

FIGURES

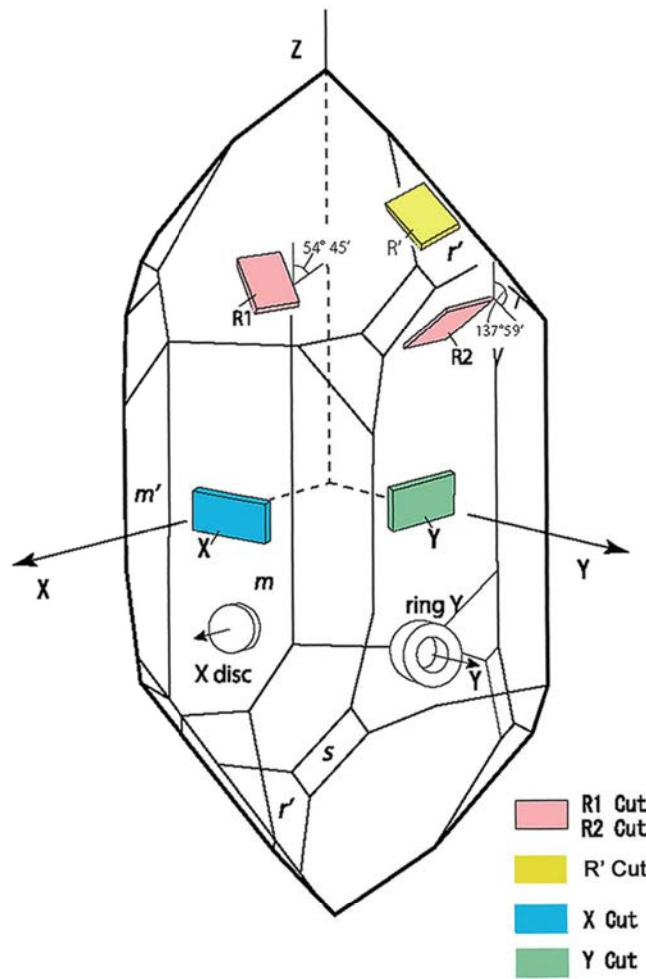


Fig. 1 Various cuts in quartz crystal

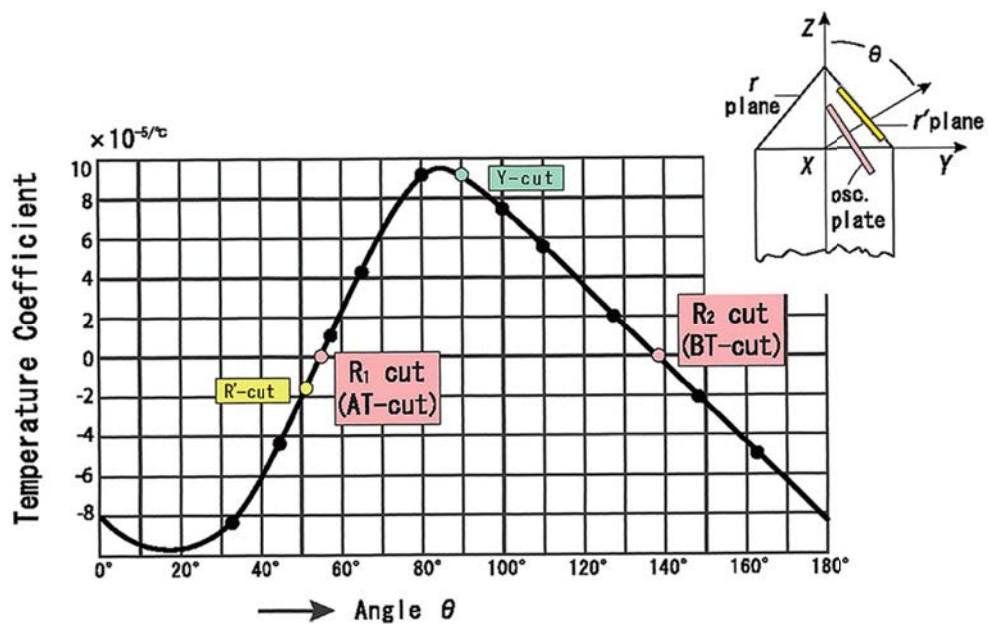


Fig. 2 Temperature coefficient versus cutting angle θ of plate



Fig. 3 Crystal plate holder apparatus used by Koga in his early research (1930)

(Tokyo Institute of Technology Museum)

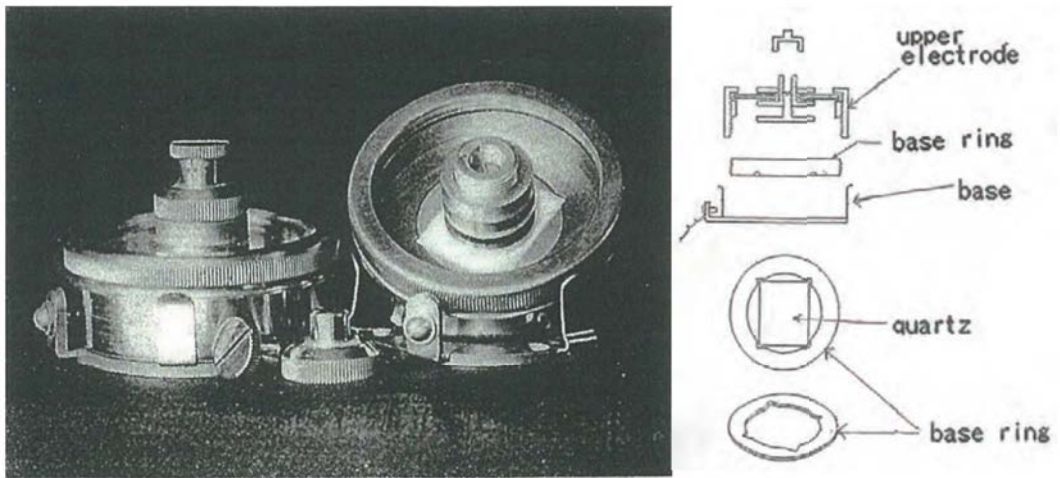
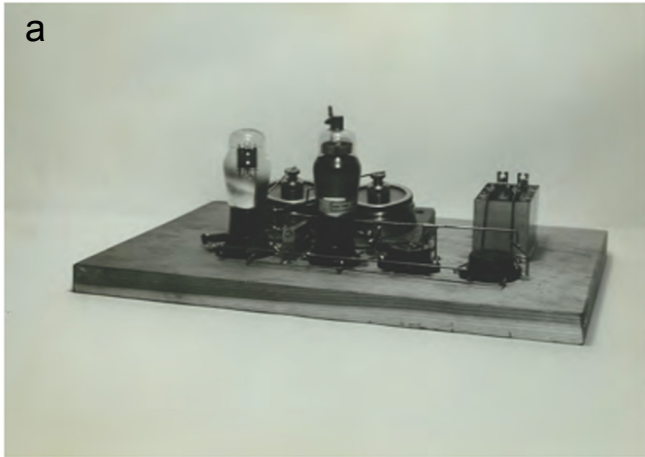


Fig. 4 Koga-type holder used for testing of temperature-insensitive plates

(Tokyo Institute of Technology Museum)



Quartz oscillator



Time indicator
(Tokyo Institute of Technology Museum)

Fig. 5 Components of the first model quartz clock (KQ-1) exhibited at the 1937 Paris International Exposition

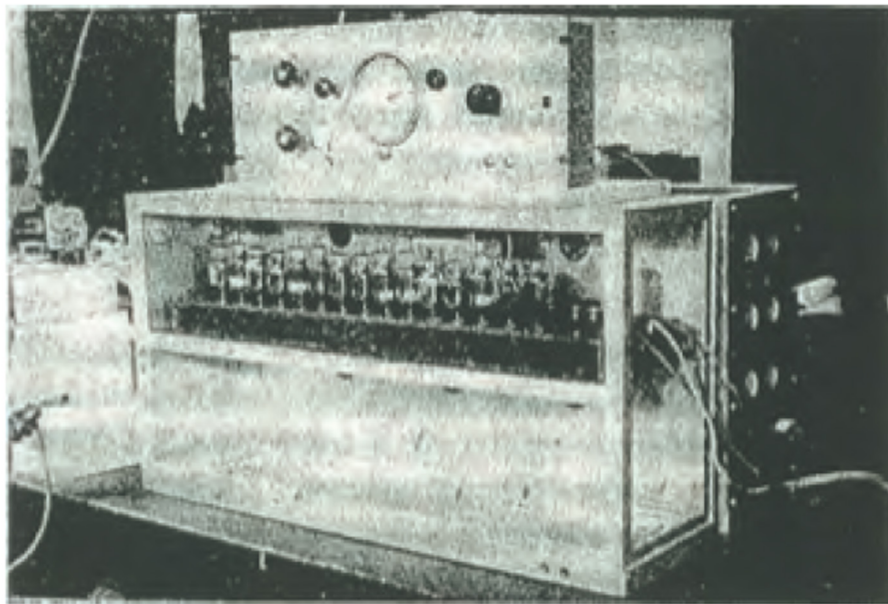


Fig. 6 Total view of the improved KQ-1 model used in cooperation with Tokyo Observatory

(KQ-1 employed the R_1 -cut oscillation plate. 1 MHz oscillation frequency was converted to 10 Hz by 5-stage multivibrator-type frequency demultiplier.)

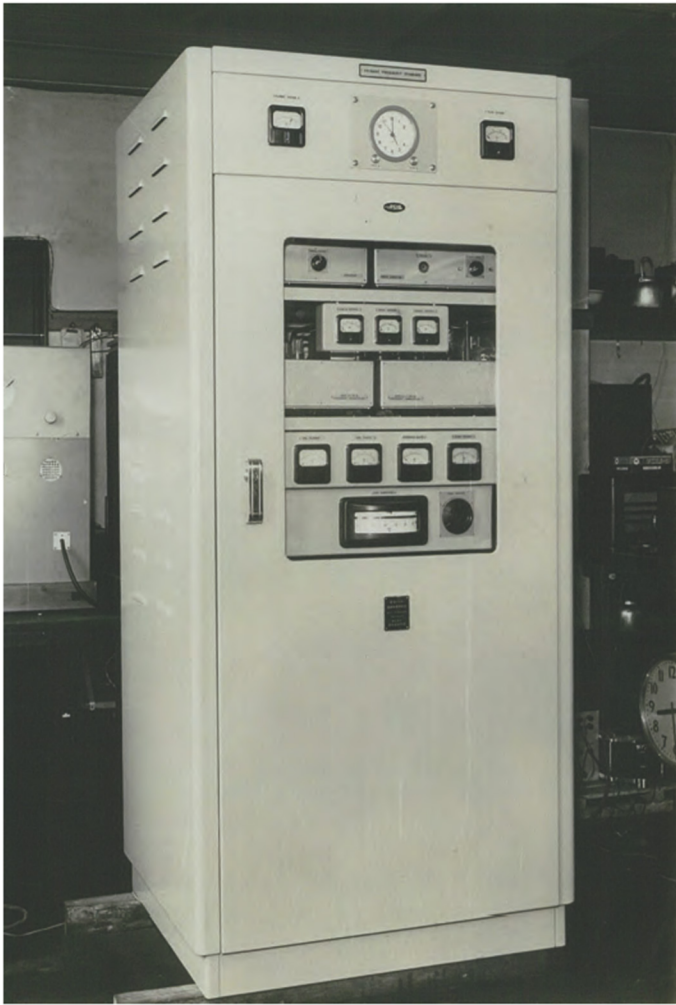


Fig. 7
Koga's final model KQ-6
installed at KDD Co. Ltd.,
providing time and frequency
standards

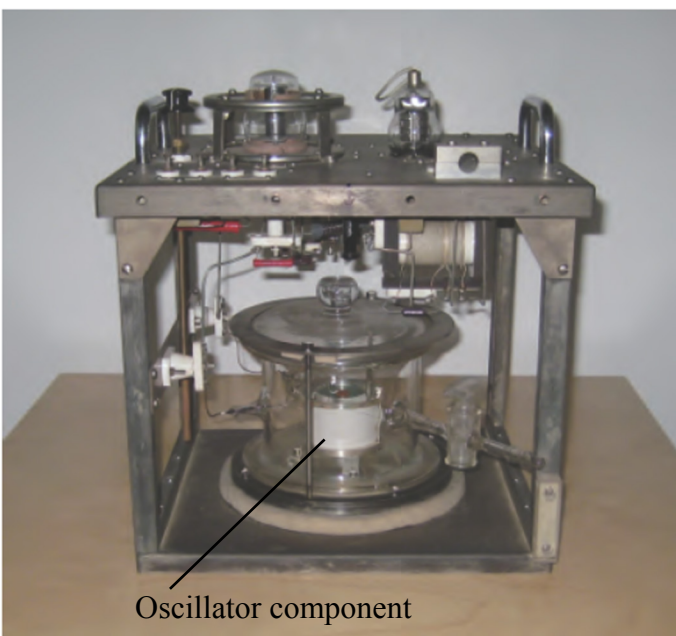


Fig. 8
Oscillator component of KQ-6
(Tokyo Institute of Technology
Museum)



Plug-in types widely used in conventional transmitters



Enclosed-type tubes made at Koga's Lab



Recent mini-size oscillation elements

Fig. 9 Various types of quartz oscillation elements

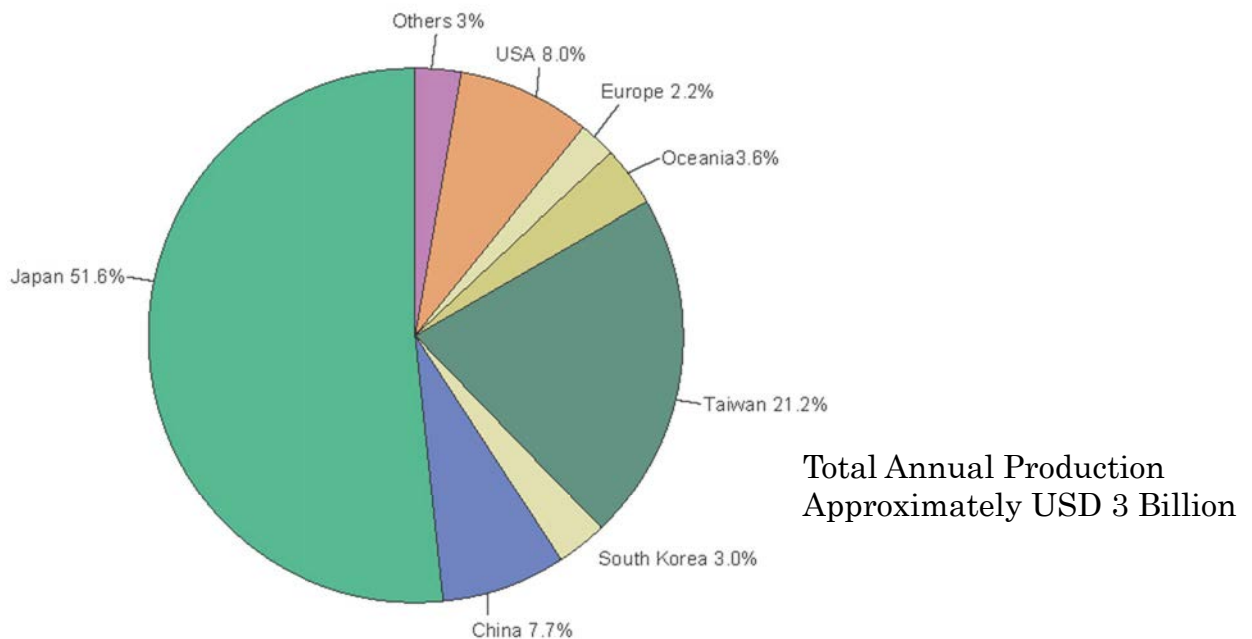


Fig. 10 Global quartz-based products (2013)
(From a report by the Quartz Crystal Industry Association of Japan)



Fig. 11 Issac Koga (front row second left) and his group at Tokyo Institute of Technology (ca. 1955)

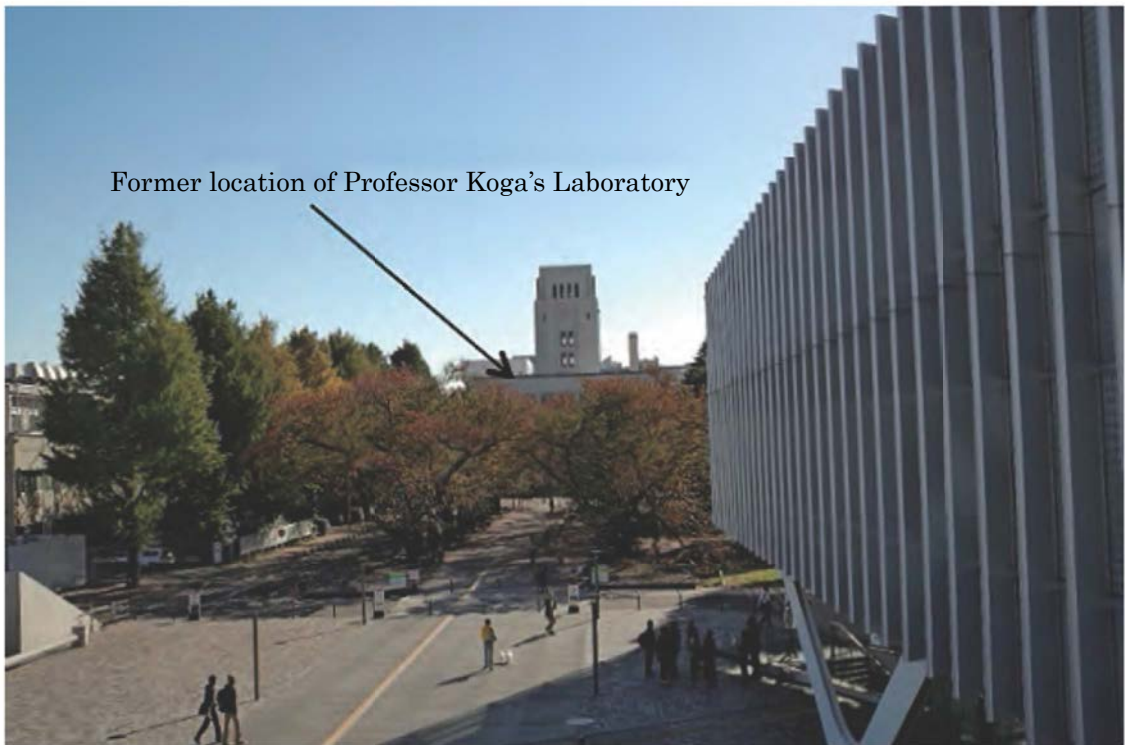


Fig. 12 Tokyo Institute of Technology



Issac Koga (1899–1982)

A native of Saga Prefecture, Japan, Issac Koga graduated from the University of Tokyo and was employed as a professor at Tokyo Institute of Technology and the University of Tokyo. His education and research were in the area of electronics and communications. Dr. Koga is known as the inventor of temperature-insensitive quartz cutting (R1-cut). He applied the R1-cut plate to wireless communications and quartz clocks. His achievement drastically stabilized the frequency of oscillators used in communication and clocks for time standards. In 1963, Professor Koga was awarded the Order of Cultural Merit. He also contributed to the activities of URSI and was elected president in 1963. He became a member of the Japan Academy in 1971.