

April 4, 1939.

C. J. FITCH

2,153,179

OSCILLATOR CIRCUIT

Filed Sept. 10, 1936

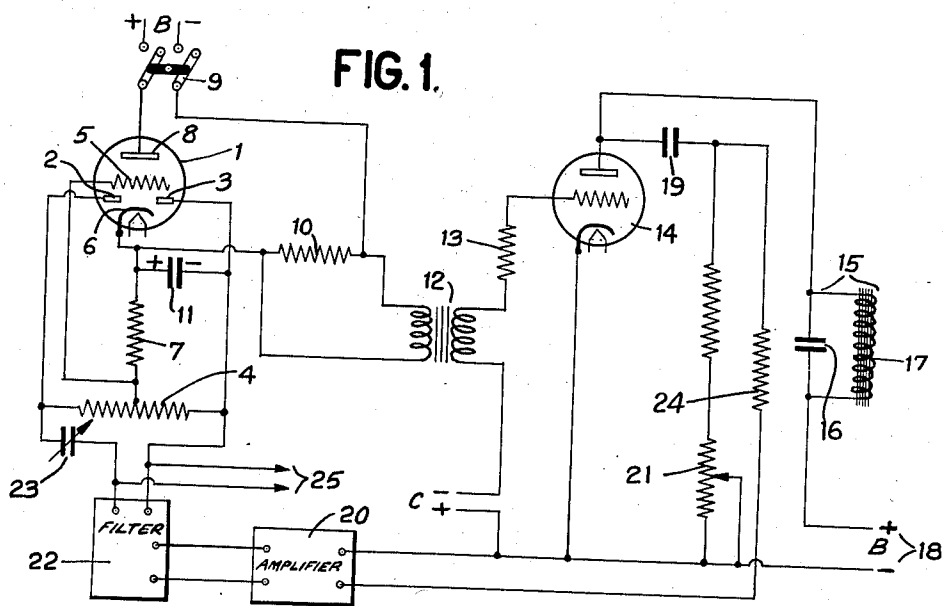


FIG. 2.

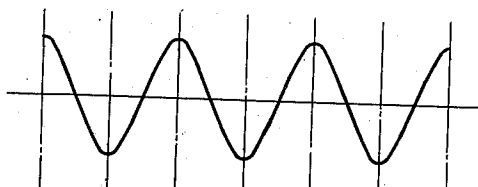


FIG. 3.

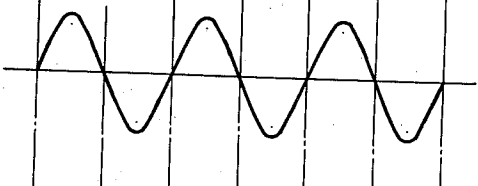


FIG. 4.

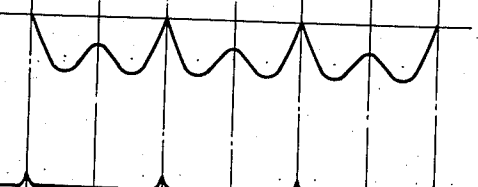


FIG. 5.



INVENTOR
Clyde J. Fitch
 BY
W. M. Johnson
 ATTORNEY

UNITED STATES PATENT OFFICE

2,153,179

OSCILLATOR CIRCUIT

Clyde J. Fitch, Endicott, N. Y., assignor to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application September 10, 1936, Serial No. 100,070

5 Claims. (Cl. 250—36)

This invention relates broadly to electron tube oscillator systems and more particularly to the type of systems in which constant frequency oscillations are generated irrespective of certain variations which may be introduced in the system.

An object of the present invention is to provide an improved constant frequency oscillator system in which the tuned circuit is virtually isolated from the system as a whole so that upon introduction of variations in the characteristics of the elements of the system, the oscillating circuit is maintained exceptionally constant in frequency.

Various other objects and advantages of the invention will be obvious from the following particular description of one form of mechanism embodying the invention or from an inspection of the accompanying drawing; and the invention also constitutes certain new and useful features of construction and combination of parts hereinafter set forth and claimed.

In the drawing:

Fig. 1 shows diagrammatically one form of circuit which may be employed whereby the invention may be carried into effect.

Figs. 2 to 5 show diagrammatically some of the characteristic curves of the system.

Referring now to Fig. 1, a brief general description of the system will be given before describing in detail the preferred form of circuit connection. The electron discharge devices 1 and 14 and the associated circuits comprise a constant frequency oscillator system so that upon closure of the control switch 9 the triode arrangement of tube 1 is activated to operate the normally high bias tube 14, permitting the tuned circuit 15 in the plate circuit thereof to be excited momentarily. The oscillations generated by the tuned circuit are in turn impressed upon amplifier 20 and filter 22 and the duplex diode arrangement of tube 1. The rectified waves are then impressed upon the triode of tube 1 so that a short control signal is impressed upon the electron discharge device 14. The control signal activates the tube 14 to permit the tuned circuit to be excited, as just explained, to energize tube 1, thus establishing an oscillatory circuit arrangement capable of generating oscillations at an extreme constant frequency. The exact mode of operation thereof will now be set forth.

The electron discharge device 1 is shown comprising the combination of a full wave rectifier and triode in one envelope and is a type well known in the art, commonly referred to as a duplex diode triode type. The diode plates 2 and

3 are joined to the terminals of resistor 4, the center tap of which is connected to the grid 5 of the tube. A resistance 7 is inserted between the said center tap and the cathode 6. The triode plate 8 is connected to positive battery through the switch 9 and the negative side thereof is connected to the said cathode through the resistance 10. A condenser 11 is inserted between the cathode 6 and one of the diode plates 3, the purpose of which will be understood as the description progresses. It is evident from the description of the circuit connections thus far that normally the grid 5 of the tube 1 is at zero bias due to the fact that no current is passing through resistor 7, therefore, upon closure of the switch 9 current flow will be established in the triode plate circuit of tube 1 as follows: from positive battery through the switch 9, plate 8 and cathode 6 of the tube, resistance 10 to the negative side of the battery through the said switch. The primary winding of transformer 12 is connected in shunt with the resistor 10 and the secondary winding thereof is included in addition to resistance 13 in the grid circuit of tube 14. A negative potential is shown applied to the grid circuit so that the tube 14 is normally biased below cutoff. Connected to the plate of tube 14 is a tuned circuit arrangement comprising capacitance 16 and inductance 17. This tuned circuit is energized upon closure of switch 9 due to the current flow in the triode plate circuit of tube 1. The initial voltage drop across resistance 10 is impressed upon the grid of tube 14 by means of transformer 12 and is sufficient to overcome the bias of the grid of tube 14 so as to cause a current pulse to flow from positive battery of source 18 through the tuned circuit 15, plate and cathode of the tube to the negative side of said source. The current flow established through the tuned circuit causes excitation thereof at a frequency depending upon the LC constants of the oscillatory circuit. The initial oscillation is passed through the coupling condenser 19 to the input of the amplifier 20. Between the tuned circuit and the input of the amplifier phase shifting means is provided comprising the combination of the condenser 19 and variable resistance 21. The phase shift may be effected and varied slightly by means of adjusting the resistor 21 for final adjustment which will be described later herein.

The generated oscillations are amplified and passed through the filter 22 which is used merely for the purpose of filtering out the higher harmonics and delivering a pure sine wave at the

output of the filter. The output of the filter is impressed upon the terminals of resistor 4. It was mentioned hereinbefore that normally the grid of tube 1 is at zero bias since there is no current passing through resistor 7. However, upon impression of the amplified oscillations at the terminals of the said resistor 4 and due to the full wave rectifier circuit arrangement the rectified current passing through resistor 7 immediately drives the grid bias negative and prevents further flow of plate current in the triode plate circuit. However, before the grid bias becomes effective to reduce the flow of plate current a pulse is impressed upon the plate circuit of the tube 1 in which resistor 10 is included. It was mentioned that condenser 11 is inserted between the cathode and one of the diode plates of tube 1. The curve in Fig. 3 shows the sinusoidal wave form impressed across the diode plates of the tube. When the polarity is such that current passes from one diode plate 2 to cathode, this current passes through the resistor 7, and charges the condenser 11 to the polarity as shown. At the end of this particular half cycle as the current passes through zero, the charge in the condenser maintains the grid of the tube negative with respect to the cathode of a value sufficient to permit no plate current to flow. The charge in the condenser leaks off through the resistor 7, the values of the capacitor and resistor being such that the time constant of the circuit is adjusted so as to maintain the tube biased below cut-off during the timed interval that the said half cycle of the a-c wave passes through zero. The following half cycle passing from diode plate 3 to the cathode and through resistor 7 has reached sufficient amplitude to maintain the tube biased below cut-off. At the end of the second half cycle, the charge in condenser 11 has completely leaked off, and as the second half cycle passes through zero, the grid bias is zero and plate current again is permitted to flow through the tube impressing an impulse upon the resistor 10. The curve in Fig. 4 shows the wave shape of the rectified voltage across the resistor 7. The effect of the condenser 11 is evident, suppressing the alternate peaks of the rectified wave as shown and, as just explained, the suppressed waves are reduced in amplitude so as to be ineffective to send out signals in the plate circuit whereas the unsuppressed waves are effective to impress signals upon the output circuit and thus it is seen that but one impulse is transmitted for a complete cycle of the input oscillations. The impulses impressed upon resistor 10 then activate the input and output circuits of tube 14 as explained to continue initiating the oscillations by virtue of the tuned circuit 15. This action is repeated and the explained circuits continue to oscillate, impulses being impressed upon the grid of tube 14 and the generated a-c impressed upon the terminals of resistor 4 and an inverted rectified wave impressed upon the grid of the tube 1. The curve in Fig. 2 shows the wave shape across the said oscillatory circuit and Figs. 3 to 5 show the other wave shapes as explained, Fig. 5 indicating the short pulses in the output circuit of tube 1 and impressed upon resistor 10.

The phase relationship of the waves generated by the oscillatory circuit, the waves impressed upon the diode plates of tube 1 and the impulses applied to the grid of tube 14 should be such that the impulses in the output circuit of tube 1 are impressed upon the grid of tube 14 during

the peak or maximum amplitude of the sine wave generated in the tuned circuit. This phase relationship is clearly shown in the curves shown in Figs. 2 to 5 and can be effected by inserting, for example, condenser 23 in one side of the filter output circuit as shown. Since the impulses flowing through the plate circuit of tube 1 occur at the zero point of the waves impressed thereupon and since they must be impressed upon the grid of the tube 14 at the peak of the generated wave in the tuned circuit, it is obvious that the phase relationship between the terminals of resistor 4 and the tuned circuit must be 90 degrees apart. This phase shift may be varied slightly by means of the adjustable resistor 21 for a final adjustment.

In the circuit just explained it will be noted that the tuned circuit is connected to tube 14 which is normally biased below cut-off. Therefore, any variations in supply voltage will have no effect upon the impedance of the tube 14 and consequently no effect upon the frequency of the tuned circuit. The oscillating circuit has been found to be exceptionally constant in frequency over a wide range of tube voltages. The said tube is biased below cut-off for about 95 percent of the cycle period, and is not biased below cut off only when the impulse is impressed upon the grid thereof to drive the grid to zero bias. The duration of the impulse, however, is so short that any change in the impedance of the tube has virtually no effect on the characteristics of the generated oscillations. The resistor 13 in the grid circuit of tube 14 limits the grid current and irrespective of the amplitude of the applied impulse, the grid voltage will not be driven positive, for as soon as grid current tends to flow, the voltage drop across resistance 13 is so great that the grid will not be driven farther from the extreme bias to zero. Therefore, any variations in amplitude of the impulse due to voltage supply variations will have practically no effect on the tuned circuit since the grid of the said tube will always be driven to zero bias and is so adjusted that the minimum impulse will drive it to that value and impulses having greater amplitude tending to drive the grid positive have no effect due to the large voltage drop across the resistor 13.

The only energy drawn from the tuned circuit is that which passes through condenser 19 and resistance 21. Resistance 24 in series with the amplifier is of a relatively high value and prevents current flow through the amplifier. Since resistors 21 and 24 and condenser 19 are all of fixed value, variations in the amplifier input circuit will have practically no effect on the amount of energy drawn from the tuned circuit. Consequently, the tuned circuit is isolated from the remainder of the circuit described and the frequency is determined solely by the inductance and capacity of this circuit which is unaffected by variations in the associated apparatus. From the terminals 25 tapped to the output of the filter, a pure sine wave generated by the tuned circuit may be impressed upon any circuit connected thereto and adaptable for use with a constant frequency generator.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art

without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

5 What is claimed is as follows:

10 1. The method of producing electrical variations in an electric circuit which consists in supplying energy to said circuit, producing from said supply of energy current variations of a predetermined frequency in a portion of said circuit and transforming said current variations to unidirectional pulses as the current variations pass through zero and utilizing said pulses to sustain further production of said current variations.

15 2. In combination, means to generate oscillations of a predetermined frequency, a rectifier system, said generated oscillations impressed upon the rectifier system, means to convert the rectified energy into short unidirectional signals comprising a thermionic device having an input and output circuit and a control grid included in the input circuit thereof, means connected to the input circuit maintaining the grid bias normally at a zero value when the input circuit is de-energized and at a variable value when the said input circuit is energized by the rectified energy, and means to conduct said signals to the oscillation generator to produce sustained electrical oscillations.

20 3. In combination, means to generate electrical oscillations of a certain frequency, means

comprising a full wave rectifier system to rectify the oscillations, means to convert the rectified oscillations into short control signals including means whereby the control signals are initiated as the oscillations pass through zero, means to limit the initiation of the control signals to one for each cycle of the generated oscillations, and means to conduct the control signals to the first mentioned means to sustain the generation of the electrical oscillations.

25 4. In combination, means to generate electrical oscillations of a certain frequency, means comprising a full wave rectifier system to rectify the oscillations, means to convert the rectified oscillations into short control signals including means whereby the control signals are initiated as the oscillations attain a predetermined value, means to limit the initiation of the signals to one for each cycle of the generated oscillations, and means to conduct the control signals to the first mentioned means to sustain the generation of the electrical oscillations.

5. In combination, means to generate electrical oscillations, means to convert said oscillations into control signals including means whereby single control signals are initiated as the oscillations pass through zero, and means to conduct the control signals to the first mentioned means to sustain the generation of the electrical oscillations.

CLYDE J. FITCH.