May 8, 1945. H. B. SHAPIRO 2,375,695

OSCILLATION GENERATOR

Filed Sept. 26, 1942 2 Sheets-Sheet 1

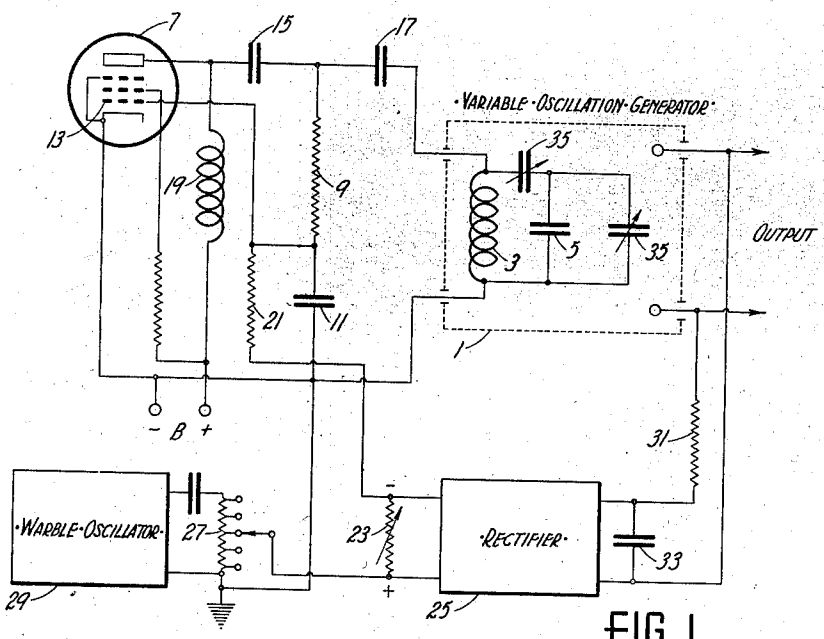


FIG. 1

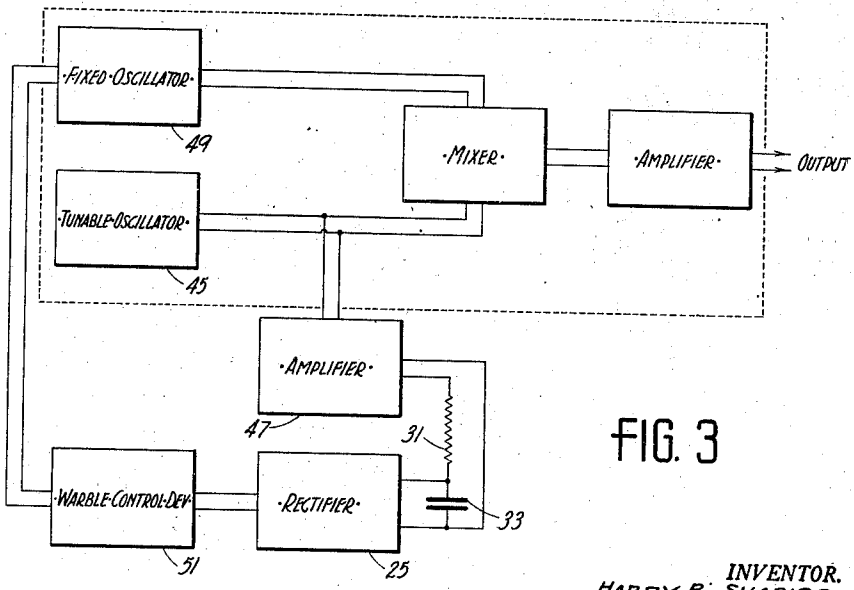


FIG. 3

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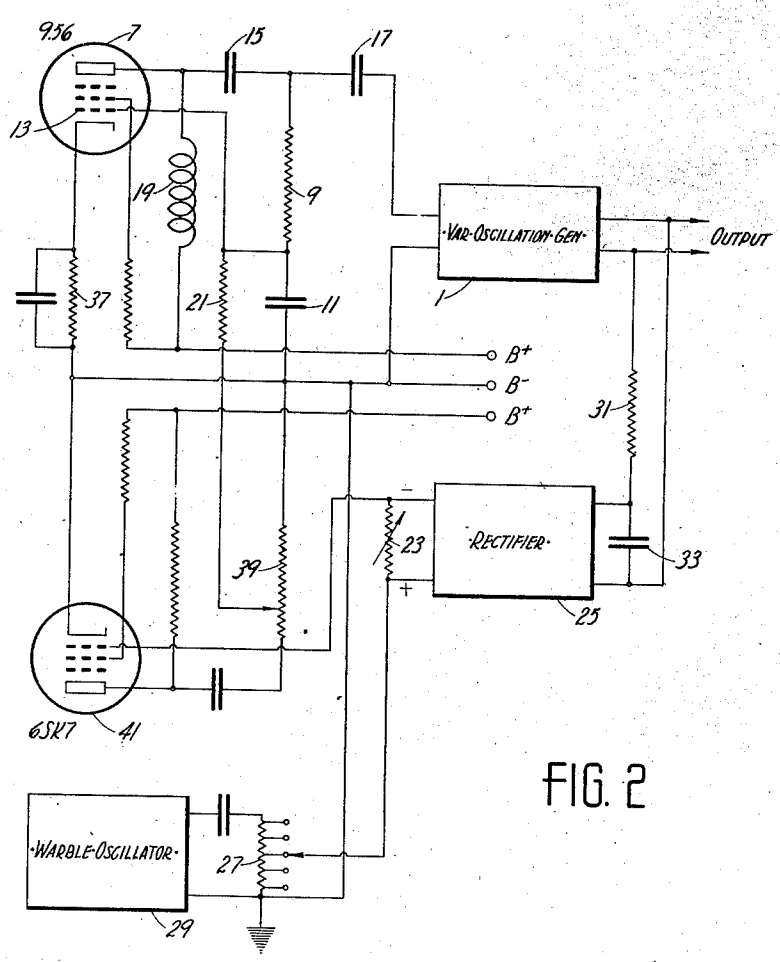


FIG. 2

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Patented May 8, 1945

2,375,695

UNITED STATES PATENT OFFICE

2,375,695

OSCILLATION GENERATOR

Harry B. Shapiro, Cleveland Heights, Ohio, now by judicial change of name Harry Bryant Shaper, assignor to The Brush Development Company, Cleveland, Ohio, a corporation of Ohio

Application September 26, 1942, Serial No. 459,756

11 Claims. (Cl. 250—36)

This invention relates to oscillation generators and, more particularly, to oscillation generators of the variable frequency type.

When taking curves exemplifying the frequency-response of various transducers such as telephone receivers, loudspeakers and the like, it is advantageous to utilize an oscillation generator that provides an output current which may be caused to vary over a wide range of audio frequencies and which, if desired, may be caused to "wobble" or "warble" a predetermined percentage above and below any frequency within said range.

Previous to this invention, the "warble" has been obtained through utilization of a mechanically driven tuning device, such as an auxiliary shunt capacitor of the type shown in the patent to Farrington No. 2,205,190. With such a device, the "warble" frequency is not a constant percentage of the particular base frequency being "warbled" but always has a fixed band width unless auxiliary compensating means are employed.

It is, accordingly, an object of this invention to provide an oscillation generator, the output from which may be "warbled" a predetermined percentage of any frequency within its range.

Another object is to provide a "warble" oscillator wherein the percentage of frequency swing is adjustable at the will of the operator.

Another object is to provide a "warble" oscillator wherein the percentage of frequency swing, after having once been adjusted, remains substantially constant over the output range.

Another object is to provide a "warble" oscillator the base frequencies of which are substantially independent of the warble-control devices.

A still further object is to provide an oscillator of the type described that shall not require mechanically moving parts for obtaining the warble effect.

In accordance with the invention, electronic warble-control means are substituted for the usual mechanically actuated warble capacitor, such means, preferably, including a reactance tube that may be so energized and connected as to cyclically cause a minor change in the effective inductance, capacity or resistance of a frequency-determining network in an oscillation generator, automatically under control of a current or potential derived from said generator. The oscillation generator may be of any of the usual types such, for example, as the audio beat frequency type wherein the output, at audio frequency is obtained through the interaction of the output currents from two relatively high frequency oscillators, one fixed and one variable. The generator, furthermore, may be of the type that is mechanically tunable over a specific range or the tuning thereof may be electronically controlled, the only requirement being that it shall include a frequency-determining element the effective impedance of which may be caused to vary by the aforementioned reactance tube.

For example, when practicing the invention in connection with a beat frequency oscillation generator, the reactance tube may be supplied with warble-control potentials from a variable low frequency oscillator and a biasing potential for the tube, derived from the generator itself, may be utilized to cause the gain therein to vary as a function of the frequency of the output from the generator. Alternatively, the reactance tube may be provided with a fixed bias and be supplied with control potentials from the warble oscillator, the amplitude of the said potentials being caused to vary as a function of the frequency of the output from the generator. In a still further embodiment, a varying biasing potential may be derived from the variable high frequency oscillator comprised in the generator instead of from the output of the generator itself and such potential may be applied to the reactance tube directly or it may be utilized to control the amplitude of the potentials supplied thereto from the low frequency oscillator.

The novel features considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with further objects and advantages thereof, will best be understood from the following description of certain specific embodiments, when read in connection with the accompanying drawings, in which:

Figure 1 is a circuit diagram exemplifying an embodiment of the invention;

Figure 2 is a circuit diagram exemplifying an alternative embodiment, and

Figure 3 is a circuit diagram exemplifying another embodiment of the invention.

In all figures of the drawings, identical elements are similarly designated.

Referring to Figure 1 of the drawings, an embodiment of the invention may include a variable beat-frequency generator, indicated generally by the numerial 1, providing an output current at audio, supersonic or radio frequency, which generator includes a frequency-determining network, or a tank circuit such as might be constituted by an inductor 3 shunted by a capacitor 5. The term "frequency determining network" is intended to

include a fixed or variable tuned circuit, a variable or fixed capacitor, inductor or resistor, or any other circuit element or network that plays a part in determining the frequency of the oscillations generated and/or delivered to an output circuit.

For the purpose of varying the effective reactance of the inductor 3, it may be connected across the output circuit of a thermionic tube 7 of the variable mu pentode type, such as the 956, and connections are provided whereby the tube draws a current that lags the alternating potential appearing across the inductor.

To obtain proper grid excitation for the tube, at the frequency of the potential appearing across the inductor 3, the connections include a phase shifting network, constituted by a resistor 9 in series with a capacitor 11, that is connected across the said inductor and the potential appearing across the capacitor is applied to the control grid 13. A blocking capacitor 15 is interposed between the phase-shifting network and the anode of the reactance tube, and a similar blocking capacitor 17 may be included in the connection between the inductor 3 and the resistor 9.

If the reactance of the capacitor 11 is very low in comparison with the resistance of the resistor 9, i. e., if

$$R > \frac{1}{\omega C}$$

the current in the said capacitor will be substantially in phase with the potential across the tank circuit, with the result that the alternating potential appearing across the capacitor 11, which is applied to the control grid 13 of the reactance tube, lags the potential impressed across the network from the inductor and the tube 11, therefore, draws a lagging current and functions as an inductor connected in shunt to the inductor 3.

Preferably, the high potential supply circuit for the reactance tube includes an inductor 19 that offers high reactance at the frequency determined by the inductor 3 and the capacitor 5.

For the purpose of introducing warble into the system, the extent of which, or swing, increases with increasing frequency of the output current from the generator, the control grid 13 of the reactance tube 7 is connected to the cathode thereof by way of a grid leak 21, a resistor 23 constituting the output circuit of a rectifier 25 and a tapped resistor 27 included in the output circuit of a low-frequency warble control oscillator 29.

The rectifier 25 is supplied with input currents from the output circuit of the generator, the supply circuit including a low-pass filter such as a series resistor 31 and a shunt connected capacitor 33. The positive terminal of the rectifier output resistor 23 is conductively connected to the cathode of the reactance tube and the negative terminal thereof to the grid of the tube, whereby the biasing potential supplied to the grid 13 becomes less negative as the frequency of the output current from the generator increases. The gain in the reactance tube, accordingly, increases with rising output frequency and the reactance-change, at the warble oscillator rate, that it can cause, is thus automatically made greater at the high frequency end of the range than at the low frequency end.

Through proper choice of the values of the various circuit elements illustrated, such as the resistors 23 and 27, the percentage of frequency-shift, or warble, may be controlled, and after once having been set it remains constant over the entire output range.

Should the connection of the reactance tube to the inductor 3 disturb the calibration of the oscillation generator, one or more padding capacitors 35 may be employed for compensation.

A modification of the invention is illustrated by Figure 2. In that embodiment, the reactance tube 7 is connected to the frequency determining element 3 comprised in a variable oscillation generator in substantially the same manner as described with reference to Figure 1. A rectifier 25 is also provided which gives an output current that decreases in response to increase in frequency of the output current from the generator. The reactance tube 7, however, is given a fixed bias from a resistor 37 in the cathode circuit thereof and the control grid 13 therein is connected to the cathode by way of the resistor 21 and a potentiometer 39 included in the output circuit of a warble control tube 41, which may be of the variable mu type such as a 6SK7. Grid bias for the warble control tube 41 is supplied by a circuit which includes the output resistor 23 of the rectifier 25 and a variable portion of the warble oscillator output resistor 27. Accordingly, the amplitude of the signal introduced from the warble control tube into the grid circuit of the reactance tube 7 is a function of the setting of the potentiometer 39, of the bias, varying with frequency, supplied from the resistor 23 and of the amount of the warble-oscillator output resistor 27 that is included in the circuit. The bias applied to the warble control tube 41 by the rectifier 25 may be permanently adjusted to select the most favorable part of the mutual conductance-grid bias curve, if desired.

Instead of utilizing the output current from the beat frequency generator to provide a warble-amplitude, or swing-control, essentially the same result may be obtained by making use of a portion of the output current from the variable high frequency oscillator. That is to say, referring to Figure 3, a portion of the output from the tunable high frequency oscillator portion 45 of the generator may be fed to an auxiliary amplifier 47 the output from which is supplied to the rectifier 25 that provides a unidirectional current which varies in accordance with the frequency of the said oscillator. The rectifier output may be utilized for varying the effectiveness of a reactance tube associated with a frequency determining element or network in the fixed oscillator 49, as described in connection with Figure 1 or Figure 2.

Inasmuch as many alternative modes of warble-control, by utilizing the varying current provided by the rectifier, will be obvious to those skilled in the art without departing from the spirit of the invention, they have been merely indicated in Figure 3 by a rectangle 51, with the general designation "warble-control devices."

An oscillation generator constructed in accordance with the invention has numerous advantages among which may be mentioned the following as perhaps being the most important:

(*a*) The integral of energy, in each band examined by means of the warble, is constant.

(*b*) The band width at each point in the range, when warble is introduced, is automatically so adjusted that no over-shooting of zero frequency takes place at the low frequency end of the range.

(*c*) The rate of warble is easily changed, which enables the avoidance of warble frequencies that might coincide with resonance frequencies of the meters or other indicating apparatus utilized.

(*d*) The percentage of warble is easily changed,

Other advantages, as well as alternative embodiments of the invention, will be apparent to those skilled in the art. The invention, therefore, is not to be restricted by the specific embodiments chosen for illustrative purposes, nor is it to be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

What is claimed is:

1. In combination, a beat frequency oscillation generator having a given frequency range, a reactor included in said generator for determining the frequency of the generated oscillations, means for causing the frequency of the generated currents to vary cyclically, and means responsive to the frequency of the generated currents for causing the percentage of cyclic variation to be constant over the frequency-range of the oscillator.

2. An oscillation generator having an output circuit and having a given frequency range, adjustable reactor means connected to said oscillation generator for influencing the output frequency of said oscillation generator within said frequency range, means interconnecting said output circuit with said reactor means and including means for establishing a first potential in accordance with currents delivered to the output circuit of said oscillation generator, oscillator means for establishing a second potential which varies cyclically, said first and said second potentials being added to establish a summation potential for adjusting the reactance of said reactor means for influencing the output frequency of said oscillation generator within its frequency range in accordance with a constant percentage function of the frequency of the currents delivered to the said output circuit and in accordance with the cyclically varying output from said oscillator.

3. The invention as set forth in claim 2 further characterized in this: that the frequency of said oscillation generator is mechanically changeable within its said frequency range, whereby said summation potential is altered to influence the frequency of the output signal from said oscillation generator.

4. The invention as set forth in claim 2 further characterized in this: that the said means for establishing a first potential is a means for establishing a direct current in accordance with the currents delivered to the said output circuit of said oscillation generator.

5. The invention as set forth in claim 2 further characterized in this: that the said adjustable reactor means includes a reactor tube having a grid and a cathode and whose grid voltage determines its reactance, said summation potential being applied to said reactance tube between the said grid and cathode.

6. The invention as set forth in claim 2 further characterized in this: that the said adjustable reactor means is a reactance tube having a grid and a cathode and whose grid voltage determines its reactance, and that said means for establishing the said first potential is means for establishing a direct current potential.

7. The invention as set forth in claim 2 further characterized in this: that the said oscillation generator is a beat frequency generator.

8. In combination, an oscillation generator having a given frequency range, reactor means connected to said oscillation generator for influencing the frequency of the generated oscillations, means connected to the said oscillation generator for causing the frequency of the generated currents to vary cyclically, and means responsive to the frequency of the generated currents for causing the percentage of frequency variation to be constant over the frequency-range of the said oscillator.

9. The invention as set forth in claim 8 further characterized in this: that the said reactor means includes a reactor tube whose grid voltage determines its reactance, and that the means responsive to the frequency of the generated currents for causing the percentage of variation to be constant over the frequency-range of the said oscillator is a means for varying said grid voltage.

10. The invention as set forth in claim 8 further characterized in this: that said oscillation generator is a beat-frequency generator and its frequency is mechanically changeable over substantially its entire frequency range, and that the said reactor means includes a reactor tube whose grid voltage determines its reactance, and that the means responsive to the frequency of the generated currents for causing the percentage of variation to be constant over the frequency-range of the said oscillator is a means for varying said grid voltage.

11. An oscillation generator including a frequency-determining reactor and having a generator output circuit; a thermionic tube having an input circuit, and having an output circuit connected effectively in parallel to said reactor; means for impressing on said input circuit a lagging potential derived from said reactor; means for impressing oscillations at low frequency upon said input circuit; and means responsive to the frequency of the currents delivered to said generator output circuit for determining the amplitude of said impressed low frequency oscillations.

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