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A. A. MACDONALD ET AL

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MULTIVIBRATOR

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Fig. 1.

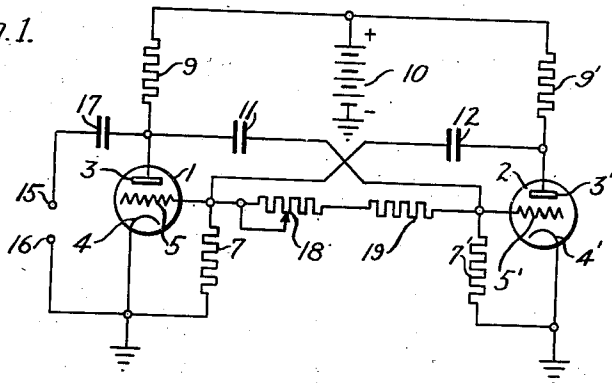
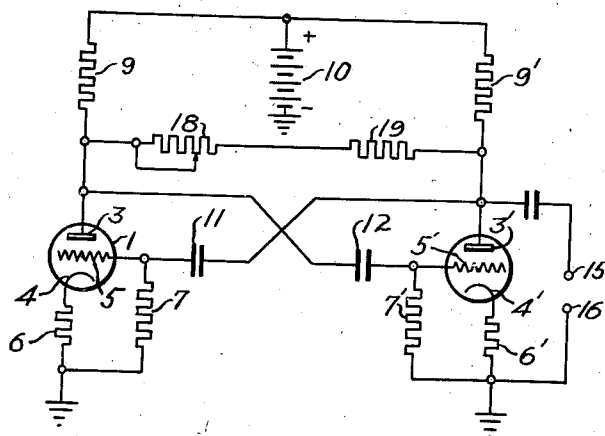


Fig. 2.



WITNESSES:

R. J. [Signature]
A. J. [Signature]

INVENTORS
John L. Johnson and
Angus A. Macdonald

BY
Hymen Diamond
ATTORNEY

UNITED STATES PATENT OFFICE

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MULTIVIBRATOR

Angus A. Macdonald and John L. Johnson,
Catonsville, Md., assignors to Westinghouse
Electric & Manufacturing Company, East
Pittsburgh, Pa., a corporation of Pennsylvania

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5 Claims. (Cl. 250—36)

This invention relates to oscillation generators, and more particularly to generators of the type known as relaxation oscillators or multivibrators.

A particular feature of this invention is that in a multivibrator type of oscillator simple means are provided for controlling the frequency of the oscillations within a wide range.

Another feature of this invention is that the novel control for the frequency will not change the amplitude of the oscillations within a comparatively wide frequency range.

A particular advantage of the invention is that only slight modifications are necessary to the standard multivibrator circuit for obtaining a wide range of frequency adjustment.

Another advantage resulting from the circuit arrangement herein proposed is that the frequency of a multivibrator may be varied by means of a single control without changing the symmetry of the wave form of the oscillations produced.

The invention in its broader aspect comprises a coupling circuit for controlling the frequency of a relaxation oscillator in which there are two vacuum tubes so interconnected that the output circuit of one tube is coupled to the input circuit of the other tube and vice versa, the output circuit of the latter is coupled to the input circuit of the former. The coupling circuit above referred to provides an interconnection between identical circuits of the tubes.

Other objects and advantages will be apparent from the following description of the invention, pointed out in particularity by the appended claims, and taken in connection with the accompanying drawing, in which:

Figure 1 shows a schematic circuit of a multivibrator with a coupling circuit interconnecting the input circuit of the tubes; and

Fig. 2 shows a modification of the circuit of Fig. 1 with a coupling circuit interconnecting the output circuit of the tubes.

Circuits of the relaxation oscillator type are widely used in the art for producing oscillations in a simple manner without tuned reactance networks. A multivibrator circuit may be regarded simply as a two-stage resistance coupled amplifier in which the voltage developed by the output of the second tube is applied to the first tube. The oscillations are produced because in each tube there will be 180° phase shift, so that the output of the second tube will supply to the first tube an input voltage that has exactly the right phase to sustain oscillations. In order to change the frequency of the oscillations of a multivibrator, it

was the practice heretofore to vary the value of the coupling condensers or the resistors in the grid circuit. Since there are two resistors and two condensers, it is necessary to vary simultaneously these elements if it is desired to maintain the symmetry of the output wave form as the frequency is changed. Controlling the frequency in this manner has many disadvantages. First of all, two controls are needed which also must be ganged together for simultaneous variation of the above-mentioned components. It is often difficult and expensive to obtain gang controls whose parameters will vary equally with equal control shaft rotation.

Another method heretofore used for varying the frequency of a multivibrator was to vary the bias voltage for the grid electrodes simultaneously for both tubes. The range over which the frequency of a multivibrator may be varied by this method is very limited.

The frequency control herein proposed will be best understood by first referring to the figures of the drawing. The simple multivibrator shown in Fig. 1 comprises vacuum tubes 1 and 2 having anodes 3 and 3', cathodes 4 and 4', and control electrodes 5 and 5', respectively. The input circuit of tube 1 between the cathode 4 and the control electrode 5 comprises the grid load resistance 7, and similarly the input circuit for tube 2, the grid load resistance 7'. The output circuit includes for the tube 1 the anode load resistance 9 for tube 2, the anode load resistance 9' connected to the high potential side of the anode supply shown here by the battery 10. The negative terminal thereof returns to ground completing the circuit to the cathodes which are also at ground potential. The output circuit of tube 1 also includes the coupling condenser 11 which is connected between anode 3 and control electrode 5' of the tube 2. Similarly, the output circuit of the latter includes the coupling condenser 12 connected between anode 3' and control electrode 5 of tube 1. The oscillations produced may be taken off for a utilization circuit between terminals 15 and 16, which connect to the anode 3 through a coupling condenser 17 and to the cathode 4, respectively.

The circuit so far described is a conventional multivibrator in which the frequency is determined by the constants of the symmetrically arranged components, namely, the resistors 7 and 7', 9 and 9', and coupling condensers 11 and 12.

The frequency control in accordance with this invention comprises the variable resistance 18 and fixed resistance 19 in series therewith con-

nected between control electrodes 5 and 5'. In other words, these resistors form a circuit which interconnects identical circuits of the two tubes, namely, in this case, the input circuits of tube 1 and tube 2. The variable resistor 18 is the effective frequency control means whereas the fixed resistor 19 is a residual resistance provided to prevent cessation of oscillations when the variable resistance 18 is at the point of minimum resistance.

In addition the multivibrator circuit of Fig. 2 also includes a certain amount of degenerative feedback for the tubes in the form of cathode resistors 6 and 6' in the cathode return of tubes 1 and 2, respectively. The degenerative feedback so obtained is particularly useful to reduce the change of amplitude encountered with change of frequency beyond a certain frequency range. The amplitude of oscillations will be more uniform over an extended frequency range with a certain amount of decrease in the voltage output of the oscillator. The inverse feedback utilized in this simple form may, of course, be applied to the circuit shown in Fig. 1 as well. Other forms of degenerative feed-back circuits can also be employed.

By proper choice of the circuit constants, it was found that by varying the value of the resistance 18 a wide variation in the frequency range of the oscillator could be obtained. In a practical embodiment, a variation in the frequency range of 120:1 was readily obtained without greatly influencing the amplitude of the oscillations. Even greater frequency ranges may be covered if appreciable amplitude variation with frequency is not objectionable.

Referring to Fig. 2, the circuit shown here is in all its essential details similar to the one shown in Fig. 1. Identical circuit elements are designated with similar reference characters. One difference is that the frequency control circuit comprising the variable resistor 18 and the fixed resistor 19 is connected here between the anodes 3 and 3' instead of the grids 5 and 5' as in Fig. 1. In other words, the connection is between the output circuits of the tubes 1 and 2. The output frequency of the oscillator is derived from tube 2 in that the terminals 15 and 16 connect to the anode 3' and cathode 4', respectively. The result obtained by this connection of the frequency control circuit is similar to the one shown in Fig. 1, and the same wide variation in frequency can be obtained.

In the operation of these circuits, when the control resistor 18 is turned to the point of maximum resistance, the frequency of the multivibrator oscillations will be determined by the time constant of resistor 7 and condenser 12 plus the time constant of the resistor 7' and the condenser 11. When the control 18 is rotated towards its minimum resistance value, the frequency of the multivibrator oscillations will increase. This is due to the fact that the reactance of the condensers 11 and 12 at the oscillation frequency must be appreciably less than the combined resistance of resistors 18 and 19, in order that oscillations shall be sustained. For this reason, the value of the resistance 18 should be high compared to the resistances 7 and 7'.

In a practical embodiment of the oscillator circuit, the following constants for the components resulted in an oscillator output of 22 volts peak-to-peak over a range from $\frac{1}{2}$ to 200 cycles. Resistors 7 and 7' were each 3 megohms; coupling condensers 11 and 12 each two microfarads; and

resistors 9 and 9' each 1500 ohms. The source of anode potential was 300 volts. The tubes used were of the type 6SN7GT. The control circuit values were 3 megohms for the variable resistance 18 and 10,000 ohms for the fixed resistor 19. The amplitude of the output was practically constant over $\frac{1}{2}$ of the frequency range with slight variation for the entire range above stated.

It is clearly seen from the above description a very simple expedient is provided for adjusting the frequency of a relaxation oscillator. By the addition of only two components, of which only one need be adjusted, a single control means will perform the function of complicated controls heretofore used. All the advantages of the relaxation type of oscillators are also retained. If it is desired to synchronize the operation of the oscillator, a voltage may be introduced in the grid circuit in the same manner as heretofore. The frequency control connection does not alter the flexibility of the oscillator circuit for various uses, rather it adds to it by making the variation of the output frequency extremely simple.

We claim as our invention:

1. A relaxation oscillator comprising a pair of electron discharge tubes, an input circuit and an output circuit for each of said tubes, circuit means for coupling the output circuit of the first tube with the input circuit of the second tube and for coupling the output circuit of the second tube with the input circuit of the first tube, and means for controlling the frequency of the oscillations generated comprising a variable resistor coupling identical points on said circuits respectively of said tubes.

2. An oscillatory system of the multivibrator type comprising two electron discharge tubes each having an anode, a cathode, and a control electrode, condensers cross-connecting the anodes and control electrodes of said tubes, a resistor connected in each of the anode circuits of said tubes, a resistor connected between the control electrode and cathode of each of said tubes, and a connection including a circuit element of variable direct current conductivity between the control electrodes of said tubes whereby the frequency of the generated oscillations may be varied in accordance with the variation of the conductivity of said element.

3. An oscillatory system of the multivibrator type comprising two electron discharge tubes each having an anode, a cathode, and a control electrode, condensers cross-connecting the anodes and control electrodes of said tubes, a resistor connected in each of the anode circuits of said tubes, a resistor connected between control electrodes and cathode of each of said tubes, and a connection including a circuit element of variable direct current conductivity between the anode electrodes of said tubes whereby the frequency of the generated oscillations may be varied in accordance with the variation of the conductivity of said element.

4. An oscillatory system of the multivibrator type comprising two electron discharge tubes each having an anode, a cathode, and a control electrode, condensers cross-connecting the anodes and control electrodes of said tubes, a resistor connected in each of the anode circuits of said tubes, a resistor connected between the control electrode and cathode of each of said tubes, and a variable resistance in series with a fixed resistance between the control electrodes of said tubes whereby the frequency of the generated

oscillations may be varied in accordance with the variation of said variable resistance.

5. An oscillatory system of the multivibrator type comprising two electron discharge tubes each having an anode, a cathode and a control electrode, condensers cross-connecting the anodes and control electrodes of said tubes, a resistor connected in each of the anode circuits of said tubes, a resistor connected between anode elec-

trodes and cathode of each of said tubes, and a variable resistance in series with a fixed resistance between the anodes of said tubes whereby the frequency of the generated oscillations may be varied in accordance with the variation of said variable resistance.

ANGUS A. MACDONALD.
JOHN L. JOHNSON.