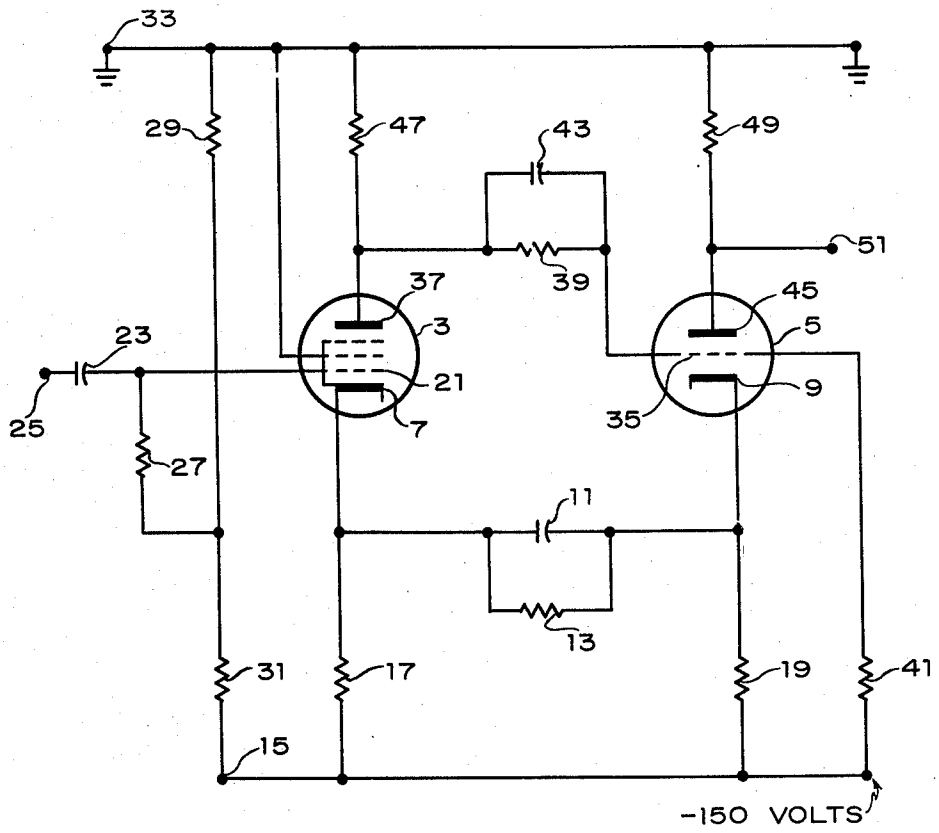
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MULTIVIBRATOR

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MULTIVIBRATOR

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This invention relates to a free-running multivibrator the output of which may be accurately synchronized with trigger signals applied thereto.

A multivibrator of this type is described in U.S. Patent No. 2,826,694, issued March 11, 1958, to R. L. Ropiequet. A drawback of the circuit shown in the above patent is that the free-running rate of the multivibrator depends in part on the impedance of the external trigger source and on the size of the input blocking condenser.

It is therefore the principal object of this invention to provide a free-running multivibrator which may be accurately synchronized with applied trigger signals and in which the free-running rate of the multivibrator is completely independent of the impedance of the trigger source and of the input circuit. This is important in an oscilloscope, for instance, where the trigger source may be external to the oscilloscope and therefore have an impedance which is not under the control of the oscilloscope designer. It also enables the designer to choose a low coupling cut-off frequency by using an appropriate input blocking condenser without affecting the free-running rate of the multivibrator.

In accordance with the illustrated embodiment of this invention the network which determines the frequency of the free-running multivibrator is entirely in the cathode circuits of the tubes while the trigger signals are applied to the grid of one of the tubes.

Other and incidental objects of this invention will be apparent to those skilled in the art from a reading of this specification and an inspection of the accompanying drawing which shows a circuit diagram of an embodiment of this invention.

Referring now to the drawing, the multivibrator of this invention includes two vacuum tubes 3 and 5. The cathodes 7 and 9 of tubes 3 and 5 are connected together through a capacitor 11 by-passed by a resistor 13, and are returned to the negative power supply terminal 15 through resistors 17 and 19 respectively. The control grid 21 of tube 3 is connected through capacitor 23 to terminal 25 to which external trigger signals may be applied. The control grid 21 is also connected through a resistor 27 to a point on the potential divider comprising resistors 29 and 31 which are serially connected between the negative power supply terminal 15 and the positive power supply terminal 33. The control grid 35 of tube 5 is directly coupled to the anode 37 of tube 3 through the voltage divider comprising resistors 39 and 41. The resistor 39 is by-passed by a capacitor 43 which compensates the voltage divider for high frequencies since at such frequencies the divider is affected by stray capacitances between the grid 35 and the supply terminal 15. The anode 37 of tube 3 and the anode 45 of tube 5 are connected to the power supply terminal 33 through resistors 47 and 49 respectively. The output signal is taken from the anode 45 at output terminal 51.

The free-running operation of the circuit of the drawing is as follows: let us assume that tube 3 has just begun to conduct. The voltage developed across resistor 47 is coupled to the grid of tube 5 by the compensated

voltage divider comprising resistors 39 and 41. This causes tube 5 to be cut off, the potential at the cathode 9 being near that at the cathode 7 due to the coupling through the capacitor 11. The current through tube 3 is supplied through its own cathode resistor 17 and through the cathode resistor 19 and capacitor 11 from the negative power supply terminal 15. The capacitor 11 charges in a direction such that the cathode 9 becomes more negative with time until the bias on tube 5 becomes less than the cut-off value and tube 5 begins to conduct. When tube 5 begins to conduct the potential at its cathode becomes slightly less negative. The cathode 7 also becomes less negative due to the coupling capacitor 11, the current through tube 3 is reduced, the anode 37 becomes less negative, the control grid 35 also becomes less negative due to the coupling elements 39 and 43, and tube 5 conducts more current. This very rapid process is repeated until tube 3 is cut-off entirely. Now the capacitor 11 charges in a direction such that the cathode 7 becomes more negative with time until the bias tube 3 becomes less than the cut-off value and tube 3 begins to conduct. The cycle described above is then repeated, tubes 3 and 5 being turned on and off alternately at a rate which is controlled by the RC circuits (19, 11) and (17, 11) and which is unaffected by the parameters of any trigger source which may be connected to terminal 27.

The multivibrator of Figure 1 may be synchronized with signals applied to its terminal 27. When the repetition rate of these signals is high with respect to the free-running rate of the multivibrator the circuit behaves like a Schmitt trigger, the cathodes 7 and 9 being coupled together through capacitor 11. As the repetition rate of these signals goes down and approaches the free-running frequency the level of the signals required to effect synchronization approaches zero. As the repetition rate of these signals goes down further the signal level required to effect synchronization goes up. The maximum signal level required to effect synchronization at low frequencies is, however, limited by the resistor 13 which, while not essential to the operation of the circuit, limits the applied voltage required to prevent the cathode potentials from going down and triggering the circuit at its free-running rate. The reason for this is that resistor 13 forms, together with one of the cathode resistors 17 or 19, a voltage divider which limits the voltage excursions of both cathodes.

We claim:

1. A free-running multivibrator comprising first and second electron discharge tubes each having cathode, grid and anode elements, separate resistors adapted to connect said cathodes to a negative power supply terminal, separate loads adapted to connect said anodes to a positive power supply terminal, means to vary the D.C. potential at the grid of said second tube proportionally with the potential at the plate of said first tube, said means comprising a resistor connected between the plate of said first tube and the grid of said second tube, and also a resistor connected between the grid of said second tube and said negative power supply terminal, a capacitor coupling said cathodes, and means to apply synchronizing signals to the grid of said first tube.

2. A free-running multivibrator comprising first and second electron discharge tubes each having cathode, grid and anode elements, separate resistors adapted to connect said cathodes to a negative power supply terminal, separate loads adapted to connect said anodes to a positive power supply terminal, means to vary the D.C. potential at the grid of said second tube proportionally with the potential at the plate of said first tube, said means comprising a resistor and a capacitor in shunt therewith connected between the plate of said first tube and the grid of said second tube, and also a resistor connected between the grid of said second tube and said negative

power supply terminal, a capacitor coupling said cathodes, and means to apply synchronizing signals to the grid of said first tube.

3. A free-running multivibrator comprising first and second electron discharge tubes each having cathode, grid and anode elements, separate resistors adapted to connect said cathodes to a negative power supply terminal, separate loads adapted to connect said anodes to a positive power supply terminal, means to vary the D.C. potential at the grid of said second tube proportionally with the potential at the plate of said first tube, said means comprising a resistor connected between the plate of said first tube and the grid of said second tube, and also a resistor connected between the grid of said second tube and said negative power supply terminal, a capacitor and a resistor in shunt therewith coupling said cathodes, and means to apply synchronizing signals to the grid of said first tube.

4. A free-running multivibrator comprising first and second electron discharge tubes each having cathode, grid and anode elements, separate resistors adapted to connect said cathodes to a negative power supply terminal, separate loads adapted to connect said anodes to a positive power supply terminal, means to vary the D.C. potential at

the grid of said second tube proportionally with the potential at the plate of said first tube, said means comprising a resistor and a capacitor in shunt therewith connected between the plate of said first tube and the grid of said second tube and also a resistor connected between the grid of said second tube and said negative power supply terminal, a capacitor and a resistor in shunt therewith coupling said cathodes, and means to apply synchronizing signals to the grid of said first tube.

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