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PIEZO ELECTRIC CRYSTAL OSCILLATOR CIRCUIT

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Fig. 1

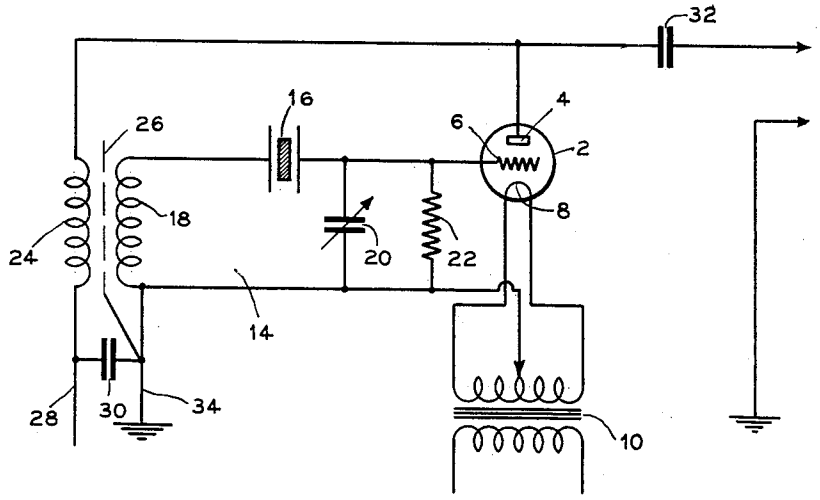
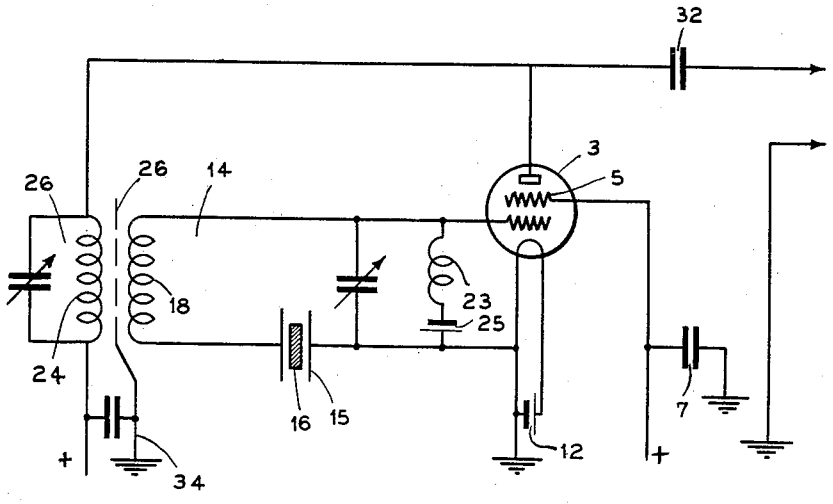


Fig. 2



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PIEZO-ELECTRIC CRYSTAL OSCILLATOR CIRCUIT

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6 Claims. (Cl. 250—36)

Cady has taught in Figure 3 of United States Patent Number 1,472,583, a very excellent crystal controlled oscillation generator. However, I have found that at certain frequencies the crystal, of that circuit, tends to act as, simply, a dielectric as a result of which spurious or parasitic oscillations of a frequency other than that corresponding to the natural frequency of the crystal may be generated. To overcome the generation of such spurious oscillations, therefore, is the principal object of my present invention and to do so, I insert the crystal in the parallel tuned circuit forming part of the grid circuit of the Cady Figure 3 oscillator referred to.

In this manner, the tuning condenser of the grid circuit acts as a by-pass for spurious frequencies. However, for energy corresponding to the frequency of the crystal, the crystal acts as a series tuned circuit and develops across the grid and cathode sufficient voltages at the desired frequency to actuate the tube oscillating system.

My present invention is more fully described with the aid of the accompanying drawing wherein Figure 1 is a schematic wiring diagram of my invention utilizing a three electrode tube, and,

Figure 2 is a modification thereof making use of a multigrid or screen grid type of tube.

Turning to Figure 1, I have diagrammatically illustrated an electron discharge device 2 having an anode or plate 4, a grid or control electrode 6, and, a cathode or filament 8. The latter may be energized with heating currents to an electron emitting condition by action of transformer 10. Of course, the cathode 8 may be of the indirectly heated type or may simply be, as illustrated in Figure 2, a D. C. energized filament, energized by a suitable D. C. source diagrammatically illustrated in Figure 2 at 12.

Referring back to Figure 1, it is to be noted that in the parallel tuned circuit 14 forming part of the input or grid circuit, I have inserted a piezo-electric frequency controlling crystal or electromechanical frequency controlling resonator 16. More particularly, I place the crystal between the inductance coil 18 and variable condenser 20 forming the parallel tuned circuit 14. It is to be noted in the Cady circuit referred to, the crystal 16 is inserted between the parallel tuned circuit and the grid or control electrode 6.

For establishing a suitable control electrode bias a grid leak resistor 22 is provided which, of course, may be replaced by a suitable D. C. source such as a potentiometer or bias source in series with a resistor or suitable choke to prevent the flow of radio frequency currents generated through the source.

An inductive feed back from plate 4 is provided by a tickler or input coil 24 coupled to the parallel tuned grid or input circuit 14. The capacitive coupling between the coils 24, 18 may be entirely eliminated or reduced to any desired amount by suitable grounded electrostatic shielding 26. Anode supply occurs through the lead 28 from a source (not shown). The D. C. end of the tickler coil attached to lead 28 is grounded through a suitable blocking condenser 30 for the alternating currents generated. Output energy is derived from the leads having arrows thereon as shown in the drawing, the output circuit being blocked off from the plate D. C. potential by action of a blocking or stopping condenser 32.

By way of further explanation, should there be a tendency for the generation of spurious or parasitic oscillations, the condenser 20 of the parallel tuned circuit 14, will effectively by-pass to ground 34 spurious frequencies of a value higher than that of the crystal, and prevent the building up of spurious frequency potentials upon the grid 6. Coil 18 acts similarly with respect to frequencies below that of the crystal. Hence, any tendency to operate at a frequency other than that corresponding to the natural frequency of the piezo-electric crystal controlling element 16, immediately dies down to zero.

However, at a frequency of oscillation corresponding to that of the piezo-electric crystal controlling element 16, or electromechanical vibrator 16, the crystal 16 may be said to act as a series tuned circuit drawing a large current through the condenser 20-coil 18 combination and causes resonance effects in the parallel tuned circuit formed by coil 18 and condenser 20. Or, it may be considered that the crystal 16 at resonance draws a large current causing a large voltage drop across the grid leak resistor 22. In any event, at the natural frequency of the crystal, voltage oscillations are set up between the grid 6 and filament 8 causing a desired output only at the desired frequency.

Preferably, the feed back coil 24 is reversed relative to coil 18 so that the circuit fails to oscillate without the crystal. I prefer, however, to reverse the magnetic coupling so that normally it is degenerative. Despite this, however, oscillations occur since it will be found that

the action of the parallel tuned circuit in the input circuit, by suitable tuning thereof, brings the feed back in correct phase for oscillation generation.

The tickler coil 24 may be tuned as indicated in Figure 2 by means of a variable condenser 26. Moreover, rather than use a three element tube as shown in Figure 1, a screen grid or multigrid tube 3 as shown in Figure 2, may be provided, the screen grid 5 being suitably grounded for radio frequency currents by the action of the grounding condenser 7.

As an added refinement, the crystal 16 may be placed in the parallel tuned circuit 14 such that one of its electrodes 15 is grounded. This arrangement presents certain advantages in the mechanical construction of such an oscillator. As already indicated, the grid leak resistor 22 may be replaced by the series combination of a choke 23 and bias source 25 also indicated in Figure 2.

Also in Figure 2, it is preferred that the inductive feed back between coils 24 and coil 18 be reversed so that the circuit fails to oscillate without the presence of crystal 16. Because of the disposition of the crystal in Figure 2, the grounding of the shielding 26 must be altered, as illustrated, so that both electrodes of the crystal are not grounded which, obviously, would render the circuit inoperative.

It is not necessary to use the feed back coil as shown in Figure 1 providing there is enough interelement capacity between the plate 4 and grid 6. Spurious oscillation generation is reduced in such a simplified circuit also by the action of the circuit formed by the series combination of crystal 16, condenser 20 and coil 18. However, I consider it preferable to use a reversed feed back coil 24 which may or may not be tuned by condenser 26 as shown in Figure 2. A test to indicate that the feed back is reversed would be to place an element, such as a piece of glass, having the same capacity as that of crystal 16 between its electrodes but without any piezo-electric properties. Generation of oscillations would show that the inductive feed back is regenerative whereas absence of oscillation generation would indicate the desired reversed feed back.

Having thus described my invention what I claim is:

1. An electron discharge device oscillator comprising an electron discharge device having a plurality of electrodes, a parallel tuned circuit connected between two of said electrodes, a piezo-electric crystal connected between the coil and condenser of said parallel tuned circuit, and, a connection to ground from a point on said parallel tuned circuit.

2. In apparatus of the character described, an electron discharge device having an anode a cathode and a control electrode, a parallel tuned circuit comprising a coil and condenser connected between said control electrode and cathode, an electro-mechanical resonator connected between said coil and condenser, and, a low impedance connection to ground from a point on said parallel tuned circuit.

3. In apparatus of the character described, an electron discharge device having an anode a cathode and a control electrode, a parallel tuned circuit comprising a condenser and a coil connected to said control electrode and cathode, a piezo-electric crystal connected in said parallel tunable circuit and serially between said coil and condenser, a feed back coil coupled to said first mentioned coil and connected to said anode, and, means for reducing capacitive effects between said coils.

4. A crystal controlled oscillation generator comprising a vacuum tube having an anode electrode, a grid and a grounded cathode; a variable condenser connected across said grid and cathode, the series combination of an inductance coil and a piezo-electric crystal also connected across said control electrode and cathode, one electrode of said piezo-electric crystal being connected to said cathode, said condenser serving to tune, to parallel resonance, said inductance coil, and, a feed back coil connected to said anode and coupled to said first mentioned inductance coil.

5. A constant frequency oscillation generator comprising a vacuum tube having an anode, a cathode and a grid; a resistance connected between said grid and cathode; a parallel tunable circuit comprising an inductance coil and the series combination of a piezo-electric crystal and a condenser connected thereacross, connected to said grid and cathode; a tickler coil coupled to the coil of said parallel tunable circuit and said anode, a grounded metallic screen interposed between said coils for reducing capacity transfer of energy therebetween, and, means for grounding a point on said parallel tunable circuit for alternating currents.

6. An oscillation generator comprising a vacuum tube having an anode, a cathode a control grid, and a screen grid; means for grounding said screen grid for alternating current potentials; a piezo-electric crystal having two electrodes, one of its electrodes being connected to its cathode; a coil, one terminal of said coil being connected to the other electrode of said piezo-electric crystal; a connection from another point on said coil to said control grid, a variable tuning condenser connected across said control grid and cathode for tuning said coil to parallel resonance, a tickler coil coupled to said first mentioned coil and connected to said anode for establishing electromagnetic feed back of energy from said anode to the circuit including said first mentioned coil, variable condenser and crystal, and, a grounded metallic screen interposed between said coils for reducing capacity transfer of energy therebetween.

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