Sept. 29, 1942. E. HEINECKE 2,297,409

QUARTZ OSCILLATOR

Filed Dec. 27, 1939

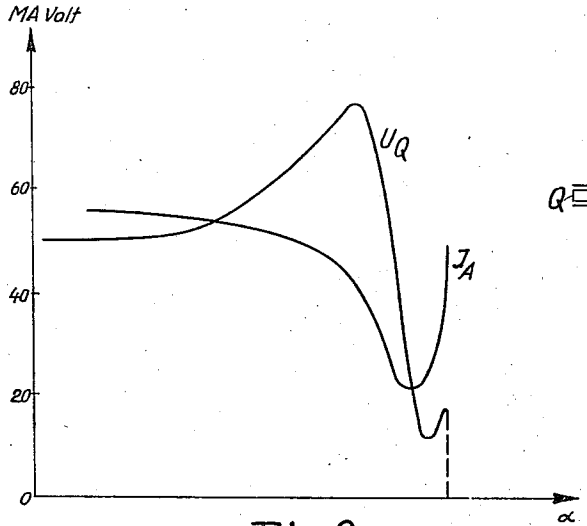


Fig. 2

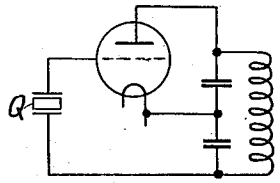
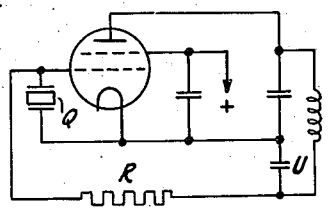


Fig. 1

Fig. 5.



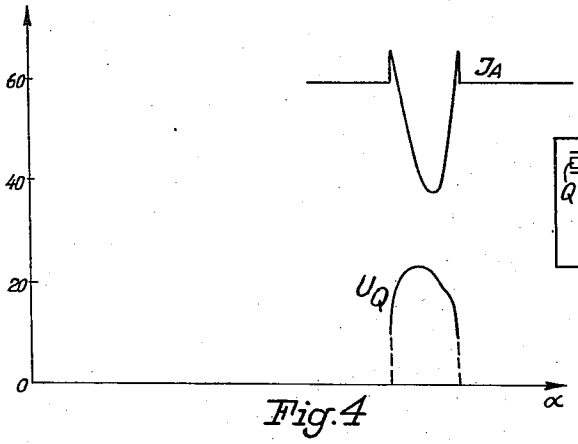


Fig. 4

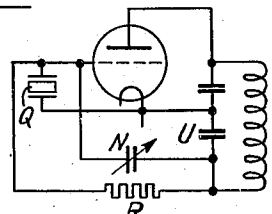


Fig. 3

Inventor:
Erich Heinecke
by E. O. Shinney
Attorney.

Patented Sept. 29, 1942 2,297,409

UNITED STATES PATENT OFFICE

2,297,409

QUARTZ OSCILLATOR

Erich Heinecke, Berlin, Germany; vested in the Alien Property Custodian

Application December 27, 1939, Serial No. 311,067
In Germany January 5, 1939

3 Claims. (Cl. 250—36)

The present invention relates to quartz oscillators, and more particularly to thermionic tube oscillation generators, the frequency of which is stabilized by means of a vibratory quartz crystal.

My invention consists in certain features of novelty which will be readily understood from the following description and be pointed out in the appended claims, reference being had to the accompanying drawing, in which

Fig. 1 shows a known type of quartz-controlled oscillation generators, Fig. 2 is a graph showing the operating characteristic of the oscillator shown in Fig. 1, Fig. 3 illustrates one embodiment according to this invention, while Fig. 4 diagrammatically shows the operating conditions obtained by the novel arrangement according to Fig. 3 and Fig. 5 is a modified circuit arrangement using a screen grid tube.

Fig. 1 which is explanatory to the state of art shows a thermionic valve oscillation generator having a vibratory quartz crystal serially interposed between its grid and its cathode and an oscillatory circuit formed in its plate circuit. The excitation is effective through suitable reactances.

The operating characteristic involved by the arrangement of Fig. 1 is shown in Fig. 2 in which the plate current J_A and the voltage U_Q occurring across the quartz crystal A is plotted versus the tuning of the oscillatory circuit which forms part of the plate circuit of the thermionic valve. As will be readily seen from this graph, the voltage across the quartz crystal Q is a minimum at a tuned condition of the plate circuit. However, a detuning of this circuit in one sense involves a rapid voltage increase, while oscillations suddenly decay in response to a detuning of this circuit in the opposite sense. It is thus obvious that the operation of the oscillation generator as a whole strongly depends upon the adjustment of the transmitter and that even the slightest detuning or mismatch might suddenly apply such high voltage to the vibratory quartz crystal that this element becomes overloaded. This deteriorate condition is particularly critical in cases when it is necessary frequently to change the wavelength of the transmitter, since each frequency adjustment may result in an excessive voltage load across the vibratory circuit. Transmitters of this type have heretofore been restricted to the use of thermionic valve of extraordinarily low efficiency and of such characteristic that the vibratory crystal is not subject to damage even if the overall power of the valve should be applied thereto.

It is the main object of this invention to eliminate the disadvantageous instability of the circuit described in the foregoing. This is accomplished according to my invention by exclusively exciting the vibratory quartz crystal through an ohmic resistance.

The corresponding novel circuit arrangement is shown in Fig. 3, in which Q designates a vibratory quartz crystal and R represents an ohmic resistance through which the feedback voltage is applied to the quartz crystal Q. The grid-to-plate capacitance is neutralized by means of a neutralizing condenser N so as to provide only one single path for exciting the crystal Q, namely through the resistor R. The means constituting the neutralizing system may be omitted if the neutralized condition is secured by the use of a screen grid tube.

The effectiveness of the above-described circuit arrangement is shown in Fig. 4 in which the voltage U_Q across the vibratory quartz and the plate current J_A are plotted as a function of the tuning condition of the oscillatory circuit. The thermionic valve and the overall operating conditions are the same as in the case of Figs. 1 and 2. The maximum value of the voltage supply to the quartz crystal in the present case only amounts to a fracition of the voltage maximum according to Fig. 2 and the characteristic of the voltage is stable and substantially symmetric and, moreover, oscillations decay uniformly whether the detuning of the oscillatory circuit is effected in the one or the other sense. This novel arrangement operates with the same superiority as an independently excited circuit. The vibratory quartz crystal is safely protected against overload conditions since the voltage is caused to decrease in response to any detuning of the oscillatory circuit. With this novel arrangement it is possible to employ tubes of higher efficiency without endangering the vibratory quartz crystal by excessive voltages. The attendance during effective transmission is considerably simplified by virtue of the fact that the maximum power value possibly occurring across the quartz crystal may, independently of the size or efficiency of the thermionic valve, be limited at will by a suitable choice of the voltage U and of the characteristic imparted to the resistor R of Fig. 3. Such voltage limitation at the vibratory quartz crystal has not been warranted in any heretofore known quartz-controlled circuit employing reactances for excit-

ing the vibratory crystal, unless low efficiency tubes have been used. The arrangement of Fig. 5 is substantially the same as shown in Fig. 3 except that a screen grid tube is used and this screen grid serves to neutralize the anode grid capacity.

What is claimed is:

1. A quartz-controlled thermionic tube oscillation generator comprising a thermionic valve having at least a cathode, a grid, and an anode, a vibratory frequency stabilizing quartz crystal connected substantially directly across said grid and said cathode, an oscillatory circuit formed between the said anode and the said cathode, means connected between the said grid and anode for substanfially completely neutralizing the grid-to-anode capacitance of the said valve, and a feedback path for exciting said crystal extending between the said oscillatory circuit and said quartz crystal, consisting of an ohmic resistor having its two ends connected, respectively, to said oscillatory circuit and said grid.

2. A quartz-controlled thermionic tube oscillation generator comprising a thermionic valve having a cathode, a grid, an anode, and a screen grid for substantially completely neutralizing the grid-to-anode capacitance, a vibratory frequency stabilizing quartz crystal connected substantially directly across said grid and said cathode, an oscillatory circuit formed between the said anode and cathode, and a feedback path extending between the said oscillatory circuit and the said quartz crystal constituting the sole path for exciting said crystal and consisting of an ohmic resistor having its two ends connected, respectively, to said oscillatory circuit and said grid.

3. A quartz controlled thermionic tube oscillation generator comprising a thermionic valve having at least a cathode, a grid, and an anode, an oscillatory circuit comprising an inductance and two serially connected condensers connected in parallel therewith, means for connecting one end of said inductance to said anode, means for connecting the common point of said condensers to said cathode an ohmic resistor, means for connecting said resistor substantially directly between the other end of said inductance and said grid, a vibratory frequency stabilizing quartz crystal, and means for connecting said crystal substantially directly between said grid and said cathode.

ERICH HEINECKE.