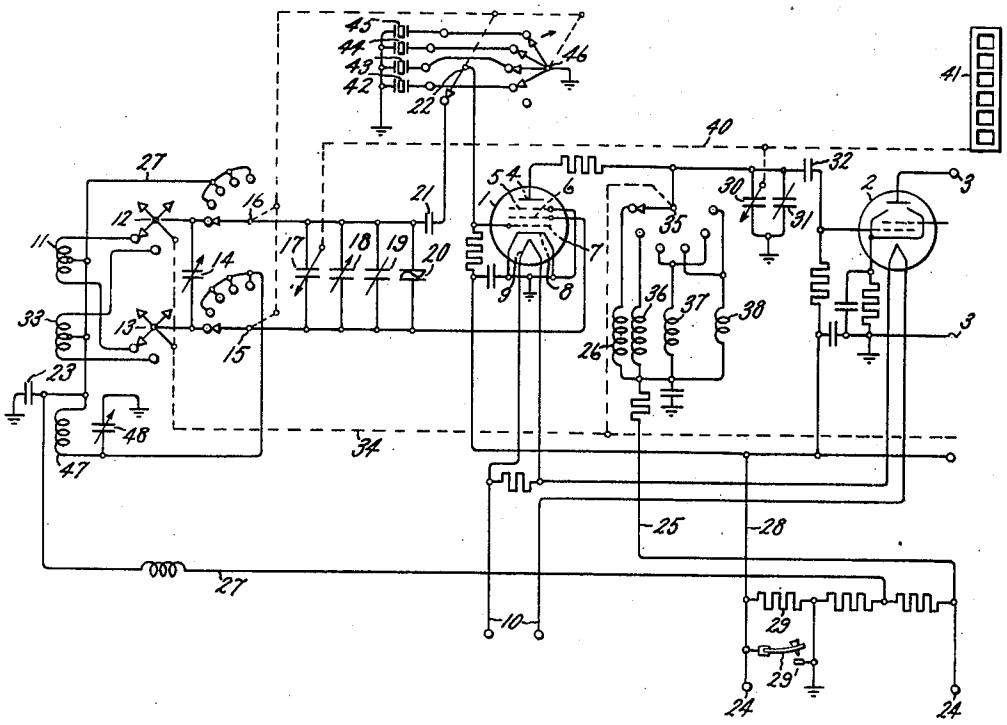
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OSCILLATION GENERATOR

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OSCILLATION GENERATOR

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5 Claims. (Cl. 250—36)

My invention relates to electron discharge oscillation generators and more particularly to such generators arranged for accurate frequency adjustment and control.

Commonly, oscillation generators arranged for accurate control of the frequency of oscillations produced employ piezoelectric crystals to effect such control. It frequently happens, however, that the generator must be variable in frequency over a wide range, whereas piezoelectric crystals usually operate only at their natural frequency.

One of the objects of my invention is to provide an oscillation generator capable of producing oscillations continuously variable in frequency over a range but which included improved means for accurate calibration of the frequency by piezoelectric means, at one or more points in the range.

A further object of my invention is to provide an oscillation generator capable of producing oscillations variable over a wide range and which is adapted to have its frequency controlled by a piezoelectric crystal at one or more points in the range by simple operation of a switch.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which the single figure represents an embodiment of my invention.

Referring to the drawing, I have shown therein an oscillator amplifier combination comprising an electron discharge device 1 arranged for the generation of oscillations, which may be amplified in an electron discharge device 2 and then supplied to an output circuit connected between the anode and cathode of device 2 through terminals 3.

The electron discharge device 1 comprises an anode 4, a suppressor grid 5, a screen grid 6, a control electrode 7, an indirectly heated cathode 8 and a heater 9 for the cathode. This heater may be energized from any suitable power supply circuit 10. Connected between the control electrode 7 and screen grid 6 of the discharge device is an oscillatory circuit comprising an inductance 11 which is connected by means of switches 12 and 13 across a condenser 14 and through switches 15 and 16, across condensers 17, 18, 19 and 20. One terminal of this oscillatory circuit is connected through the usual grid condenser 21 and a switch 22 to the control electrode 7. The opposite terminal is directly connected to the screen grid 6 and an intermediate point on inductance 11 is connected through a condenser 23 to ground and thence back to the cathode 8 of the discharge device.

Operating potential for the anode of the discharge device is supplied from a suitable source 24 through conductor 25, and inductance coil 26 to the anode, and similarly, operating potential for the screen grid of the discharge device is supplied from the source 24 through conductor 27 and switches 13 and 15 to the screen grid of the discharge device.

Bias potential for the control electrode of discharge device 1 and 2 may be supplied thereto over conductor 28 from resistance 29 the positive terminal of which is grounded. The potential on this resistance is such as to render devices 1 and 2 inoperative. This resistance is arranged to be short-circuited by telegraph apparatus such as a keying relay, or key, as conventionally indicated by the telegraph key 29', thereby to render the system operative in accordance with telegraph signals.

As thus described it will be seen that the circuits comprise those of the usual so-called Hartley oscillator and that oscillations are generated in the oscillatory circuit by reason of the interaction between the screen grid 6, acting as an anode, and the control electrode 7. These oscillations are electronically coupled within the discharge device to the anode 4 thereof and excite the output circuit which comprises inductance 26 and condensers 30 and 31. This circuit may be tuned either to the fundamental frequency to which the circuit 11, 14, 17, 18, 19, 20 is tuned or it may be resonated to a suitable harmonic thereof. These oscillations are then supplied through the coupling condenser 32 to the input of an electron discharge amplifier 2 whereby they are amplified and supplied to the output circuit 3.

The frequency of the oscillations generated may be varied over a broad range by variation of the tuning condenser 17. This condenser is arranged for unicontrol with a second condenser 30 which correspondingly varies the tuning of the circuit 26, 30, 31.

Condensers 14, 18, 19 and 20 may be the usual condensers commonly employed in such circuits and may be either fixed or variable for the purposes of initial adjustment of the system. One of these condensers, as for example the condenser 20, may be one incorporating means to

maintain the frequency of the system constant irrespective of temperature variations. Such condensers are well known in the art and require no description here.

If it be desired to operate the system over different ranges of frequency, one or more additional inductances 33 may be provided and arranged to be switched into the oscillatory circuit by means of the switches 12 and 13. With this switch in the position shown the inductance 11 comprises the inductance of the oscillatory circuit. If this switch be operated in the counterclockwise direction, inductance 11 is removed from the circuit and inductance 33 substituted in its place. This inductance 33 adapts the oscillator for the generation of oscillations in a higher frequency band. Switches 12 and 13 are unicontrolled by means represented by the dotted lines 34 with an additional switch 35 in the output circuit of the discharge device 1. This switch 35 is arranged to disconnect inductance 26 from the circuit and to substitute inductance 36 in its place simultaneously with the removal of inductance 11 from the circuit and the substitution of inductance 33 therefor. Switches 12, 13 and 35 have six positions and may be operated counterclockwise through these positions from the position shown. The inductances 11 and 33 are placed in circuit alternately, each inductance being in circuit in alternate positions of the switch. Inductances 26, 36, 37 and 38 are selectively connected in circuit by the switch 35 to resonate with the condensers 30 and 31 at the fundamental or suitable harmonic of the frequency to which the oscillatory circuit of the oscillator resonates. Thus, while the oscillator itself operates only over two ranges of frequency the output circuit comprising condensers 30 and 31 may operate over four different ranges of frequency.

Condensers 17 and 30 are arranged for unicontrol by means represented by the dotted line 40, which may comprise a rotatable shaft to which may be geared a suitable mechanism 41 for producing a continuous indication of the frequency produced at the different positions of the condenser 17. This mechanism may comprise a series of counting devices, such as is commonly known as a Veeder counter, and which is shown, for example, in Wolff Patent No. 1,692,604, geared together and arranged to read directly in kilocycles on a number of dials the frequency of the oscillations produced and which corresponds to the particular setting of the condensers 17 and 30.

It is desirable that means be provided whereby accurate calibration of frequency at a number of points in one of the bands of frequencies produced may be readily effected. To this end a plurality of piezo-electric crystals 42, 43, 44 and 45 are provided and arranged to be connected selectively between the grid 7 and cathode 8 of the discharge device by means of the switch 22. Switch 22 is arranged for unicontrol with switches 15, 16 and 46, all of which may be operated from the position shown in the clockwise direction through a plurality of positions as shown. With the switch in the position shown, all of the crystals 42 to 45 are short-circuited by the switch 46. This expedient prevents any crystal from being excited into oscillations, when not connected in the circuit, through undesired extraneous capacity between the various conductors employed and thereby exerting undesired control of the frequency when the frequency is varied by condenser 17 through the region of proximity to the natural frequency of the crystal. This latter effect, were the crystal not short circuited, may tend to cause the frequency of the oscillator to pull in step with any crystal as the frequency is varied through the neighborhood of the natural frequency of the crystal.

When the switches are operated in a clockwise direction to the first position piezo-electric crystal 42 is connected between the control electrode 7 and the cathode of the discharge device. The connection between the grid condenser 21 and the control electrode 7 is broken by the switch 22 and the upper terminal of the condensers 17 to 20 are connected through switch 16, conductor 27 and condenser 23 to ground and to the cathode of the discharge device. The lower terminals of these condensers 17 to 20 remain connected to the screen grid 6 of the discharge device. Inductance 47 is now connected in shunt with the condensers 17 to 20 through the switches 15 and 16, this inductance being effectively shunted by the trimmer condenser 48, which is variable for purposes of initial adjustment.

Thus the circuit is now the conventional circuit of a crystal oscillator, the crystal 42 being connected between the control grid and cathode of the discharge device and the tuned circuit comprising condensers 17, 18, 19 and 20, condenser 48 and inductance 47, all in shunt with each other, being connected between the anode and cathode of the discharge device.

This circuit 17 to 20, 47, 48, by reason of the insertion of the reactive elements 47 and 48, now resonates at a frequency higher than the natural frequency of the crystal by an amount sufficient to permit efficient operation of the oscillation generator at the crystal frequency and under control of the crystal.

Thus the operator having the switches in the position shown in the drawing, and desiring to produce the frequency at which the crystal 42 operates, first adjusts the condenser 17 until that frequency is read upon the dials of the indicating mechanism 41. This frequency may be a low frequency in the band of frequencies over which the system operates when switches 12 and 13 are in the position shown. He then may operate the switches 15, 16, 22, 46 in the clockwise direction to its first position where the crystal 42 is connected between the control electrode and cathode. The oscillator then oscillates at the same frequency as before but with its frequency controlled by the crystal.

Similarly, if the operator desires to adjust the frequency to the frequency of any of the other crystals, he operates the tuning condenser until that frequency is noted on the dials of the mechanism 41. He then throws the switch 22 to the corresponding crystal and the oscillator oscillates at the desired frequency with crystal control. Thus the operator desiring to calibrate the system may adjust it for proper operation under crystal control at the frequency determined by any of the crystals 42, 43, 44 and 45, all of which may have natural frequencies in the band over which the system operates when the switches are in the position shown. Having done this, the operator may then adjust the elements 14 and 11 so that there is no change in frequency when the switch 22 is returned to the position shown. When so adjusted the system oscillates at an accurate frequency at any frequency in the continuous band over which the sytem is tunable by means of the condenser 17.

If desired an additional reactance element cor-

responding to the inductance 47 and condenser 48 may be provided for use over the band of frequencies over which coil 33 operates. This, of course, involves the use of a second set of crystals and the necessary switching means.

It will be understood that it is highly important that the oscillatory circuit be adjusted by switches 15 and 16 to substitute the reactance elements 47 and 48 for 14 and 11 or 14 and 33 as the case may be since if that were not done, oscillations would cease, or the system would operate unsatisfactorily, when the switch 22 is thrown to any crystal position. This is because when the crystal is connected to the discharge device the oscillating circuit is required to be tuned to a frequency higher than the natural frequency of the crystal for satisfactory operation at that frequency, and higher than the frequency at which the circuit comprising condensers 14 and 17 to 20 resonates when that circuit is adjusted to produce the natural frequency of the crystal but without crystal control.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since different modifications may be made without departing from the spirit and scope of my invention, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The combination, in an oscillation generator of an electron discharge device having input and output electrodes, a switch having a plurality of positions, regenerative circuits connected to said discharge device through said switch in one position thereof and coupling said electrodes to support oscillations, said circuits including a frequency determining oscillatory circuit including a reactance element variable to change the frequency of oscillations produced over a range, a piezo electric crystal having a natural frequency in said range, said crystal being arranged to be connected to said input electrodes when said switch is operated to a second of its positions, and means responsive to operation of said switch to said second position to connect said oscillatory circuit between said output electrodes and to tune it to a frequency sufficiently higher than the natural frequency of said crystal to support oscillations having a frequency in said range and controlled in frequency by said crystal whereby the frequency of oscillations determined by said frequency determining circuit may be compared with the frequency of oscillations controlled by said crystal by changing the position of said switch.

2. In combination, in an oscillation generator, of an electron discharge device having a cathode, anode, and control electrodes, a switch having a plurality of positions, an oscillatory circuit connected through said switch in one position thereof between said anode and control electrode to support oscillations, said circuit including a tuning condenser to vary the frequency produced over a range of frequencies, a piezo electric crystal having a natural frequency in said range, means responsive to operation of said switch to a second position to connect said crystal between said cathode and control electrodes, to disconnect said oscillatory circuit from said control electrode, to connect it between said cathode and anode and sufficiently to increase the resonance frequency thereof that when said tuning condenser is adjusted to a position corresponding to the natural frequency of said crystal oscillations of said natural frequency are produced with said switch in either said one or said second position and the frequency of oscillations produced with said switch in said two positions may be compared by operating said switch from one of said positions to the other while the position of said tuning condenser remains unchanged.

3. The combination, in an oscillation generator, of an electron discharge device having input and output electrodes, regenerative circuits coupling said electrodes to support oscillations, tuning means to vary the frequency of said oscillations over a range of frequencies, a piezo electric crystal having a natural frequency in said range, and switching means operable when said tuning means is adjusted to the frequency of said crystal to connect said crystal to said discharge device to control the frequency of oscillations produced and simultaneously to alter the tuning of said circuits to resonate at a frequency appropriately higher than the frequency produced to accommodate said crystal, whereby oscillations of the same frequency may be produced having frequency either controlled by said crystal or independent of said crystal in accordance with the operation of said switching means and the frequency of said oscillations produced without crystal control may be compared with that produced with crystal control by changing the position of said switch from one position to the other.

4. The combination, in an oscillation generator, of an electron discharge device having input and output electrodes, regenerative circuits coupling said electrodes to support oscillations, said circuits including an inductance and a condenser variable to resonate with said inductance over a range of frequency, a piezo electric crystal having a natural frequency in said range, switching means operable to connect said crystal to said discharge device to control the frequency of oscillations produced and simultaneously to disconnect said inductance and to substitute therefor reactance resonating with said condenser at a frequency such that oscillations are generated of the same frequency irrespective of the operation of said switch, whereby the accuracy of the frequency determined by said regenerative circuits may be compared by operating said switch to produce oscillations of the same frequency controlled by said crystal.

5. An oscillation generator adapted to generate oscillations continuously variable over a wide range of frequencies and arranged to be crystal controlled at a number of frequencies in said range, said generator including an electron discharge device having input and output electrodes, and a plurality of oscillatory circuits, said circuits having a variable frequency determining reactance element common thereto and having individual reactance elements, a plurality of piezo electric crystals having different natural frequencies in said range, means to connect one of said oscillatory circuits between input and output electrodes of said discharge device to generate oscillations having frequency variable over said range by variation of said common element, and means selectively to connect said piezo electric crystals to said input electrodes and simultaneously to disconnect said first connected individual reactance element and to connect a second of said individual reactance elements to said common variable reactance ele-

ment thereby to generate oscillations having a frequency in said range and controlled by the crystal connected to said input electrodes, said second individual reactance element being proportioned to resonate with said common reactance element, at any adjustment thereof, at a frequency sufficiently higher than said one individual element resonates therewith to accommodate said crystals at their respective frequencies in said range whereby the frequency in said range produced independent of said crystals may be compared with the same frequencies of oscillations controlled by respective crystals by operating said connecting means.

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