

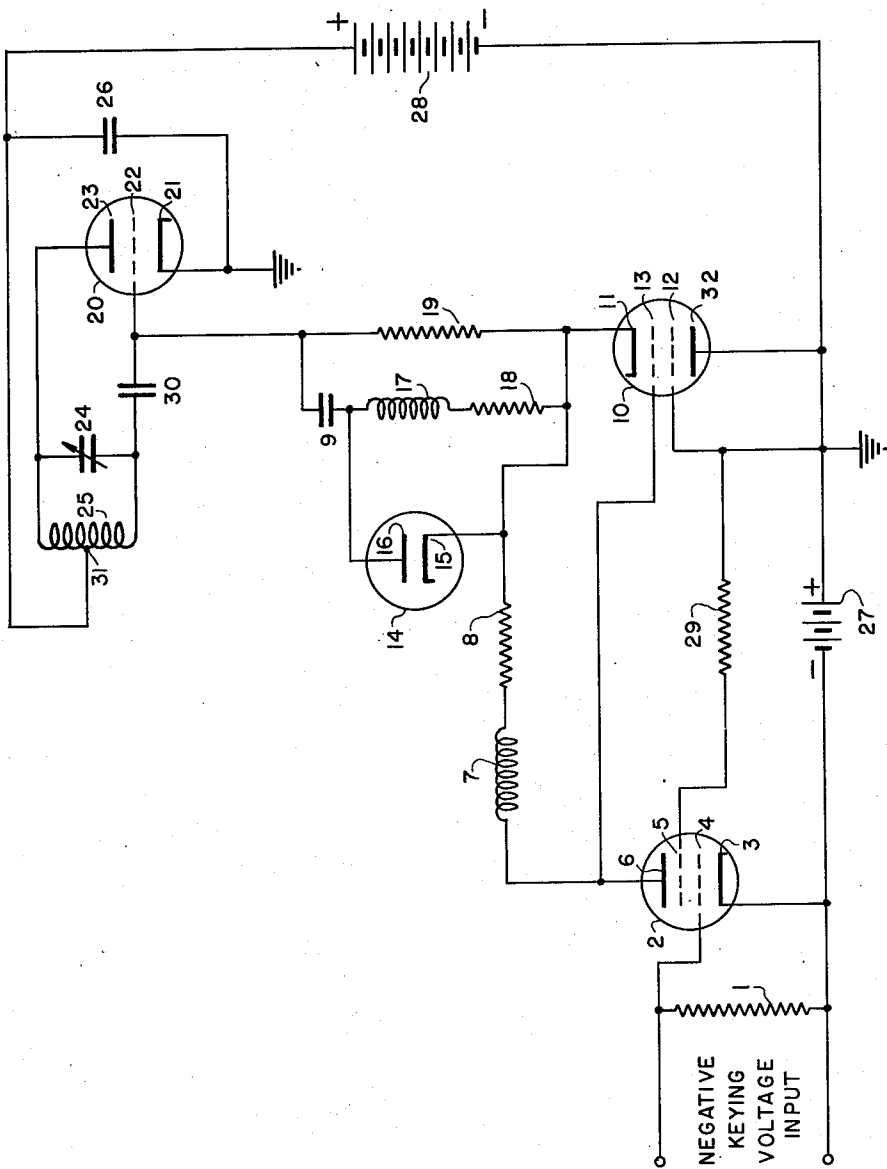
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VACUUM TUBE KEYING CIRCUIT

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VACUUM TUBE KEYING CIRCUIT

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This invention relates to the keying of vacuum tube circuits, and is particularly directed to a means by which vacuum tube apparatus may be keyed, or modulated with rectangular impulses, recurrently at a wide range of speeds.

An object of this invention is to provide a means by which a vacuum tube can be alternately rendered operative and blocked by effecting variations in its grid bias potential.

Another object of this invention is to provide a means for keying a vacuum tube at speeds up to several hundred thousand impulses per second.

Another object of this invention is to provide a means whereby a vacuum tube oscillator can be keyed by effecting variations in the grid bias potential of the oscillator tube.

A further object of this invention is to provide a means whereby the output of a vacuum tube oscillator can be modulated with rectangular impulses at speeds up to several hundred thousand impulses per second.

Still a further object of this invention is to provide a means of keying a high-power vacuum tube oscillator or transmitter with small apparatus consuming little power.

Still another object of this invention is to provide a means for keying a high-power vacuum oscillator or transmitter at high or low speed without the necessity for mechanically breaking high-voltage or heavy-current circuits.

The invention will be described with reference to the drawing appended hereto, which is a schematic diagram of an exemplary embodiment of the invention.

In the drawing, the vacuum tube circuit to be keyed is shown as a Hartley oscillator incorporating tube 20. Inductance 25 and condenser 24 are connected in parallel to form a tank circuit. One side of the tank circuit is connected to plate 23 of tube 20, the other side being connected through condenser 30 to grid 22 of tube 20. Cathode 21 of tube 20 and the negative side of D. C. source 28 are grounded. Tap 31 on inductance 25 is connected to the positive side of D. C. source 28 and is by-passed to ground by condenser 26.

Grid 22 of oscillator tube 20 is connected to cathode 11 of tube 10 through resistor 19. In parallel with resistor 19 is the network comprising condenser 9, radio-frequency choke coil 17, and resistor 18 in series. Plate 16 of diode tube 14 is connected to the junction of condenser 9 and choke coil 17. Cathode 15 of diode tube 14 and cathode 11 of tube 10 are connected together. Cathode 11 of tube 10 is connected to the plate 6

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of tube 2 through radio-frequency choke coil 7 and resistor 8 in series. Control grid 13 of tube 10 is connected directly to plate 6 of tube 2. Screen grid 12 and plate 32 of tube 10 are grounded. The positive side of D. C. source 27 is grounded, and the negative side of D. C. source 27 is connected to cathode 3 of tube 2. Screen grid 5 of tube 2 is connected to ground through resistor 29. Control grid 4 is connected to cathode 3 of tube 2 through resistor 1.

Keying impulses from an external source are applied between control grid 4 and cathode 3 of tube 2, and are so polarized that during an impulse grid 4 is negative relative to cathode 3. These keying impulses need be only of sufficient magnitude to cause plate current cut-off in tube 2. In a practical construction using type 807 tubes as tubes 2 and 10, 25 volts was found to be adequate amplitude for the keying impulses.

The system operates as follows. The D.-C. grid return circuit for oscillator tube 20 comprises resistor 19 and tube 10 in series; hence the grid bias on oscillator tube 20 is the sum of the D.-C. voltage drops across resistor 19 and tube 10. Tube 10, resistor 8, choke coil 7, and tube 2 are in series across D.-C. source 27 and current from that source normally flows through them. When no voltage from an external source is applied between the control grid and cathode of tube 2, tube 2 presents a low impedance, since its grid and cathode are at the same potential. Tube 10 is a high impedance under the same conditions because its grid is negative relative to its cathode by the amount of the voltage drop across resistor 8 and choke coil 7. Normally, therefore, most of the voltage from D.-C. source 27 is developed across tube 10. As a result, the grid of oscillator tube 20 is biased so far negative that the tube is completely blocked and unable to start or maintain oscillations.

When a keying voltage is applied between the grid and cathode of tube 2, tube 2 ceases to pass current. This causes the voltage drop across resistor 8 to disappear, and the collapsing magnetic field of coil 7 produces a positive surge of voltage which very quickly drives the control grid of tube 10 to a positive value. Tube 10 becomes a low impedance, and the cathode of tube 10 rises toward ground potential, thus removing all the D.-C. bias from the grid of oscillator tube 20 and allowing oscillations to start. After oscillations have started in tube 20, a grid leak voltage is built up across resistor 19 and tube 10, in conventional fashion. So long as keying voltage is applied to tube 2, tube 10 remains a low impedance, since its

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grid is at or above the potential of its cathode so long as tube 2 is cut off. As tube 20 oscillates condenser 9 is charged from condenser 30 with the side of condenser 9 connected to grid 22 going negative to a voltage equal to the grid leak potential developed across resistor 19. The function of coil 17 and resistor 18 is to prevent an excessive peak value of oscillator grid current by making this charging process gradual.

When the keying voltage is removed from the grid of tube 2, tube 2 becomes again a low impedance. It starts a draw current. The plate potential of tube 2 and the control grid potential of tube 10 drop very sharply. Tube 10 becomes again a very high impedance, and grid 22 of oscillator tube 20 is suddenly biased very negatively, the instantaneous negative bias being equal to the voltage across tube 10 plus all the voltage across condenser 9. This sudden surge of negative bias completely blocks tube 20 and stops oscillations therein. Condenser 9 quickly discharges through diode 14 and resistor 19.

Oscillations build up very rapidly after the application of a keying impulse; the oscillations reach 90% of final amplitude within a fraction of a microsecond after keying voltage is applied.

Recovery time after a keying impulse has ended is likewise very rapid; in a practical construction embodying this invention it was found to be less than one microsecond.

These properties of the invention make possible its use at extremely high keying speeds; the practical construction already mentioned could be successfully keyed at a speed of about three hundred thousand impulses per second. The system may likewise be used at as slow speed as desired, since both "on" and "off" conditions are stable.

It will be understood that the embodiment of the invention herein described is exemplary only, and that the scope of the invention is to be determined from the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. In combination, a vacuum tube having control grid means, a source of supply voltage connected to said vacuum tube, a negative blocking voltage connected to said grid means, said negative blocking voltage including means operative intermittently to apply a positive voltage shift to the grid means and effect grid current conduction; a grid leak return circuit including a condenser connected between the negative blocking voltage and the grid means, said condenser disposed to accumulate a charge proportional to the flow of grid leak current during operation of the vacuum tube; and impedance means operative to limit the rate of flow of grid leak current into the condenser; the charge on the condenser accumulated during the vacuum tube operation being effective on termination of the positive voltage shift as additional blocking bias for the vacuum tube.

2. In combination, an electron tube having control grid means, a source of supply voltage connected to said vacuum tube, a negative blocking voltage connected to said grid means, said negative blocking voltage including means operative intermittently to apply a positive voltage shift to the grid means and effect grid current conduction; a grid leak return circuit including a condenser connected between the negative blocking voltage and the grid means, said condenser dis-

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posed to accumulate a charge proportional to the flow of grid leak current during operation of the electron tube; impedance means operative to limit the rate of flow of grid leak current into the condenser; and unilateral impedance means operative to effect rapid discharge of the condenser after blocking of the tube; the charge on the condenser accumulated during electron tube operation being effective on termination of the positive voltage shifts as additional blocking bias for the electron tube.

3. In combination, a first electron tube having control grid means; a source of supply voltage connected to said vacuum tube, a second electron tube having a space-current path; a grid leak return circuit for the first tube comprising the space-current path of the second tube; means operative to pass a direct current through the space-current path of the second tube; space-current path conductivity control means for the second tube operative to vary the direct current potential across the second tube in a positive direction for rendering the first tube operative and effecting grid current conduction therein and thereafter in a negative direction for blocking the first tube; a condenser incorporated in the grid return circuit of the first tube operative to accumulate a charge proportional to the flow of grid leak current during operation of the first tube; impedance means operative to limit the rate of flow of grid leak current into the condenser; and unilateral impedance means operative to effect rapid discharge of the condenser after blocking of the first tube; the charge on the condenser accumulated during operation of the first tube being effective as additional blocking bias for the first tube when the potential across the second tube is shifted in a negative direction.

4. In combination, an electron tube having a cathode and a control electrode, a vacuum tube having cathode and anode electrodes and a space current path fed thereby, a grid return circuit for the first tube comprising a direct current resistance element and the space current path of said vacuum tube connected in series between the grid and cathode electrodes of said electron tube, said resistance element serving to connect the cathode electrode of said vacuum tube to the grid electrode of said first tube, an electron discharge device and a source of direct current potential connected in series with the anode cathode path of said vacuum tube to bias the cathode of said vacuum tube negative of the anode thereof, and means operative to vary the impedance of said discharge device and thereby the voltage at the cathode of said vacuum tube.

5. In combination, an electron tube having a cathode and a control electrode, a second electron tube having cathode and anode electrodes and a space current path fed thereby, a grid return circuit for the first tube comprising a direct current resistance element and the space current path of said second tube connected in series between the grid and cathode electrodes of said electron tube, said resistance element serving to connect the cathode of said second tube to the control electrode of the first tube, an energy storage element connected in parallel relation with said resistance element, an electron discharge device and a source of direct current potential connected in series with the anode cathode path of said second electron tube, to bias the cathode of said second tube negative of anode thereof, and means operative to vary the imped-

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ance of said discharge device and thereby the voltage at the cathode of said second electron tube.

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