

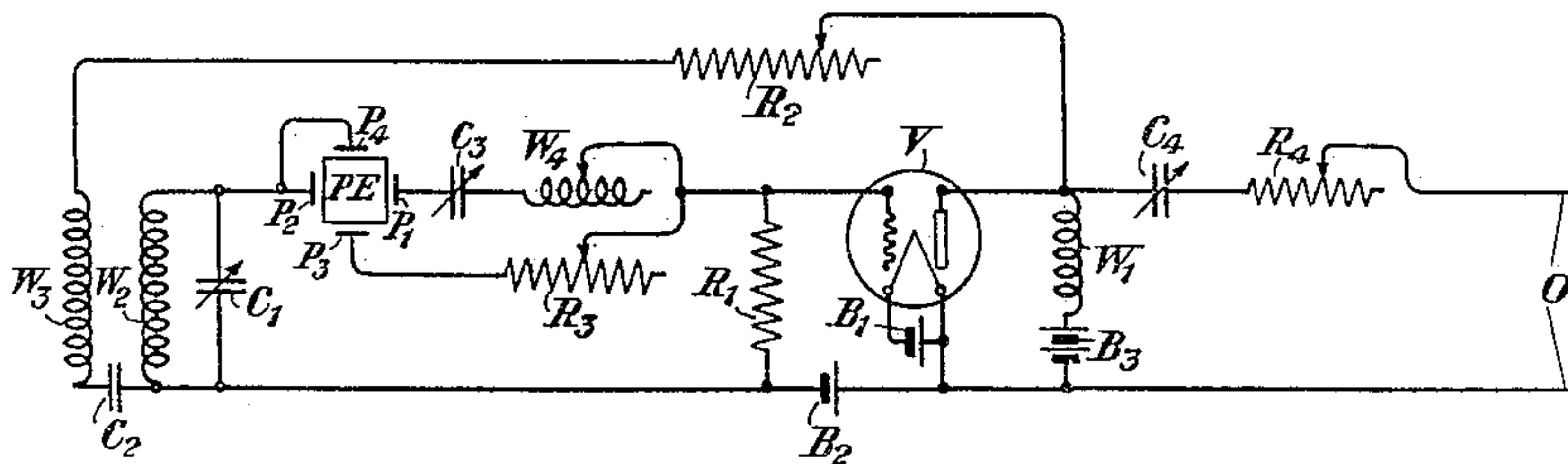
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OSCILLATION GENERATOR

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OSCILLATION GENERATOR

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This invention relates to oscillation generators, and more particularly to generators having means for maintaining substantially constant the frequency of the sustained oscillations.

A piezo-electric device may be employed to control the frequency of oscillations generated by, for example, space discharge tube oscillators. Such a device may be cut from a substance such as quartz, and it is a fact that such a device responds to a plurality of frequencies with various degrees of activity. There is one of these frequencies at which the device exhibits its greatest response, this frequency being generally known as the natural frequency of the device.

In accordance with this invention, it is proposed to simultaneously set a piezo-electric device into vibration at a plurality of frequencies and to utilize this device for maintaining the frequency of oscillations of, for example, an oscillation generator of the vacuum tube type constant within very narrow limits in accordance with a frequency derived from two or more of the vibratory periods of the device. Thus, if a piezo-electric device be found to have two vibratory periods of, for example, 1100 kilocycles and 1095 kilocycles, it is proposed to use the beat period of five kilocycles in order to control oscillations in a vacuum tube oscillation generator thereat. Yet, if there are a greater number of vibratory periods for a particular piezo-electric device, it is proposed to utilize some of the various vibratory periods in suitable combination to provide a stabilizing medium for sustained oscillations of an oscillation generator.

Accordingly, it is one of the objects of this invention to unite or combine any two or more of the vibratory periods of a piezo-electric device in order to produce some desired resultant period, constant in its vibrations within exceedingly narrow limits.

It is another object of this invention to relate a piezo-electric body capable of vibrating at a plurality of frequencies to an oscillator so as to control the frequency of sustained oscillations in accordance with the

beat period corresponding to certain selected vibrations of said body.

It is a further object of this invention to provide a piezo-electric structure capable of vibrating simultaneously at a plurality of frequencies and to change one or more of these frequencies of vibration with respect to a selected frequency of vibration of said structure.

And it is a further object of this invention to provide a piezo-electric structure capable of vibrating simultaneously at a plurality of frequencies and to further provide means for changing the amplitude of the vibrations at one of these frequencies with respect to the amplitude of vibrations of another of these frequencies.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood in connection with the detailed description hereinafter following, when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, there is shown a piezo-electric device associated with the circuits of an electron tube arrangement so that sustained oscillations, controlled as to frequency by the piezo-electric device, may be generated. The oscillating circuit includes a thermionic tube V having a filament, a grid and a plate, the filament being heated to an electron-emitting temperature by battery B₁. The grid is connected to the filament of this vacuum tube through a resistance R₁ and a battery B₂, battery B₂ aiding to maintain the grid of tube V at a suitable potential with respect to its filament. The necessary operating potential for the plate of tube V is provided by a battery B₃, battery B₃ being connected to the plate of tube V through a choke coil W₁.

The input circuit of the vacuum tube V includes a winding W₂ and a condenser C₁, these being tuned to give oscillations of the desired frequency. The period of the oscillations may be changed by varying the magnitude of the capacity of condenser C₁ or the

magnitude of the inductance of winding W_2 , or both, as found desirable. A circuit including the adjustable resistance R_2 , a winding W_3 and a condenser C_2 permits the transmission of energy from the output circuit of the vacuum tube V to its input circuit. Thus, energy is fed from the output circuit of tube V to its input circuit, due particularly to the inductive relationship existing between windings W_3 and W_2 . The amplitude of the current transmitted to the input circuit may be controlled by manipulation of the movable contact of the resistance R_2 . Condenser C_2 prevents the application of the potential of battery B_3 to the input circuit, and particularly to the grid of vacuum tube V . The output of the oscillation generating circuit is applied to an output circuit O through an adjustable condenser C_4 and through an adjustable resistance R_4 .

A piezo-electric structure or device is designated by the reference characters PE. This piezo-electric structure has two sets of terminals or electrodes P_1 and P_2 , P_3 and P_4 . Terminal P_1 is connected to the grid of the vacuum tube V through a condenser C_3 of adjustable capacity, and a winding W_4 of adjustable inductance. Terminal P_3 is connected to the grid of vacuum tube V through a variable resistance R_3 .

The piezo-electric structure or device PE may set up vibrations of two or more frequencies. Vibrations of one frequency may be impressed across the terminals or conductors P_1 and P_2 , while vibrations of another frequency may be impressed across terminals or conductors P_3 and P_4 . Condenser C_3 may be changed in capacity, or winding W_4 may be changed in inductance, or both may be changed, to provide a change in the vibratory period of the piezo-electric device PE established between terminals or electrodes P_1 and P_2 . Such a change may often be made only between narrow limits of frequency. It is to be understood, however, that while inductance and capacity have been shown in series relationship with the piezo-electric device to produce a variation in one of its vibratory periods, shunt inductance and capacity may be similarly employed, or a variable air-gap may be provided for a similar purpose, within the scope of this invention.

Vibrations of another frequency may be established between terminals or electrodes P_3 and P_4 . By changing the magnitude of resistance R_3 , the amplitude of these vibrations may be changed, as desired, with respect to the amplitude of the vibrations established between electrodes P_1 and P_2 . Obviously, by decreasing the magnitude of resistance R_3 , the amplitude of the vibrations between electrodes P_3 and P_4 are increased, and, conversely, by increasing the magnitude of resistance R_3 , these vibrations are decreased in amplitude.

In this arrangement, oscillations are sustained, the frequency of which is maintained constant in accordance with the beat period corresponding to selected vibrations of the piezo-electric device. As mentioned hereinabove, if one of the frequencies of response of the piezo-electric device is 1100 kilocycles, and if another frequency of response is 1095 kilocycles, the vacuum tube oscillation generator may be caused to sustain oscillations at the beat period of 5 kilocycles. It is to be understood, however, that while only two of the vibratory periods of a piezo-electric device or structure have been combined for illustration in the production of oscillations corresponding to their beat period, three or more vibratory periods of a piezo-electric structure or device may be similarly combined within the scope of this invention. It is to be further understood that while two of the response frequencies of a piezo-electric structure or device have been combined to maintain sustained oscillations constant at a frequency corresponding to their difference, it is within the scope of this invention to maintain sustained oscillations constant at frequencies corresponding to their sum or to the sum of any three or more of the response frequencies of any piezo-electric structure or device.

Heretofore, a piezo-electric device has been employed to control and stabilize oscillations of an oscillation generator in accordance with a single selected frequency of the device, which was of exceedingly high order. The vacuum tube oscillating generator shown herein is capable of sustaining oscillations at a considerably lower frequency, which may be in the audible range, the sustained oscillations being maintained constant in accordance with the frequency corresponding to the difference between two of the response frequencies of the piezo-electric device which are above the audible range.

The tuned circuit comprising winding W_2 and condenser C_1 may, if desired, be replaced by a pair of tuned circuits in series relationship, each of suitable inductance and capacity, one tuned circuit corresponding to one of the vibratory periods of the piezo-electric device, and the other tuned circuit corresponding to another vibratory period of the piezo-electric device, within the scope of this invention.

While this invention has been pointed out in one particular embodiment merely for the purpose of illustration, it is to be distinctly understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The combination of a piezo-electric device capable of vibrating simultaneously in

a plurality of modes at different frequencies, said piezo-electric device having a pair of electrodes for its vibration in each mode, and means for uniting selected frequencies of vibration of said piezo-electric device to produce a substantially different frequency of vibration.

2. The combination of a piezo-electric device capable of vibrating naturally at a plurality of frequencies simultaneously, resistive means for controlling the amplitude of vibration of one of said frequencies, and means for changing by a predetermined amount the frequency of another of the vibrations of said piezo-electric device with respect to the frequency of the vibrations being controlled as to amplitude.

3. The combination of a piezo-electric device having four electrodes, a resistance of adjustable magnitude in series with two of said electrodes to control the amplitude of the current of one of the frequencies impressed therebetween, and a reactance of adjustable magnitude in series with the other two of said electrodes to control the frequency of the other current impressed therebetween.

4. The combination of a piezo-electric device having two pairs of electrodes between which independent vibrations of different frequencies may take place, a circuit including an adjustable resistance in series with one pair of said electrodes, and a circuit including an adjustable reactance in series with the other pair of said electrodes.

5. The combination of a piezo-electric device capable of vibrating naturally at a pair of frequencies simultaneously, means including variable inductance and variable capacity in series relationship to change one of said frequencies of vibration of the piezo-electric device by a predetermined amount with respect to the other said frequencies, and an oscillator controlled as to frequency in accordance with the beat period of the resultant pair of frequencies.

6. The combination of a piezo-electric device capable of vibrating naturally at a pair of frequencies simultaneously, reactive means comprising variable inductance and variable capacity in series relationship to change one of said frequencies of vibration of said device by a predetermined amount with respect to said other frequency of vibration, means for combining the resultant frequencies so as to produce vibrations of an audible frequency, a vacuum tube oscillator, and means to control the oscillations of said vacuum tube oscillator in accordance with said audible frequency.

7. The combination of a piezo-electric structure having two natural vibratory periods, both periods being inaudible though differing from each other by an audible amount, means including variable inductance

and variable capacity in series relationship for changing one of the vibratory periods of said piezo-electric structure with respect to the other by any predetermined amount, and means for combining the resultant frequencies in order to produce the audible frequency.

8. The combination of a piezo-electric structure having two natural vibratory periods which differ from each other by an audible frequency, resistive means for varying the amplitude of one of the vibrations by a predetermined amount with respect to the amplitude of the other of the vibrations, means for combining these frequencies to produce said audible frequency, and a vacuum tube system sustaining oscillations which may be maintained constant in frequency in accordance with said audible frequency.

9. The combination of a piezo-electric body having dimensions permitting its vibration in two modes simultaneously at two distinct frequencies corresponding to its physical dimensions, means for changing the amplitude of one of the vibrations of the piezo-electric body by a predetermined amount with respect to the amplitude of the other of the vibrations, means for varying the frequency of one of the vibrations of the piezo-electric body with respect to the other of the vibrations, and a work circuit controlled by said body at a frequency equal to the difference between the resultant frequencies of vibration.

In testimony whereof, I have signed my name to this specification this 7th day of September, 1927.

ESTILL I. GREEN.