Nov. 19, 1935. H. E. GOLDSTINE ET AL 2,021,722

CRYSTAL CONTROLLED GENERATOR

Original Filed March 9, 1932

Fig. 1

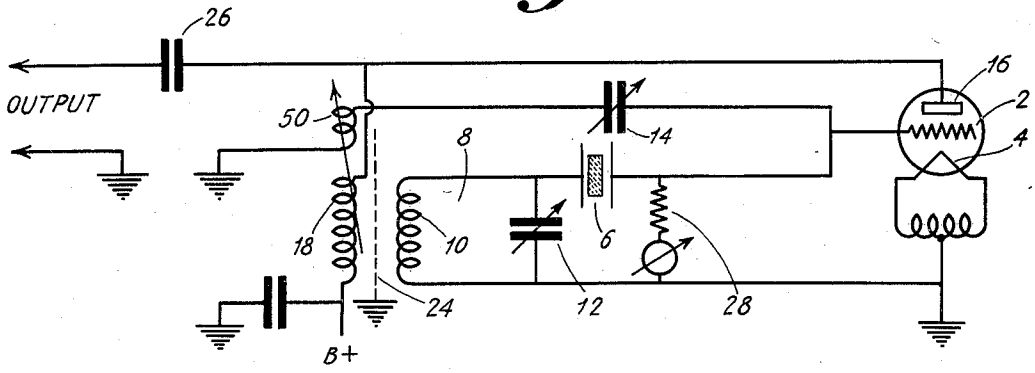
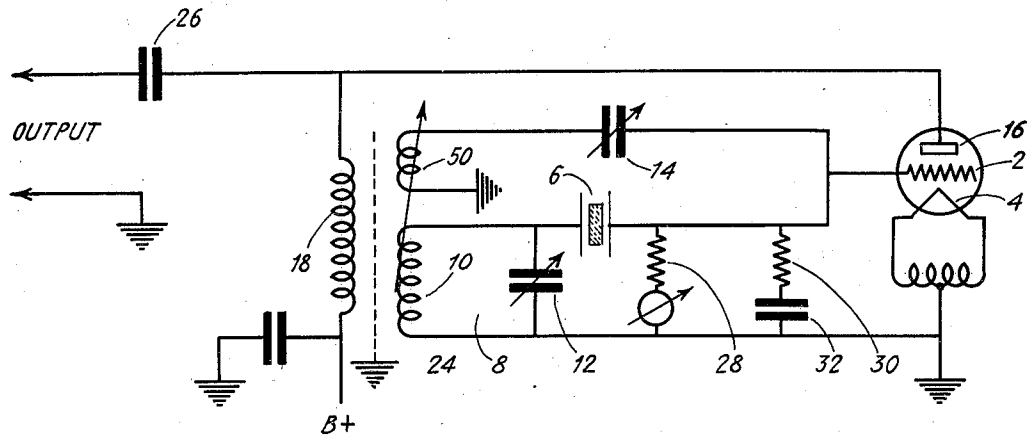


Fig. 2



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CRYSTAL CONTROLLED GENERATOR

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Original application March 9, 1932, Serial No. 597,740, now Patent No. 1,989,442, dated January 29, 1935. Divided and this application January 25, 1935, Serial No. 3,424

3 Claims. (Cl. 250—36)

Our present invention relates to crystal controlled oscillation generators and has as its principal object an improved circuit which shall be highly constant in frequency of operation, simple to set up, and readily adjustable for optimum operation.

This application is a division of our copending application Serial No. 597,740, filed March 9, 1932, Patent Number 1,989,442, dated January 29, 1935.

Our present invention is described more fully with the aid of the accompanying drawing wherein Figures 1 and 2 are wiring diagrams of crystal controlled oscillators embodying the principles of our present invention.

Referring to the drawing, between control grid 2 and cathode 4 of a vacuum tube represented by the solid line circle, there is connected a piezo-electric frequency controlling element 6 having, as illustrated, two electrodes. Also, between the grid 2 and filament 4 there is connected parallel tuned circuit 8 comprising an inductance coil 10 shunted by a variable tuning condenser 12.

Also, between the grid 2 and the cathode 4 or between the grid 2 and ground there is connected the serial combination of a neutralizing condenser 14 and coupling coil 50. In Figure 1 the coupling coil 50 is coupled to the plate tickler coil 18 which, as shown, is connected to the plate 16 and coupled to the coil 10 of the input circuit 8. In Figure 2 the coil 50 is coupled only to the coil 10 of the input circuit 8.

The shielding 24 is provided between the coils 18, 10 to prevent, to any desired degree, capacitive or electrostatic coupling therebetween. Output energy is derived through blocking condenser 26 through the leads indicated "output" on the drawing.

For establishing a suitable bias on control grid 2, resistor 28 is provided and is preferably of high ohmic value.

At resonance, the capacitance of the crystal and its associated electrodes has a value in impedance equal to the resistance of the resonator at the desired frequency. Consequently, it will be obvious that at the desired frequency the phase of voltages applied to the grid and plate will not be exactly that required for best operation at the natural frequency of the crystal. Accordingly, by adjustment of condenser 14 until the capacitive reactance of the crystal and its associated electrodes are eliminated or effectively neutralized or compensated, the circuit will oscillate at a frequency corresponding almost exactly with that frequency for which the crystal is ground. In addition, as already pointed out, variations in load will produce no effective reaction back upon the crystal as a result of which relatively large stable outputs may be derived from the present system.

As a further improvement, as shown for example in Figure 2, there may be provided in shunt with the grid leak resistor 28 a low impedance connected across the grid 2-filament 4 circuit in the form of a resistance 30 in series with a bypassing condenser 32. Resistance 30 is of relatively low value and prevents the generation of spurious oscillations through its bypassing effect.

However, oscillations of desired frequency are built up in the parallel tuned circuit 8 by virtue of the lower impedance to the desired frequency offered by crystal 6, as a result of which in the output circuit of the system, only energy of desired frequency, namely, that of the crystal, appears.

It is to be noted that the crystal neutralizing circuit is inductively coupled in Figure 1 to the plate circuit and in Figure 2 it is inductively coupled by coil 50 to the input or grid circuit.

Having thus described our invention, what we claim is:

1. A crystal controlled oscillator comprising a tube having a plate, a grid and a filament, a parallel tuned circuit consisting of a coil and a condenser connected in parallel, a two electrode piezo-electric crystal connected between one side of said tuned circuit and said grid, a connection between the other side of said tuned circuit and said filament, a coil connected between said plate and filament and coupled to said tuned circuit, and the series combination of a condenser and a coil connected between said grid and filament, said last mentioned coil being coupled to one of said first mentioned coils.

2. Apparatus as claimed in the preceding claim characterized by the fact that said last mentioned coil is coupled to the coil connected between said plate and filament.

3. Apparatus as claimed in claim 1 characterized by the fact that said last mentioned coil is coupled to the coil of said parallel tuned circuit.

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