Jan. 14, 1936. H. O. PETERSON 2,027,448

CRYSTAL CONTROLLED OSCILLATOR

Filed March 21, 1927

Fig. 1

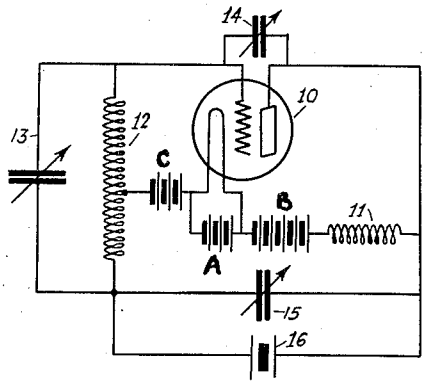


Fig. 2

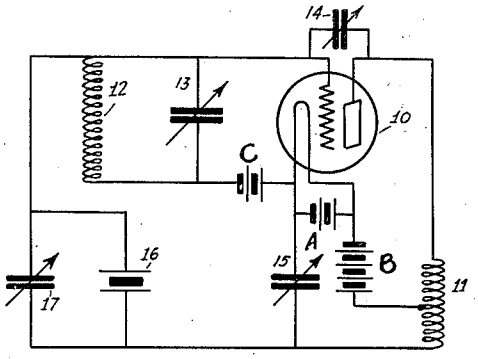


Fig. 3

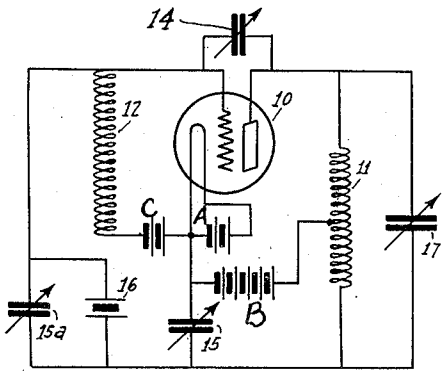


Fig. 4

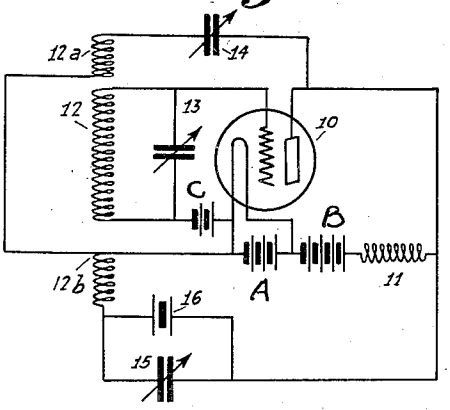
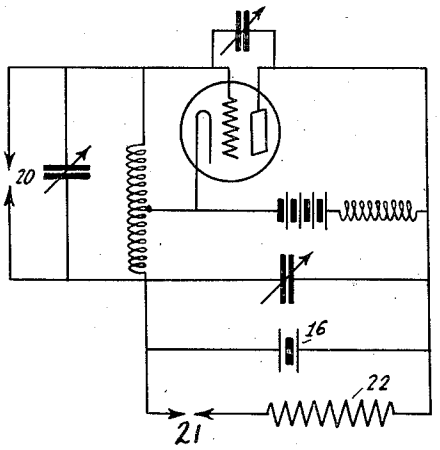


Fig. 5



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CRYSTAL CONTROLLED OSCILLATOR

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9 Claims. (Cl. 250—36)

This invention relates to the piezo electric art and deals more specifically with a piezo electric crystal controlled oscillator.

It has been found that certain piezo electric crystals when cut in accordance with the specifications now well known relative to the preparation of such crystals, are set into oscillation only with great difficulty.

It is, therefore, an object of this invention to devise a circuit which is more forceful in causing a piezo-electric crystal to oscillate.

It has also been found that the degree of control exercised by a crystal upon an oscillating circuit is an inverse function of the amount of regeneration necessary to make the crystal oscillate.

It is, therefore, a further object of this invention to devise a crystal controlled oscillation circuit arranged for minimum regeneration.

These and other objects of the invention will be apparent readily to those skilled in the art from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a diagrammatic sketch showing one embodiment of my invention.

Figures 2 to 5 inclusive are diagrammatic views showing modified forms of the invention.

Referring in detail to Figure 1, a vacuum tube 10 having the usual filament, grid and plate is provided with the usual A, B and C batteries as shown. A choke coil 11 is connected in the plate circuit of the tube 10. The input or grid-filament circuit of the tube 10 is tuned by means of the inductance 12 and variable condenser 13. A neutralizing variable condenser 15 is connected between the plate and the resonant circuit 12—13. The piezo-electric crystal 16 is connected in parallel with the variable condenser 15 between the resonant circuit 12—13 and the plate of the vacuum tube. 14 indicates an additional balancing variable condenser to enable the circuit to be balanced in case the capacity of the crystal 16 plus the capacity of the condenser 15 is so much greater than the internal plate to grid capacity of the tube, that the circuit would oscillate as an ordinary tube oscillator, for adjustments of the resonant circuit 12—13 at frequencies other than the natural periods of the crystal. The condenser 15 is chosen of as small capacity as possible to obtain the balanced effect, for the reason that the balancing or unbalancing coupling should be made through the crystal 16.

The operation of the circuit is as follows:

When the vacuum tube 10 is energized and the circuit 12—13 is properly tuned the system goes into oscillation at a frequency substantially equal to the mechanical frequency of vibration of the crystal, and the frequency of oscillations generated remains substantially constant for a considerable variation in the electrical constants of the circuit.

Referring to Figure 2 the vacuum tube 10 provided with the usual filament, grid, and plate and also the usual A, B and C batteries, has the coil 11 in the plate filament circuit. The B battery is connected between the positive terminal of the filament and the mid-point of the coil 11. A neutralizing variable condenser 15 is connected between the coil 11 and the negative terminal of the filament. The input circuit of the vacuum tube 10 is provided with the usual coil 12 and condenser 13. A second neutralizing or balancing variable condenser 14 is connected between the plate and grid of the tube 10 as shown. Connected between the grid of the tube and the coil 11 is the crystal 16 which is by-passed by a variable condenser 17.

Figure 3 shows a vacuum tube 10 having a plate circuit tuned by the coil 11 and the variable condenser 17. The B battery is connected between the negative terminal of the filament and the mid-point of the coil 11. A neutralizing variable condenser 15 is connected between the filament of the tube 10 and the coil 11 in a manner similar to the modification shown in Figure 2. The second neutralizing or balancing variable condenser 14 is connected between the plate and grid of the tube 10. The input circuit of the vacuum tube 10 comprises the coil 12 connected between the grid and filament. A balancing variable condenser 15*a* is connected between the filament and grid and the piezo electric crystal is shunted across said last mentioned variable condenser 15*a*.

Referring to Figure 4 the vacuum tube 10 having the usual filament, grid and plate and also the usual A, B and C battery connected as shown is provided with the coil 11 in the plate circuit. The input circuit of the vacuum tube 10 comprises the coil 12 and the variable condenser 13 connected as shown. A variable condenser 14 in series with a coil 12*a* is connected between the plate and the negative terminal of the filament. Similarly a neutralizing variable condenser 15 and a coil 12*b* are connected in series between the negative terminal of the filament and the plate of the vacuum tube. The piezo electric crystal 16 is shunted across the variable condenser 15.

It has been found that when the plate poten-

tial is first applied exceedingly high voltages are developed across the plates of the crystal and in order to protect the crystal, I have provided the arrangement shown in Figure 5 which is the same circuit as shown in Figure 1 having in addition the gap or lightning arrester **20** across the input circuit and also the gap or lightning arrester **21** connected across the plates of the piezo-electric crystal **16**. I have also found it desirable to include the high resistance **22** in the gap **21**, which resistance is of the order of magnitude of 50,000 ohms.

I claim as my invention:

1. The combination of a vacuum tube oscillation generator having a filament, grid and plate, a first means to augment the inherent capacity between said plate and said grid, auxiliary means to neutralize said augmented capacity, and piezo electric means connected in parallel with a portion of said last mentioned means.

2. An oscillation generator comprising the combination of a tube having an anode, a cathode and a grid, a coil connected at an intermediate point to said cathode and at one end to said grid, a variable condenser connecting the other end of said coil to said anode, a coil connected between said anode and cathode, a variable condenser connected across said anode and grid, and a two electrode piezo-electric crystal connected in shunt to said first mentioned condenser.

3. An oscillation generator comprising the combination of an electron discharge device having an anode, a cathode and a grid, a circuit comprising a condenser and an inductance coil connected between said grid and cathode, a second inductance coil, one terminal of said second coil being connected to said anode and an intermediate point on said second coil being connected to said cathode, a variable condenser connecting the other end of said second coil to said grid and a two electrode piezo-electric crystal connected in shunt to said last mentioned variable condenser.

4. Apparatus as claimed in the preceding claim characterized by the fact that there is provided in shunt to said grid and anode a variable condenser and that there is connected between said cathode and one terminal of said piezo-electric crystal an additional variable condenser.

5. An oscillation generator comprising the combination of an electron discharge device having an anode, a cathode and a grid, high frequency circuits interconnecting said anode, grid and cathode electrodes, a two electrode piezo-electric crystal connected to a pair of said electrodes for frequency stabilizing the frequency of oscillations generated by said device and, a two electrode spark gap connected across said piezo-electric crystal.

6. Apparatus as claimed in the preceding claim characterized by the fact that in series with said spark gap there is connected a resistance.

7. In a crystal controlled oscillator, comprising a vacuum tube having cathode, grid and plate electrodes, an output oscillatory circuit connected between said plate and grid electrodes, a connection from said cathode to an intermediate point on said oscillatory circuit and a piezo electric control crystal and a variable compensating condenser being inserted in the lead from said output circuit to said grid electrode.

8. In a high frequency oscillator, comprising a vacuum tube having filament, grid and plate electrodes, an output circuit connected between said grid and said plate electrode, a connection from said filament to a tap point on said output circuit, and a compensating condenser and an electromechanical oscillating control device connected in the lead from said grid electrode to said output circuit.

9. In a high frequency oscillator, comprising a vacuum tube having filament, grid and plate electrodes, an output circuit connected between said grid and said plate electrode, a connection from said filament to a tap on said output circuit, and a compensating condenser and a piezo electric control device connected in the lead from said grid electrode to said output circuit.

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