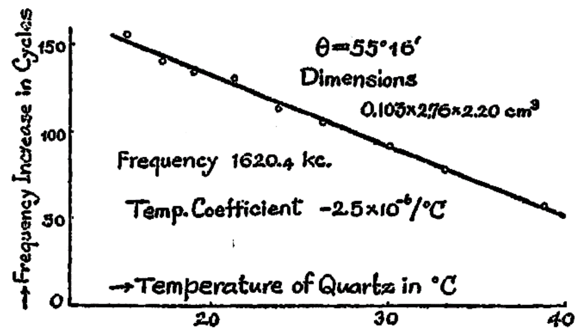

Figure 2

In order to find the temperature coefficients of adiabatic elastic constants C_{11} and C_{12}, we measured temperature coefficient of frequency of oscillator using plates having various cutting angles θ.
We first tried R-cut plate [(8)] cut in parallel to r(1011)-face and R'-cut plate cut in parallel to r'(0111)-face. The results are as follows. Frequency change of R-cut was about + 2 X 10^{-5}/C°. However, for R'-cut, it was -2 X 10^{-5}/C°. As well known, frequency change of Y-cut plate (corresponds to θ = 90° in Fig. l) is about + 6 X 10^{-5}/C°. Comparing the value of Y-cut plate with our results, we can estimate the existence of θ where temperature coefficient becomes zero when we

decrease the angle θ from 90 degree. We actually made various plates having θ between 90° and 51° 47’ (angle of R'-cut), and measured their oscillating frequencies. As the result, temperature coefficients were -2.5×10^{-6} /C° at θ= 55° 16’ and $+6.0 \times 10^{-6}$ /C° at θ= 55° 33' respectively (see Figs 2 and 3). It is clear that there is an angle where temperature coefficient is zero between these two angles.

With these plate we assured vigorous oscillation without any trouble up to about 5 MHz.

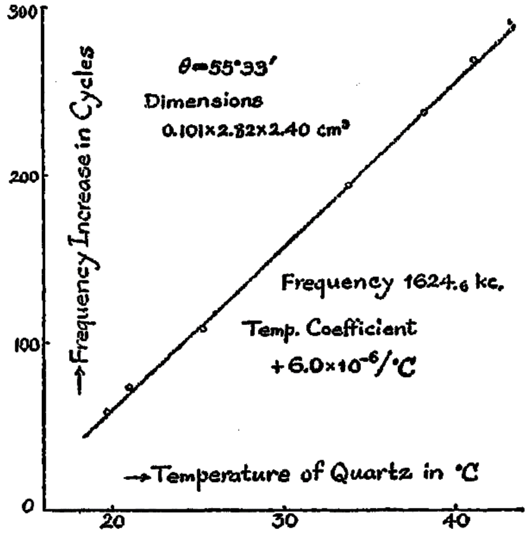

Figure 3

References

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The Institute of Electrical Engineers of Japan, The Institute of Telegram and Telephone of Japan, The Illumination Engineering Institute of Japan

Proceeding of 8th Joint Conference on Electrical Engineering

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 8th Joint Conference on Electrical Engineering was held on April 2, 3 and 4, 1933 at Kyushu Imperial University in Fukuoka. Following seven papers were presented at the conference which were related to illumination engineering.

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