

June 22, 1948.

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2,443,922

CONTROL CIRCUIT FOR RELAXATION OSCILLATORS

Filed Aug. 2, 1944

FIG. 2.

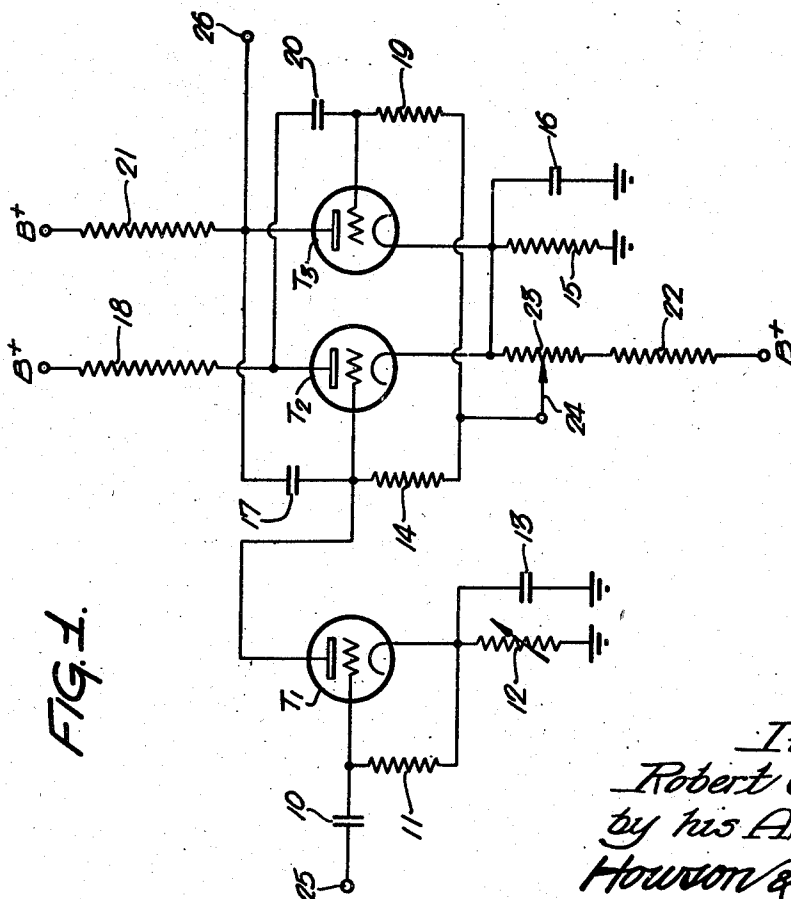
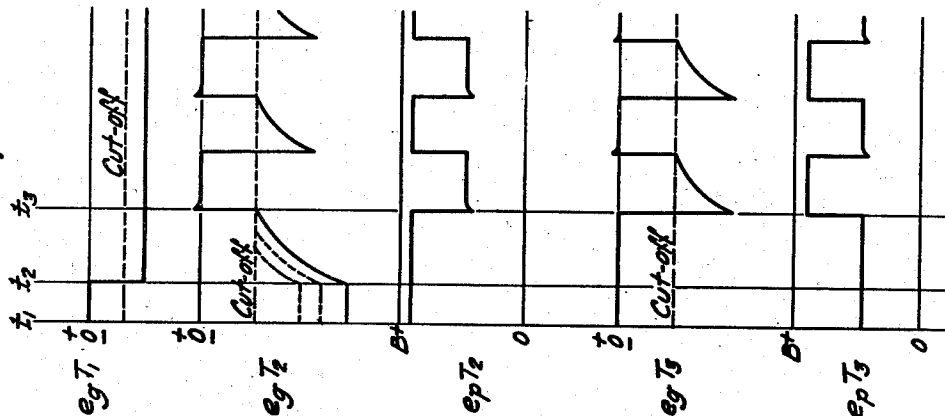


FIG. 1.

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UNITED STATES PATENT OFFICE

2,443,922

CONTROL CIRCUIT FOR RELAXATION
OSCILLATORS

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Application August 2, 1944, Serial No. 547,719

3 Claims. (Cl. 250—36)

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This invention relates to the control of relaxation oscillators, and more particularly to the control of an oscillator whose operation is initiated and maintained in response to a control signal.

It is sometimes desirable to utilize a relaxation oscillator arrangement in which the operation of the oscillator takes place only during the occurrence of a control signal, i. e., the oscillator is started in response to commencement of the control signal and is stopped when the signal terminates. Prior devices of this character have exhibited an undesirable tendency to produce a transient or disturbance during the starting of the oscillator.

The principal object of the present invention is to effect improved control of such an oscillator, and more particularly to effect starting of the oscillator without the production of any undesirable transient or disturbance.

Another object of the invention is to provide a novel control circuit by which the oscillator is started after a predetermined time interval following the commencement of the control signal, to the end that at the instant of starting the oscillator shall be conditioned for normal operation and there shall be no tendency toward the production of any transient or disturbance.

A further object of the invention is to provide a novel control circuit of the stated character in conjunction with a relaxation oscillator of the multivibrator type.

Other objects and advantages of the invention will become apparent during the course of the following description with reference to the accompanying drawings, in which:

Fig. 1 illustrates schematically one embodiment of the invention; and

Fig. 2 is an explanatory diagram illustrating the voltage wave forms at various parts of the circuit of Fig. 1.

Referring to Fig. 1, there is shown a relaxation oscillator of the multivibrator type comprising vacuum tubes T_2 and T_3 and their associated circuit elements. A control tube T_1 and its associated circuit elements serve to control the operation of the multivibrator. While the tubes are shown as triodes, it is to be understood that multi-grid tubes may be employed together with the necessary circuit modifications to accommodate the particular tubes employed in any instance. Furthermore, tubes T_2 and T_3 may be combined in one envelope, as in the well known twin type vacuum tube.

The control tube T_1 is arranged to receive a

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negative timing pulse through a grid coupling condenser 10. Preferably the grid of tube T_1 is operated at zero bias, being connected to the cathode by means of grid resistor 11. The cathode of tube T_1 is connected to ground through a variable cathode resistor or potentiometer 12, shunted by a condenser 13. The anode of tube T_1 is directly connected to the grid of the first multivibrator tube T_2 and may receive its potential from the cathode circuit of the multivibrator by way of grid resistor 14. Alternatively, the return for grid resistor 14 (and also resistor 19) may be made to a separate supply. The two tubes T_2 and T_3 are arranged generally in conventional multivibrator fashion, with the cathodes tied together and connected to ground through a common cathode biasing resistor 15 having a by-pass condenser 16. The grid coupling condenser and plate load resistor for tube T_2 are shown at 17 and 18, respectively, while the grid resistor, grid condenser and plate resistor for tube T_3 are represented at 19, 20 and 21. A suitable source $B+$ serves as the anode potential supply for the multivibrator tubes T_2 and T_3 . A resistance network consisting of resistor 22 and potentiometer 23, in series, may be connected between the anode voltage supply $B+$ and the common cathode connection of tubes T_2 and T_3 . By connecting the grid resistors 14 and 19 of tubes T_2 and T_3 to the movable arm 24 of potentiometer 23, an arrangement is provided for controlling and adjusting the frequency of the multivibrator.

The input terminal of the device is shown at 25, while the output of the multivibrator may be obtained from the anode of tube T_3 by way of the output terminal 26.

It will be apparent to those familiar with the art that grid resistor 11 of control tube T_1 may, alternatively, be connected to ground instead of to the cathode of tube T_1 , as shown in Fig. 1, in which case potentiometer 12 would become a variable cathode biasing resistor.

The operation of the circuit will now be described with reference to the embodiment shown in Fig. 1 and the voltage wave forms of Fig. 2.

With no signal applied to the grid of control tube T_1 , this tube is conducting since its grid is at zero bias, and the magnitude of its plate current is governed in part by the adjustment of potentiometer 12. The plate current of tube T_1 , flowing through grid resistor 14, produces a voltage drop thereacross which biases the grid of tube T_2 well below cut-off, thereby preventing tube T_2 from conducting and preventing the multivibrator from oscillating. The other multi-

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vibrator tube T_3 is, of course, conducting since its grid is at cathode potential or some small positive potential, depending upon the position of potentiometer arm 24.

The voltage wave forms at several parts of the circuit for this no-signal input condition are shown in Fig. 2 for the interval between the time reference lines t_1 — t_2 . Referring to Fig. 2, the grid potential of tube T_1 with respect to its cathode is represented by curve $e_g T_1$; the potential of the grid of tube T_2 with respect to its cathode is represented by curve $e_g T_2$, the dotted lines indicating other potentials for different settings of the potentiometer 12; the potential on the plate of tube T_2 , which is approximately equal to the supply voltage $B+$ since this tube is not conducting, is represented by curve $e_p T_2$; the grid potential of tube T_3 with respect to its cathode, assuming that the contact arm 24 of potentiometer 23 in Fig. 1 is at the cathode end, is zero as represented at $e_g T_3$; and the potential on the plate of tube T_2 which is conducting, is represented by curve $e_p T_3$.

Referring again to Fig. 1, when a negative pulse is applied to the input terminal 25, driving the grid potential of tube T_1 below its cut-off value, the grid potential of tube T_2 rises as the charge on grid condenser 17 leaks off through resistor 14 and the conducting tube T_3 . When the grid potential of tube T_2 reaches its cut-off value, this tube conducts and the multivibrator begins to oscillate in normal multivibrator fashion. The multivibrator will then continue to function for the duration of the negative pulse on the grid of control tube T_1 . At the end of this timing pulse, the grid potential of tube T_1 rises to its normal "no signal" value, whereupon tube T_1 conducts, thereby lowering the grid potential of tube T_2 below its cut-off value and interrupting multivibrator oscillation. The application of another negative timing pulse causes repetition of the above cycle of operation.

The voltage conditions in the circuit during the interval between the commencement of the negative timing pulse and the time that the grid potential of tube T_2 reaches its cut-off value are represented in Fig. 2 between the vertical lines t_2 — t_3 . It will be noted that the only changes in the circuit conditions are the drop in grid potential of tube T_1 to some value below cut-off, as shown by curve $e_g T_1$, and the exponential rise in grid voltage of tube T_2 , as shown by curve $e_g T_2$.

At the instant the grid potential of tube T_2 reaches its cut-off value, i. e., at time t_3 , the multivibrator is ready to function in its normal manner, as indicated by the grid voltage and plate voltage wave forms for tubes T_2 and T_3 in Fig. 2, since the voltages on the plate of tube T_2 and on the grid and plate of tube T_3 are identical to those conditions during that portion of the multivibrator cycle when the grid voltage of tube T_2 is below its cut-off value.

Since the multivibrator goes into oscillation at some time, t_3 in Fig. 2, after the application of the negative pulse at time t_2 , it is apparent from wave form $e_g T_2$ that the time t_3 , at which multivibrator action begins, depends upon the potential of the grid of tube T_2 during the no signal input period. The dotted lines in Fig. 2 for the grid potential of tube T_2 (wave form $e_g T_2$) show that for less negative potentials the time required for the grid of tube T_2 to reach its cut-off value is shorter than for more negative potentials. The delay interval between the time of application of the negative timing pulse to the input ter-

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minal 25 and the beginning of multivibrator oscillations may then be varied or adjusted by the potentiometer 12 in the cathode circuit of tube T_1 , since this potentiometer varies the cathode voltage of tube T_1 and hence the plate voltage of tube T_1 and the no input signal potential of the grid of tube T_2 .

In practicing this invention in accordance with the embodiment shown in Fig. 1 with type 7N7 tubes and an anode potential source of 200 volts, the values for the circuit elements were as follows:

Condensers 10—0.005 microfarad

Resistor 11—220,000 ohms.

15 Potentiometer 12—100,000 ohms.

Condensers 13 and 16—0.005 microfarad each

Resistors 14 and 19—100,000 ohms each

Resistor 15—4,700 ohms

20 Condensers 17 and 20—100 micro-microfarads each

Resistors 18 and 21—4,700 ohms each.

Resistor 22—150,000 ohms

Potentiometer 23—25,000 ohms

25 It will be understood, of course, that the invention is not limited to the specific embodiment illustrated and described herein nor to the values of the various elements given as a specific example. The invention is capable of various embodiments or modifications which may be resorted to without departing from its scope.

I claim:

1. In combination, a multivibrator comprising a pair of inter-coupled vacuum tubes having at least triode elements, means normally biasing the grid of one of said tubes below cut-off value, thereby rendering said multivibrator normally inoperative, means responsive to a control signal for decreasing the bias of said one grid so as to render said multivibrator operative for the duration of said signal only, and means for delaying the starting of said multivibrator for a predetermined time interval following the commencement of said signal.

2. In combination, a multivibrator comprising a pair of inter-coupled vacuum tubes having at least triode elements, a normally conductive control tube, means controlled by the anode current of said control tube for normally biasing the grid of one of said multivibrator tubes below cut-off value, thereby rendering said multivibrator normally inoperative, means for applying to said control tube a control signal adapted to reduce the anode current of the control tube and thereby decrease the bias of said grid, so as to render said multivibrator operative for the duration of said signal only, and means for delaying the starting of said multivibrator for a predetermined time interval following the commencement of said signal.

3. In combination, a multivibrator comprising a pair of inter-coupled vacuum tubes having at least triode elements, a resistor connected between the grid and cathode of one of said tubes, a control tube having its anode connected to the junction between said resistor and said grid, a source of anode potential connected to the opposite end of said resistor, whereby said resistor serves to bias said grid under control of the anode current of said control tube, means for normally operating said control tube so as to bias said grid below cut-off value, thereby rendering said multivibrator normally inoperative, means for applying to said control tube a control signal adapted to reduce the anode current of the control tube

and thereby decrease the bias of said grid, so as to render said multivibrator operative for the duration of said signal only, and a condenser connected to said grid and forming with said resistor a time delay means for delaying the starting of said multivibrator for a predetermined time interval following the commencement of said signal.

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