Sept. 8, 1936. K. HEEGNER 2,053,524

CRYSTAL OSCILLATOR

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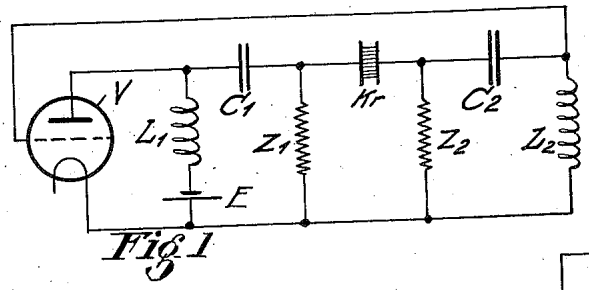

Fig. 1

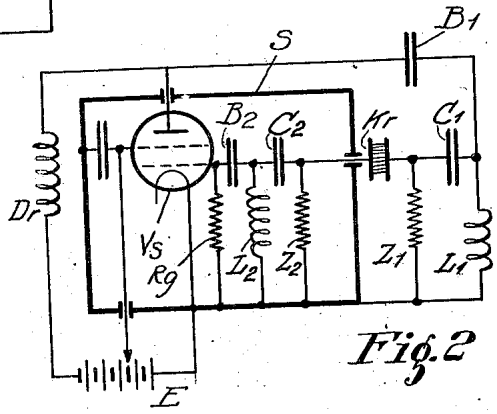

Fig. 2

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CRYSTAL OSCILLATOR

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4 Claims. (Cl. 250—36)

The excitation of piezo-electric crystal resonators by electronic tubes is known for the purpose of maintaining the frequency of an oscillator constant. In the usual connection system, however, the frequency depends on the electrode capacities of the tubes and other electrical connection values. The problem accordingly exists of exciting the piezo-electric resonator in a defined natural frequency. This natural frequency is arrived at if the electrodes of the crystal resonator are short-circuited. Different approximate methods of solving the problem of exciting the short-circuit frequency have already been proposed. However, none of the known schemes works with satisfactory constance and exactness.

According to the present invention there is provided in an oscillation generator an electronic tube with cathode, grid and plate and a piezo-electric crystal, which controls the oscillation of that tube and having two tunable circuits, each pole of the crystals being connected to the cathode of said tube via one of said oscillatory circuits. These circuits consist of a coil and a condenser in series. One of the oscillatory circuits is connected to the anode of the tube, while the corresponding point of the other oscillatory circuit is connected to the grid of the tube, in order of back-coupling. The tube according to the invention is provided with a screen grid and a metallic screen casing which is connected to earth. It contains the tube and the circuits which are connected to the grid of the valve. The metallic screen casing possesses an opening through which there is conducted the lead to the crystal.

This may be accomplished, according to the invention, by connecting each pole of the crystal to the cathode of the valve via an oscillatory circuit, consisting of a coil and a condenser in series, and moreover, via a damping resistance, and by connecting the point between coil and condenser of one oscillatory circuit to the anode of the valve and the corresponding point of the other oscillatory circuit for the purpose of back-coupling the crystal to the grid of the valve.

In the drawing Fig. 1 illustrates a circuit arrangement according to the invention. Fig. 2 illustrates a modification circuit.

An embodiment of the invention is illustrated in Fig. 1. One pole of the crystal Kr is connected to the cathode of the valve V via an impedance Z_1 and, in parallel to it, via condenser C_1 and L_1, the other pole of the crystal via Z_2, C_2 and L_2. The point between L_1 and C_1 is connected to the anode of the valve, the point between L_2 and C_2 to the grid. The anode battery E is in series with coil L_1.

It is to be mentioned that L_1 and C_1 and, at the same time L_2 and C_2 may be exchanged.

The coupling impedances Z_1 and Z_2 should be selected as large as possible, and should possess a preponderant ohmic component in order to damp the electric circuits in the desired fashion. The impedances should be selected in such fashion that disturbing waves, which may be caused by the electrode capacity of the crystal, are suppressed. One of the impedances may be dispensed with if the other is made smaller. It is also possible to dispense with both impedances if a resistance is put in parallel to the crystal.

The exact tuning of the electric circuits to the crystal frequency may be performed as follows: The impedance Z_2 is replaced by an ohmic resistance, which is in the order of the coil resistance of L_2. When in this connection the oscillations cease, a suitable resistance should be connected in parallel with the crystal. The tuning of the series element (C_2, L_2) may then be recognized from the anode current of the tube. The crystal circuit (Z_1, Kr, Z_2) is then replaced by a low ohmic coupling resistance, and the circuit (L_1, C_1) tuned to the circuit (L_2, C_2). The procedure is similar in the case of other connection systems.

It is advantageous to replace the single grid valve V by a screening grid valve Vs (Fig. 2) in order to make the inner resistance of the valve large in comparison with the reactance of L_1. Further screening means are essential at higher frequencies. An arrangement of this kind, corresponding to the scheme of Fig. 1, is shown in Fig. 2. The earthed screen S embraces the screen grid valve Vs and the elements connected to the grid up to the crystal Kr which possesses nearly earth potential. In order to show possible variations of the scheme coil L_2 is connected to the grid via a condenser B_2 and also coil L_2, to the anode via a condenser B_1, grid back resistance Rg and anode choke Dr being provided.

I claim:

1. In an oscillation generator an electronic tube having cathode, grid and plate, and a piezo-electric crystal controlling the oscillation of said tube, two tunable circuits, each pole of said crystals being connected to the cathode of said tube via one of said osillatory circuits, consisting of a coil and a condenser in series, one of said oscillatory circuits being connected to the anode of said tube and the corresponding point of the other oscil-

latory circuit being connected to the grid of said tube in order of back-coupling.

2. In an oscillation generator an electronic tube having cathode, grid and plate, and a piezo-electric crystal controlling the oscillation of said tube, two tunable circuits, each pole of said crystals being connected to the cathode of said tube via a damping resistance and via one of said oscillatory circuits, consisting of a coil and a condenser in series, one of said oscillatory circuits being connected to the anode of said tube and the corresponding point of the other oscillatory circuit being connected to the grid of said tube in order of back-coupling.

3. In an oscillation generator an electronic tube having cathode, grid and plate, and a piezo-electric crystal controlling the oscillation of said tube, two tunable circuits, each pole of said crystal being connected to the cathode of said tube via one of said oscillatory circuits, consisting of a coil and a condenser in series, one of said oscillatory circuits being connected to the anode of said tube and the corresponding point of the other oscillatory circuit being connected to the grid of said tube in order of back-coupling, said tube being provided with a screen grid, means connecting said screen grid to said cathode.

4. In an oscillation generator an electronic tube having cathode, grid and plate, and a piezo-electric crystal controlling the oscillation of said tube, two tunable circuits, each pole of said crystal being connected to the cathode of said tube via one of said oscillatory circuits, consisting of a coil and a condenser in series, one of said oscillatory circuits being connected to the anode of said tube and the corresponding point of the other oscillatory circuit being connected to the grid of said tube in order of back-coupling, said tube being provided with a screen grid, means connecting said screen grid to said cathode, a metallic screen casing connected to earth and containing said tube and the circuits connected to the grid of said valve, in said screen casing an opening through said opening there is conducted the lead to the crystal.

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