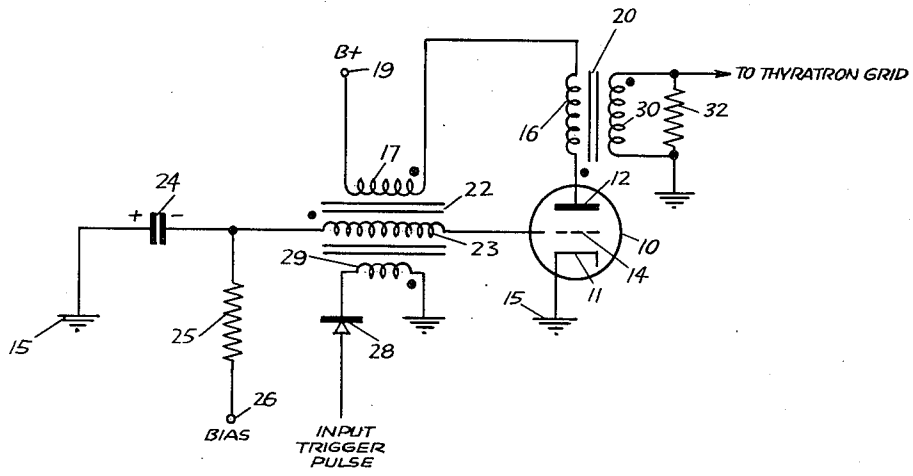
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BLOCKING OSCILLATORS

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BLOCKING OSCILLATORS

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This invention relates to means for generating electromagnetic energy and more particularly to an improved blocking oscillator adapted for supplying short-circuited loads.

Blocking oscillators of the prior art are characterized in that the feedback from the plate circuit to the grid circuit is in parallel with the load. Such oscillators operate satisfactorily if the load circuit impedance is relatively high, that is, when the oscillator output circuit is coupled to an open circuit or to a circuit which draws a relatively small current. When such blocking oscillators are used to supply a load which draws relatively large currents, serious difficulties are encountered. For example, when such oscillators are used as a driver for thyratron grids, the action of the blocking oscillator is interrupted by the short-circuit placed across the output coil of the blocking oscillator transformer when the thyratron fires. As a result, an erratic series of short pulses is generated instead of a single pulse of the resquired duration.

Although this problem may be partially solved in low power thyratrons by inserting a resistor in series with the thyratron grid, so that a direct short-circuit does not appear across the blocking oscillator transformer, the larger thyratrons now in common use require such a low impedance driver that some other means of solution must be resorted to.

In accordance with this invention a feedback winding is placed in series with the load rather than in shunt with the load. The regeneration thereby obtained is proportional to the load current so that the regenerative feedback continues and actually improves when the load is short-circuited. This current feedback is in contradistinction to the voltage feedback of prior blocking oscillator circuits.

In order to adapt the blocking oscillator of the subject invention for operation into an open-circuited load, a resistor is connected across the output winding of the blocking oscillator so that sufficient current feedback is provided for satisfactory operation of the circuit.

An additional advantage obtained with this circuit is that the source of the triggering pulse is not loaded by any coupling to the load as in prior blocking oscillator circuits.

In the drawing a schematic diagram of a blocking oscillator in accordance with the invention is shown.

Referring to the drawing, the blocking oscillator circuit includes a vacuum tube or other electron discharge device **10** having at least a cathode **11**, an anode **12**, and a control electrode **14**. Although the electron discharge device is shown for the sake of clarity as a triode, it may contain other control electrodes. For example, in one practical embodiment of the invention, electron discharge device **10** is a beam power pentode amplifier. The principles of this invention, however, are equally applicable to a blocking oscillator using any type of amplifier. The cathode **11** of tube **10** is grounded at **15**. Anode **12** is connected through serially-connected windings **16** and **17** of transformers **20** and **22**, respectively, to a terminal **19** of

a suitable source of positive voltage. The relative position of windings **16** and **17** may be reversed; that is, one terminal of winding **17** may be connected directly to anode **12** and the other terminal connected to the lower end of winding **16**. In this case, the upper end of winding **16** is connected directly to terminal **19**. Grid **14** is connected through a second winding **23** of transformer **22** and through a capacitor **24** to ground **15**. A resistor **25** serves the dual purpose of a discharge circuit for capacitor **24** and a biasing circuit for grid **14**, and one end of said resistor is connected to the terminal **26** of a source of biasing voltage.

When a positive input trigger pulse is applied to the winding **29** of transformer **22**, the voltage induced in the grid winding **23** overcomes the bias on grid **14** and causes the grid to become more positive with respect to the cathode. This positive grid voltage causes anode current to flow through winding **16** of transformer **20** as well as through serially-connected winding **17** of transformer **22**; this current, in turn, induces a voltage in the grid winding **23** of transformer **22**. The dots adjacent to each winding indicate similar polarities. Because of the polarity of the windings, the induced voltage in winding **23** causes grid **14** to become more positive and more anode current flows in tube **10**. Because of this regenerative action, the anode current rises very rapidly. A rectifier **28** may be used to prevent undesirable coupling to the source of trigger pulse after the regenerative action has been initiated.

When the thyratron grid voltage becomes sufficiently positive for the thyratron to fire, a virtual short circuit is connected across output winding **30** and the current in anode winding **16** increases suddenly. This increased current, also flowing in winding **17**, causes an increase in current in winding **23** and the grid **14** of tube **10** becomes still more positive. In other words, tube **10** is driven heavily after the load is shorted out, in comparison with the conventional blocking oscillator in which a short circuit across the output winding results in a sudden decrease in grid voltage to the point where regeneration ceases.

Grid **14**, when driven positive relative to cathode **11**, draws current and the grid current flowing through capacitor **24** to ground causes a negative charge to accumulate on the plate of the capacitor **24** nearest the grid. The polarity of the plates of grid capacitor **24** during this time is as shown in the drawing. The voltage across capacitor **24** gradually rises until eventually it becomes sufficient to overcome the voltage across the grid winding **23**; the regenerative process then reverses, the tube ceases to draw current, and the output voltage drops to zero. The period of the output voltage waveform is thus determined in part by the value of capacitor **24**. After the grid potential drops below cutoff, the charge on capacitor **24** leaks off through resistor **25** until the capacitor is once more in a discharged condition awaiting arrival of the next trigger pulse. Other means for terminating the output voltage may also be used. For example, reliance may be had upon saturation of the core of transformer **22** in the manner well known in the blocking oscillator art. Alternatively, a delay line may be included in the grid circuit of the blocking oscillator to accomplish the same results.

Unlike the conventional blocking oscillators, which are particularly suited for operation into an open circuit, means must be provided in the blocking oscillator circuit of the invention to permit operation into an open circuit. In order to provide sufficient load for regeneration in the case of an open-circuited load, a resistor **32** is connected in shunt with transformer winding **30**. In this way, there will always be some load in the circuit.

Inspection of the circuit will show that when the tube **10** is in the cut-off condition, there are no loads on any of

the windings on the transformer **22**, so that negligible driving power is required to trigger the tube into conduction, after which the tube supplies its own driving power. Other methods of inserting the trigger pulse into the grid circuit may, of course, be used, and winding **29** may then be omitted. For example, the trigger pulse may be applied directly to the grid **14** by way of an appropriate coupling capacitor. Alternatively, the circuit may be made free running, i. e., may be made to deliver an output pulse at regular intervals, without trigger, by adjustment of the bias voltage supplied to the terminal **26** to a value which will not maintain the tube **10** in a cut-off condition; in this case a trigger pulse is not necessary, but may be used for synchronization if desired.

This invention is not limited to the particular details of construction, materials and processes described, as many equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. A blocking oscillator for providing an output waveform when triggered by an input trigger pulse comprising an electron discharge device having at least an anode, a cathode, and a control grid, a first transformer having a primary winding and a secondary winding, said primary winding connected in series with said anode, a load circuit coupled to said secondary winding, said load circuit including a resistor connected in parallel with said secondary winding, a second transformer having a first winding in series with said primary winding and a second winding in series with the grid of said electron discharge device, means inductively coupled to said second winding for introducing a trigger pulse into the grid circuit of said electron discharge device, and means including said second transformer for effecting regenerative current feedback in said electron discharge device which is proportional to the current in said load circuit.

2. A blocking oscillator for providing an output waveform when triggered by an input trigger pulse comprising an electron discharge device having at least an anode, a cathode, and a control grid, a source of anode potential, a first transformer having a primary winding and a secondary winding, a second transformer having a first winding and a second winding, said primary winding and said first winding serially connected between said anode and said source, a load circuit coupled to said secondary winding, said second winding connected in series with said control grid, means inductively coupled to said second winding for introducing a trigger pulse into the grid circuit of said electron discharge device, a shunt combination of a resistor and a capacitor connected in series with the grid of said electron discharge device, said capacitor being charged by conduction of said electron discharge device to eventually terminate said output waveform and discharged by said resistor during the intervals between successive trigger pulses, and means including said second transformer for effecting regenerative current feedback in said electron discharge device which is proportional to the current in said load circuit.

3. In combination, an electron discharge device having at least an anode, a cathode, and a control grid, a source of anode potential, a first transformer having a primary winding and a secondary winding, a second transformer having a first winding and a second winding, said electron discharge device having an output circuit including said first winding and said primary winding serially connected between said anode and said source, a load circuit coupled to said secondary winding, said electron discharge device having an input circuit including a capacitor, a resistor and said second winding, said resistor providing a discharge path for said capacitor during a portion of the operating cycle of said electron discharge device, means responsive to a predetermined degree of discharge of said capacitor for intiating the flow of current in said output circuit and said load circuit, means responsive to the flow of current in said load circuit for effecting regenerative current feedback in said electron discharge device and for charging said capacitor, means responsive to a predetermined degree of charge of said capacitor for terminating the flow of current in said output circuit and said load circuit.

4. In combination, an electron discharge device having at least an anode, a cathode, and a control grid, a source of anode potential, a first transformer having a primary winding and a secondary winding, a second transformer having a first winding and a second winding, said electron discharge device having an output circuit including said first winding and said primary winding serially connected between said anode and said source, a load circuit coupled to said secondary winding, said electron discharge device having an input circuit including a capacitor, a resistor and said second winding, said resistor providing a discharge path for said capacitor during a portion of the operating cycle of said electron discharge device, means responsive to a trigger pulse for initiating the flow of current in said output circuit and said load circuit, means responsive to the flow of current in said load circuit for effecting regenerative current feedback in said electron discharge device, means including said capacitor for terminating the flow of current in said output circuit and said load circuit prior to the arrival of the next trigger pulse.

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