

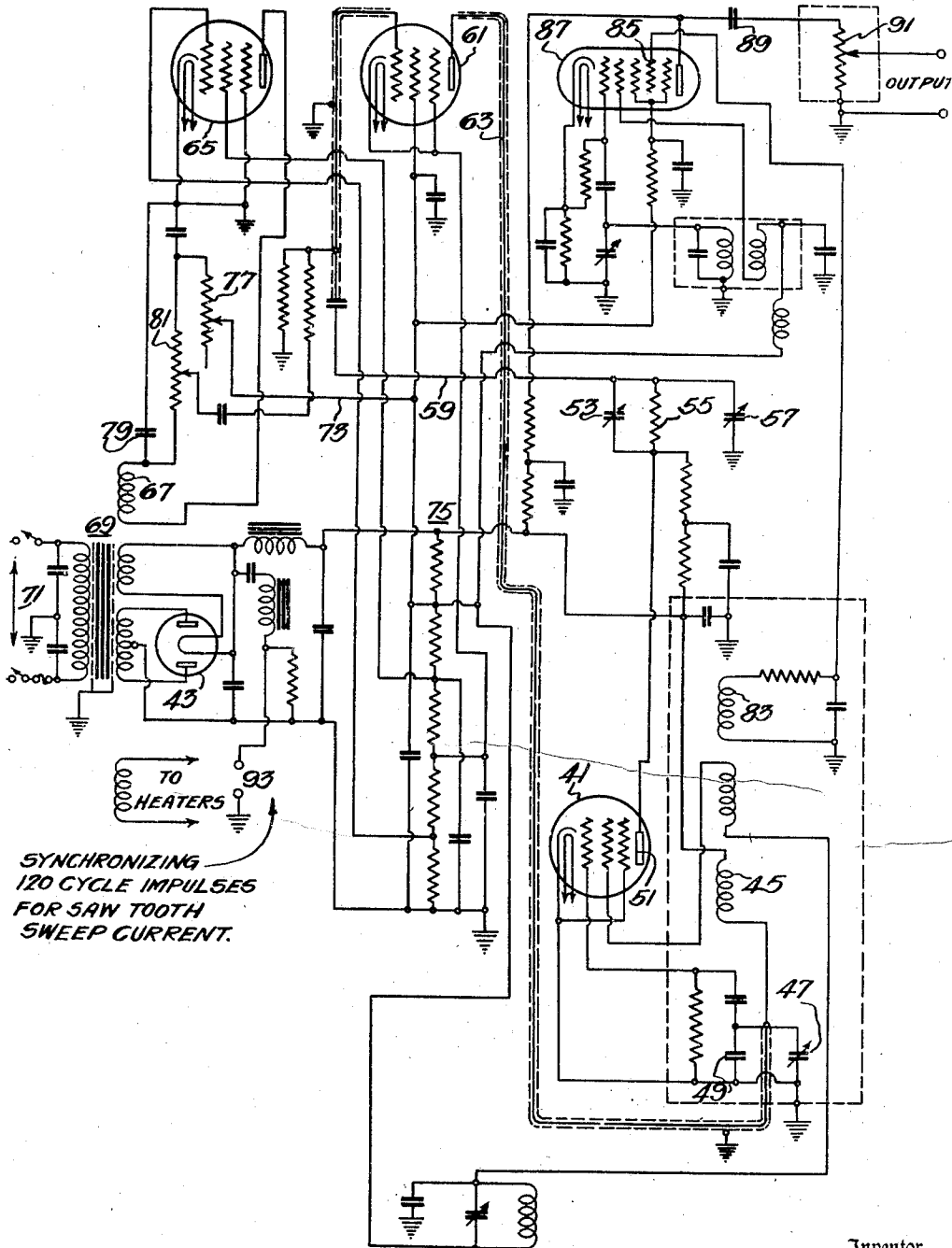
Nov. 11, 1941.

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2,262,147

CATHODE RAY DEVICE FOR PRODUCING RESONANCE GRAPHS

Original Filed Sept. 17, 1936



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2,262,147

CATHODE RAY DEVICE FOR PRODUCING
RESONANCE GRAPHSOllie M. Owsley, Haddon Heights, N. J., assignor
to Radio Corporation of America, a corporation
of DelawareOriginal application September 17, 1936, Serial
No. 101,206. Divided and this application April
23, 1938, Serial No. 203,724

4 Claims. (Cl. 250—36)

My invention relates to a method and means for automatically and cyclically varying the frequency of an oscillator over a predetermined range.

Cathode ray and mechanical oscilloscopes have frequently been used in connection with oscillators whose frequency is varied over a predetermined range for obtaining the frequency characteristic of various devices. Such an application is described in my copending U. S. patent application No. 101,206, filed September 17, 1936, and entitled "Cathode ray device for producing resonance graphs," of which this is a division.

Such oscillators involve the use of driving motors, frictional electrical contacts and other arrangements which not only set up undesirable interference but often amplitude modulate the carrier and also fail to produce steady images. I overcome these difficulties by substituting synchronized electrical frequency varying means for the mechanically variable frequency element.

One of the objects of my invention is to provide electrical means for automatically varying the frequency of an oscillator over a predetermined range.

Another object is to provide electrical means for automatically and linearly varying the frequency of an oscillator.

This invention will be better understood from the following description when considered in connection with the accompanying drawing, and its scope is indicated by the appended claims.

Referring to the drawing, the single figure is a circuit diagram of an embodiment of my invention.

Referring to the figure, a thermionic oscillator 41 is suitably energized by rectified filtered current from the rectifier 43. The grid circuit of the oscillator 41 is tuned by a resonant circuit comprising inductor 45 and capacitors 47, 49. The electronically coupled output circuit of this oscillator includes the anode 51 whose output circuit includes a variable capacity 53 which shunts a phase correcting resistor 55 and a serially connected capacitor 57. The phase correcting network 53, 55 prevents undesired amplitude modulation. The function of the series variable capacitor 57 is to change the phase of the oscillatory output currents so that they lead by 90°. These leading currents are fed through a conductor 59 to the input circuit of frequency control tube 61. The frequency control tube further changes the phase by 180° so that the currents in the output circuit of the frequency

control tube are in effect 90° lagging currents which are impressed by the lead 63 across the resonant circuit 45, 47, 49 of the thermionic oscillator 41.

The effect of the 90° lagging current is the full equivalent of an inductance shunting the resonant circuit. As is well known to those skilled in the art, the effect of shunting a resonant circuit with inductance is to decrease the resonant frequency. If the frequency control tube 61 is further biased by an increasing and decreasing potential its output circuit currents will vary in amplitude over a predetermined range to thereby alter the oscillatory frequency of tube 41. By adjusting the amount of such variable bias the range of the aforesaid frequency variation may be controlled within the limits determined by the voltage fed the grid of tube 61 from the capacitor 57. While I have found that an alternating current may be thus applied to bias the control tube I prefer to use a biasing potential derived from currents having a triangularly peaked wave form because the alternating current bias does not vary linearly and results in a frequency change which does not have a linear characteristic.

To avoid the hyperbolic scale of frequency characteristic I employ a pentode tube 65 whose grid and plate circuits are energized by a secondary winding 67 which is a part of the transformer 69 which is coupled to the commercial alternating current source indicated by reference numeral 71. I have found it desirable to variably bias the plate by a connection 73 to the D. C. bleeder circuit 75 which is connected across the output of the rectifier 43. This steady bias may be adjusted by a variable resistor 77. The pentode tube 65 has a constant current characteristic which charges the capacitor 79, connected in its output circuit, by a uniformly increasing potential. After this capacity 79 reaches predetermined charge, which is controlled by the alternating potential applied to the grid circuit of tube 65, it discharges at a uniform rate through the resistor 81. The result is a current which has a triangularly peaked wave form.

An adjustable connection to the resistor 81 impresses currents of the triangularly peaked wave form on the input circuit of tube 61. Thus the grid circuit of the frequency control tube 61 has impressed on it the 90° leading currents from the capacitor 57 in the output circuit of the oscillator 41 and the triangularly peaked currents from the tube 65. These currents in the input of the frequency control tube cause the output

currents to linearly vary over a predetermined range. Since these varying currents are lagging 90° with respect to the currents in the tuned circuit of the oscillator 41 they cause the output currents of the oscillator to vary linearly over a frequency range which is determined by the tri-
 angularly peaked currents. The oscillatory currents from the tube 41 are induced in inductor 83 which is suitably coupled to inductor 45. The currents thus induced are impressed on a grid 85 of the oscillator and mixing tube 87. The oscillatory section of this tube is made adjustable so that the frequency in the mixing section is due to the algebraic combination of currents of the oscillatory frequency of tube 41 and the frequency of the oscillatory section of 87. The output currents in the mixing section of tube 87 are impressed through the capacitor 89 on a suitable attenuator represented by reference numeral 91. It should be understood that the adjustable frequency section of tube 87 permits the user to determine the resonant frequency which will be impressed on the circuit or circuits whose frequency characteristics are to be determined.

In order that the sweep circuit of a cathode ray may be synchronized with the varying frequency of the oscillator, a pair of output terminals 93 have been provided, which are connected to the output section of the rectifier 43. The impulses across these terminals have a frequency of 120 cycles and, because they are derived from the common source 71, are in synchronism with the triangularly peaked currents impressed on tube 65. Since the frequency of the synchronizing impulses is twice that of the triangularly peaked currents it will be observed that the horizontal sweep of the oscillator is made once for a rising characteristic and once for a falling characteristic of the triangular peaks.

It is important that the triangularly peaked impulses should be of the same duration and the same slope. If this precaution is not taken the scanning in one direction will not be equal to the scanning in the other with resulting lack of symmetry in the curves traced on the cathode ray screen. The proper adjustment of the direct current bias, controlled by resistor 77, establishes the equi-lateral characteristic which is required in the triangularly peaked wave form. This adjustment may be effected by observing the characteristics of any tuned resonant circuit on the screen of a cathode ray oscillograph and adjusting the direct current bias on the plate circuit of tube 65 until the sweeps of the characteristic curves are equal on both sides of resonance, indicating that the required symmetry of horizontal sweep circuit has been obtained.

Thus I have described means for generating oscillatory currents which vary over a predetermined frequency range without amplitude modulation. It should be understood that this frequency range operates over an increasing and then a decreasing frequency scale. The precise frequency about which this variation occurs may be determined by adjusting one of the oscillator tubes. I have also explained how the variable frequency characteristic may be made to vary over a linear scale. The fact that the scale is linear is a great advantage in the adjustment of radio receivers. Receivers of the radio frequency or superheterodyne type may be readily adjusted so that their several circuits are properly aligned and symmetrically tuned.

I claim as my invention:

1. A variable radio frequency generator comprising first and second oscillators, means for combining the outputs of said oscillators to produce a radio frequency resultant, means for adjusting the frequency of said first oscillator throughout a substantial range to determine the average output frequency of said generator, an oscillatory circuit coupled to said second oscillator, means for deriving substantially 90° leading currents from said oscillatory circuit, means for converting said currents into substantially lagging currents, means for impressing said lagging currents on said oscillatory circuit to control the frequency of said second oscillator, and means for continuously varying the amplitude of said lagging currents whereby the frequency of said resultant is continuously varied.

2. A variable radio frequency generator comprising first and second oscillators, means for combining the outputs of said oscillators to produce a radio frequency resultant, means for adjusting the frequency of said first oscillator throughout a substantial range to determine the average output frequency of said generator, an oscillatory circuit coupled to said second oscillator, means for deriving substantially 90° leading currents from said oscillatory circuit, means for converting said currents into substantially lagging currents, means for impressing said lagging currents on said oscillatory circuit to control the frequency of said second oscillator, a source of linearly varying alternating voltage for continuously varying the amplitude of said lagging currents, and means for adjustably controlling the amplitude of said alternating voltage.

3. A frequency modulated oscillator comprising a thermionic discharge device having cathode, anode, and a plurality of grid electrodes, means including an oscillatory circuit in circuit with said cathode and two of said grid electrodes for producing radio frequency oscillations, a shielding electrode between said anode and grid electrodes, means coupled to said anode for deriving oscillatory currents therefrom, means including phase shifting means for applying said derived currents to said oscillatory circuit in substantial phase quadrature with said oscillations, and means for varying the amplitude of said derived currents to thereby modulate the frequency of said oscillations.

4. A frequency modulated signal generator comprising first and second oscillators, means for combining the output currents of said oscillators to produce a resultant radio frequency current, the first of said oscillators including an electron discharge device having cathode, anode and grid electrodes, and means including an oscillatory circuit coupling said grid electrodes for producing radio frequency oscillations, a shielding electrode between said anode and said grid electrodes, means coupled to said anode for deriving oscillatory currents therefrom, means including phase shifting means for applying said derived currents to said first oscillator in substantial phase quadrature with said oscillations, and means for cyclically varying the amplitude of said applied currents whereby the frequency of said resultant current is varied over a predetermined frequency range which is independent of its average frequency as determined by the frequency of said second oscillator.

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