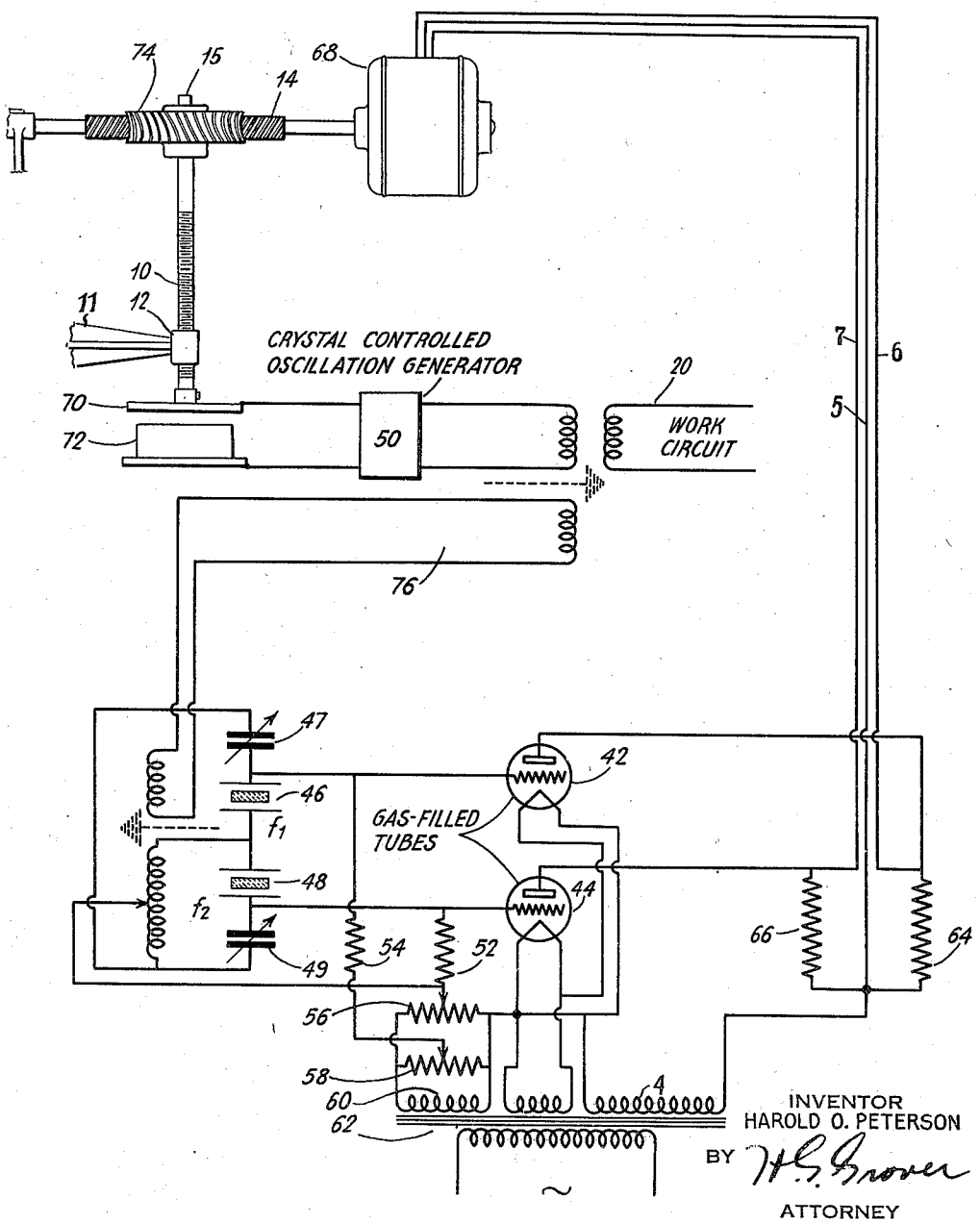
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FREQUENCY COMPENSATOR FOR AN OSCILLATION GENERATOR

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FREQUENCY COMPENSATOR FOR AN OSCILLATION GENERATOR

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6 Claims. (Cl. 250—36)

This application is a division of my co-pending application, Serial No. 542,208, filed June 5, 1931, which application has now matured into Patent #2,007,145, dated July 2, 1935. The invention relates to means for accurate adjustment of the frequency of a high frequency oscillation generator.

It is an object of my invention to provide an oscillation generator having an automatically adjustable piezo-electric crystal device associated therewith for producing oscillations at a predetermined frequency.

It is a further object of my invention to provide means for compensating an oscillation generator so as to maintain its frequency substantially constant, notwithstanding the presence of factors which would tend to introduce a frequency drift into the oscillatory output from such a generator.

Still another object of my invention is to provide for the automatic adjustment in frequency of an oscillating source to correspond with a desired predetermined frequency or band of frequencies.

In carrying out my invention I preferably employ a piezo-electric crystal having at least one spaced electrode adjustably associated therewith and I provide automatic means for varying the spacing of such electrode with respect to a face of the crystal so that its operating frequency may be varied within certain limits. This crystal when placed in circuit with an oscillation generator is caused to control the frequency of oscillations and to compensate for a drift in the frequency of the oscillations generated. If, therefore, I provide an auxiliary circuit operative under control of a portion of the output energy of the oscillation generator and further provide two parallel monitoring circuits one of which has a frequency characteristic at the upper limit of the tolerable frequency variation for my oscillation generator while the other of the circuits has a frequency characteristic at the lower limit, then it becomes possible to utilize output energy from these two parallel monitoring circuits alternatively so as to actuate a motor or other device thereby to adjust the variable spacing between the first mentioned piezo-electric crystal and one of its electrodes.

The features of my invention which are considered novel and patentable have been defined according to the appended claims. The invention itself, however, may be best understood both as to its structural organization and mode of operation upon reference to the accompanying drawing, the sole figure of which shows illustratively an arrangement for automatically maintaining the frequency of an oscillation source within desired limits.

Referring to the drawing I show conventionally an oscillation generator 50 under control of a piezo-electric crystal 72 having two electrodes, one of which, the electrode 70, is preferably supported in spaced relation to the crystal. The means for maintaining a suitable spaced relation between the crystal and its electrode 70 may, if desired, include a threaded shaft 10. This shaft, together with the structure as described in the following paragraph, is merely illustrative of such adjusting mechanisms as might be chosen for the purposes indicated. Other mechanisms may, of course, be utilized according to the choice of those skilled in the art without departing from the spirit of the invention.

A motor 68 is provided for driving a worm 14 with which a worm wheel 74 is meshed. The shaft 10 is rotated by the worm wheel. Means (not shown) are provided for maintaining the worm and the worm wheel properly aligned while the shaft 10 when raised or lowered is permitted to slip longitudinally through the hub of the worm wheel. A bracket 11 carries a threaded bearing 12 for supporting the shaft 10. The electrode 70 is mounted on the lower end of the shaft 10.

It will be seen from the above description that the motor 68, if it is made reversible, will drive the shaft 10 in either direction, thereby to raise or lower the same and to adjust the spacing between the electrode 70 and the piezo-electric crystal 72.

A work circuit 20 is shown coupled to the output circuit of the generator 50. An auxiliary or monitoring circuit 76 is also coupled to the output circuit of the generator 50, this auxiliary circuit being used to control further monitoring circuits by which the motor 68 may be driven from time to time whenever it is required that the adjustment of the electrode 70 should be varied. To the grid circuits of electron discharge devices 42, 44, preferably of the gas-filled, or so-called "Thyratron" type, there are coupled respectively the crystal 46 having the frequency f_1 and crystal 48 having the frequency f_2 between which it is desired that the crystal controlled source 50 operate. Preferably, the crystals are chosen so as to have overlapping resonance curves.

Neutralizing condensers 47, 49 are provided to neutralize the interelectrode capacities of the

crystals 46, 48 respectively. Normal grid bias is obtained by the action of resistors 52, 54 tapped across resistors 56, 58 in turn connected across the secondary 60 of the alternating current supply transformer 62. The transformer also supplies cathode heating energy and anode current for the electron discharge devices 42, 44.

Now, with a shift in frequency towards the resonance frequency of either of the crystals 46, 48, there will be a corresponding increase in current in the anode resistors or impedances 64, 66, connected respectively to the output electrodes of tubes 42, 44. Assume, for example, that the tube 42 is rendered more conductive in response to a shift in frequency toward the resonance frequency of crystal 46. Then the power supplied by the secondary 4 of the power transformer 62 will be conveyed principally to the motor 68 through the conductor 5 and will return therefrom through conductor 6 to the anode of the gas filled tube 42. Such action is due to the fact that there is a greater drop of potential across the resistor 64 than across the resistor 66 which leads to the anode of the gas filled tube 44. The potential of tube 44 would at this time be high due to a high impedance in the space path of the tube. The motor will, therefore, be driven in one direction to adjust the spacing of the electrode 70 with respect to the crystal 72. When, however, the tube 44 becomes conductive in response to a resonant condition in the circuit which includes the crystal 48, then the motor 68 will be reversed and the current returning from its windings will choose the path of conductor 7 leading directly to the anode of the tube 44. At this time the potential drop across the resistor 66 becomes greater than that across the resistor 64 and hence the motor 68 operates in the reverse direction. As a result, reversible motor 68 will be operated reversibly varying the spacing of the electrode 70 of the frequency controlling crystal 72 by virtue of the worm and gear mechanism 74 coupled to the reversible motor 68. Consequently, the output of the oscillating apparatus or source 50, controlled by crystal 72, will be varied so that the energy fed back through the inductive coupling link 76 lies between the frequency f_1 and f_2 of crystals 46, 48.

In other words, for example, a shift in frequency towards frequency f_2 of crystal 48 will cause a predetermined current flow through resistor 66 as a result of which the motor will operate varying the spacing of the electrode 70 in the proper direction to bring the frequency of the crystal oscillating apparatus 50 back in frequency towards the direction of frequency f_1.

Obviously other frequency adjusting means may be used. For example, rather than vary the spacing of a crystal, variation of capacity may be used to effect a change in frequency of an oscillating source as desired, or, ordinary manual frequency adjusting means may be used, in which case resistors 66, 64 would be replaced or used to supply voltage to indicating devices, whereupon manual adjustment of the oscillator would be relied upon to produce oscillations of the correct frequency. The correct frequency would be indicated by like readings or indications on the indicators coupled to impedances 64, 66.

I claim:

1. In combination, a source of oscillatory energy, means including a piezo-electric device having at least one electrode disposed in adjustably spaced relation to the crystal element thereof for varying the frequency of said source, a pair of electron discharge devices each having an anode, a cathode and a grid, a piezo-electric crystal ground to a predetermined frequency coupled to the grid and cathode of one of said devices, another piezo-electric crystal ground to a different frequency coupled to the grid and cathode of the other of said devices, means coupling said source to said crystals, and, means responsive to the output of either of said electron discharge devices for controlling the electrode spacing of the first mentioned piezo-electric device thereby to adjust the frequency of said source so as to lie intermediate the frequencies of the two crystals last mentioned.

2. In combination, a source of oscillatory energy, means including a piezo-electric device having at least one electrode disposed in adjustably spaced relation to the crystal element thereof for varying the frequency of said source, a pair of electron discharge devices each having an anode, a cathode and a grid, a piezo-electric crystal ground to a predetermined frequency coupled to the grid and cathode of one of said devices, means for neutralizing the inter-electrode capacity of said crystal, another piezo-electric crystal ground to a different frequency coupled to the grid and cathode of the other of said devices, means for neutralizing the inter-electrode capacity of said last mentioned crystal, means coupling said source to said crystals, and means responsive to the differential output of said electron discharge devices for varying said frequency varying means and thereby the frequency of said source, whereby said source is maintained in frequency intermediate the resonant frequencies of said crystals.

3. In combination, a crystal controlled oscillation generator, the crystal thereof having an electrode of variable spacing whereby to vary the frequency of oscillations under its control, a pair of electron discharge devices each having an anode, a cathode, and a grid, a piezo-electric crystal ground to a predetermined frequency coupled to the grid and cathode of one of said devices, another piezo-electric crystal ground to another frequency coupled to the grid and cathode of the other of said devices, means coupling energy from said crystal controlled generator to said crystals, and means responsive to the output of said electron discharge devices for adjusting the spacing of said electrode and hence the frequency of said crystal controlled generator so as to lie intermediate the frequency of said frequency controlling crystals.

4. In a device of the class described, an oscillation generator having a piezo-electric crystal for controlling the frequency thereof, electrodes one, at least, of which is adjustably spaced from said crystal, motor actuated mechanism for varying the spacing between said crystal and the adjustable electrode, a work circuit and a monitoring circuit both coupled to the output circuit of said generator, a pair of electron discharge devices each having an input circuit coupled to said monitoring circuit, and an output circuit including windings in the motor of said electrode spacing adjustment mechanism, and means including a piezo-electric device in each of said input circuits for rendering its electron discharge device conductive in response to excitation by said monitoring circuit at a frequency to which said piezo-electric device is naturally resonant, said frequency being in one case the upper limit and in the other case the lower limit of the frequency

range within which said oscillation generator is to be controlled.

5. A device in accordance with claim 4 and having said pair of electron discharge devices each constituted by a plurality of electrodes immersed in a suitable gaseous medium whereby currents of relatively large amplitude may be controlled.

6. In combination, a crystal controlled oscillation generator, the crystal element thereof having at least one of its electrodes variably spaced therefrom, a load circuit and a monitoring circuit coupled to the output circuit of said generator, a pair of frequency-discriminating circuits each including a piezo-electric device and a reactive impedance coupled to said monitoring circuit and each circuit being resonant at a slightly different frequency, means including a reversible motor for varying the electrode spacing in respect to the first said crystal, and relay means including gas filled discharge tubes acting in response to variations in the excitation of said frequency discriminating circuits for actuating said motor in a direction such as to adjust the crystal electrode spacing, thereby to maintain substantially constant the frequency of the oscillations delivered by said generator.

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