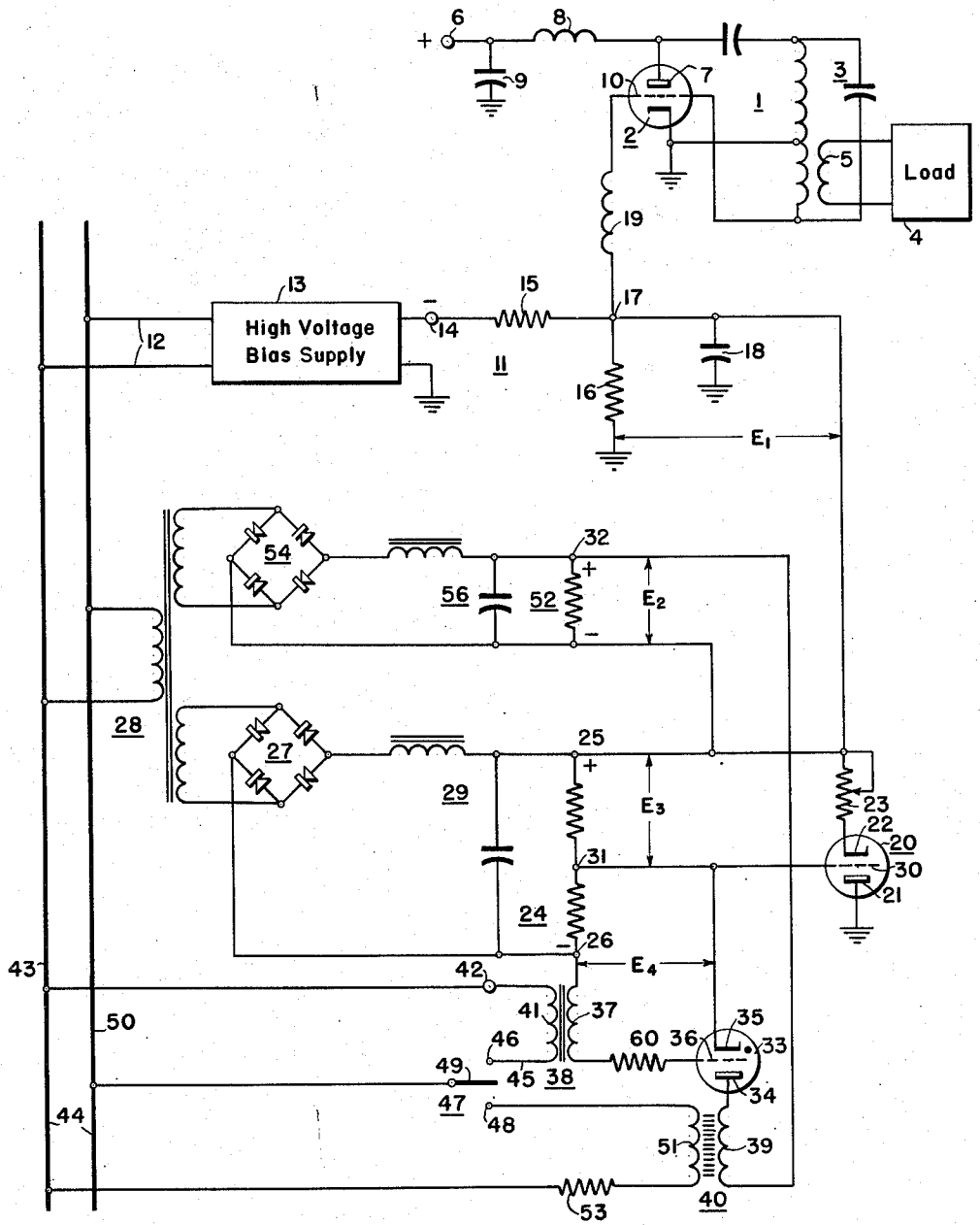
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ELECTRONIC KEYING

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ELECTRONIC KEYING

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The present invention relates generally to keying and control circuits for high power oscillators, and more particularly to short time interval keying circuits for high power oscillators, and to circuits which maintain constant the grid current of the oscillator tube over a wide range of operating conditions.

This application is a continuation-in-part of application Serial No. 162,074, filed May 15, 1950, now abandoned.

Short time interval keying and maintenance of constant grid current, in high power oscillators, present serious problems which are not met with in keying and controlling relatively low power oscillators. These problems revolve about the desirability of maintaining minimum power absorption in the keying circuit, and that of accomplishing keying by means of electronic circuits, capable of extremely rapid operation, without requiring use of expensive high power keying tubes and components, rather than by means of mechanical structures.

The present invention is embodied in a circuit for electronically keying a high power oscillator, which is capable of high keying speeds, and which has relatively low power consumption, and which may be constructed of commonly available, and inexpensive, electronic tubes and other circuit components. The circuit provides for stabilization of grid current of the oscillator at a predetermined value, in its preferred form.

Briefly described, the present invention involves keying of a high power oscillator, shown for purposes of example as of the Hartley type, but which may be of other grid controlled types, without departing from the spirit of the invention. The oscillator tube is normally biased to cut-off by means of a poorly regulated source of negative voltage, connected from the grid of the oscillator to ground. A hard grid-controlled keying and grid current regulating valve is connected at its cathode via a variable regulating resistance to the grid of the oscillator and at its anode to ground. A bias source in the form of a bleeder is provided for the grid controlled keying and grid current regulating valve, which maintains the latter normally at cut-off, so that the bias source for the oscillator is fully effective to cut-off the latter. Upon varying the bias of the valve to render the latter conductive, the bias source is rendered ineffective and bias for the oscillator is developed in the circuit containing the keying and grid current regulating valve, the latter then acting as a variable grid leak resistor.

Since grid current for the oscillator finds a path through the grid current regulating valve and the regulating resistor in its cathode circuit, the total voltage on the regulating resistor is one of the factors which establishes the bias of the grid current regulating valve. Any increase in grid current of the oscillator drives the bias on the grid current regulating valve more negative, which increases the internal resistance of the valve, thus reducing oscillator grid current. Alternatively, any decrease in grid current drives the bias on the grid current regulating valve more positive, which decreases the internal resistance of the grid current regulating valve, increasing oscillator grid current. The grid current regulating valve, by virtue of the resistance in its cathode circuit, operates then as a variable grid resistance, and serves to stabilize oscillator grid current.

The advantage of maintaining constant grid current is that it results in more efficient oscillator operation over a wide range of oscillator loads. The variation of grid drive on the oscillator, which occurs as the load on the oscillator varies, is automatically compensated for by providing a variable grid resistance.

The system as described hereinbefore is capable of rapid keying of a high power oscillator, and inherently controls the amplitude of oscillator grid current, and thereby maintains high oscillator efficiency as the load on the oscillator varies. The same valve which controls keying of the oscillator also maintains regulation of bias voltage of the oscillator, and control of oscillator grid current amplitude, by providing a grid current regulating resistance variable in response to change of oscillator grid current.

The grid current regulating valve which is utilized for controlling oscillator grid current, and for keying the oscillator, is itself controlled or keyed by a gaseous conduction valve or thyratron. The properties of the latter are, per se, well understood. The thyratron is connected across a portion of the bleeder which supplies normal bias to the grid controlled keying valve, and with the cathode of the thyratron connected to the grid of the grid controlled keying valve, and with the anode of the thyratron connected at a point on a second bias source which is positive with respect to the thyratron cathode by sufficient voltage difference that upon firing of the thyratron the grid of the grid controlled keying and grid current regulating valve goes positive with respect to its cathode, and is unblocked.

The thyratron may be fired by applying raw alternating-current voltage in its cathode-to-control-electrode circuit, and may be blocked, after firing, by applying raw alternating-current voltage of sufficient magnitude between anode and cathode of the thyratron. Application of the alternating-current voltage to either circuit may be simply controlled by means of a two position switch, and it is characteristic of the present system that once the thyratron has fired and the oscillator set into oscillation in response to that firing, the oscillator will continue to oscillate until the thyratron is once more blocked. Accordingly, in one closed position of the two position switch the oscillator oscillates, and in the other it fails to oscillate. While the switch is open, or intermediate its closed positions, no change in operation of the oscillator takes place.

When two or more oscillator tubes are connected in parallel or push-pull, each tube may be provided with its own keying and bias circuit. The oscillator tubes may be adjusted to draw the same plate current by adjusting the bias voltage of the grid current regulating values, as derived from the bleeder. Thereby, the oscillator tubes may operate with independent grid drive and still be balanced.

It is accordingly a broad object of the present invention to provide a novel system of oscillator keying.

It is a further object of the invention to provide a system of keying a high power oscillator by means of an electronic keying tube of relatively small capacity.

It is another object of the invention to provide a novel keying circuit for an oscillator which shall provide regulation and stabilization of the grid current of the oscillator.

It is still a further object of the invention to provide a vacuum tube keyer for an oscillator, the vacuum tube keyer being in turn controlled in respect to its bias by a grid controlled gaseous conduction device, or thyratron.

It is another object of the invention to establish a single bleeder circuit as a bias source for a vacuum tube keyer and as a source of bias for a grid controlled gaseous conduction device, the fired or unfired condition of the latter determining the bias of the keyer tube, and hence its operative condition.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of a specific embodiment thereof, especially when taken in conjunction with the accompanying drawings, wherein the single figure is a schematic circuit diagram of a system embodying the invention.

Referring now more particularly to the drawings, the reference numeral **1** identifies a Hartley type oscillator comprising an electronic vacuum tube in the form of a triode **2**, a tank circuit **3**, and a load **4** coupled to the tank circuit **3** by means of a coupling winding **5**. The tube **2** may be energized from a source of high voltage **6**, which may be connected to the anode **7** of the tube **2** via a high frequency choke **8** connected in series between the source of voltage and the anode **7**. A high frequency by-pass condenser **9** may be connected between the source of high voltage **6** and ground. Operation of the oscillator **1** may be controlled by varying the bias on the grid or control electrode **10** of the triode **2**, and in particular the oscillator may be keyed off by impressing a voltage of negative polarity of sufficient magnitude on the grid **10**, and may be keyed on by impressing a lesser negative voltage on the grid **10**. A Hartley oscillator is included as exemplary only, since many types of grid controlled oscillators may be employed, without departing from the spirit of the invention.

Cut-off bias voltage for the grid **10** of the oscillator tube **2** may be derived from a source of bias voltage supply, generally identified by the reference numeral **11**. The latter may be energized from alternating-current line **12**, which supplies altternating-current energy to a rectifier system **13**, of conventional character, having its positive terminal grounded and its negative terminal **14** connected to ground over series connected resistors **15** and **16**. Bias voltage for the grid **10** of the triode **2** may be derived from the junction point **17** of the resistors **15** and **16**. This junction point may be by-passed to ground for high frequency by means of a by-pass condenser **18**, and additionally the bias supply may be isolated from high frequency currents by means of a radio frequency choke **19** connected in series between the junction point **17** and the grid or control electrode **10** of the triode **2**. Bias voltage for the control electrode **10** of the triode **2** accordingly is the voltage E_1 existing between the junction point **17** and ground, or the total voltage appearing across the resistance **16**.

Connected between the junction point **17** and ground, or in shunt to the resistance **16**, is a keying and grid current regulating valve **20**, the anode **21** of which is grounded, and the cathode **22** of which is connected via a voltage dropping variable resistor **23** to junction point **17**. The high voltage bias supply **11**, having its output resistor **16** shunted by the valve **20**, constitutes a poorly regulated high voltage bias supply, or one in which the output voltage varies widely in accordance with its output current. The valve **20** operates as a variable grid resistor and hence as a grid current regulating valve for the oscillator tube **2**, in parallel with the resistance **16** across which bias voltage is generated by the high voltage bias supply **11**. When the valve **20** is blocked it presents an infinite resistance, so that substantially no grid current flows by virtue of the very high resistance of resistor **16**, and oscillator **1** is blocked. In this condition, the total or maximum possible voltage available across the resistance **16** is impressed on the control electrode **10** of the triode **2**, and that voltage is so selected that the triode **2** is blocked, and the oscillator **1**, accordingly, is keyed off. For a condition of substantially zero internal resistance of the valve **20** on the other hand, the control electrode **10** of the triode **2** is substantially grounded, and the oscillator **1** accordingly oscillates strongly. For intermediate values of internal resistance of the valve **20** intermediate magnitudes of bias voltage are applied to the control electrode **10** of the triode **2**, and accordingly the oscillator **1** oscillates at intermediate strengths. The valve **20** accordingly becomes a keyer for the oscillator **1** in accordance with whether it is blocked or unblocked, and the total grid voltage and the magnitude of the output oscillations from the oscillator **1** depend upon the total internal resistance of the valve **20**, since it is the latter which determines the grid current of the oscillator triode **2**.

Operating voltage for the valve **20** is supplied from a bleeder **24** having a positive terminal **25** and a negative terminal **26**. The bleeder **24** is supplied with voltage from a rectifier unit **27**, energized from a transformer **28**, and which is supplied with commercial voltage from a conventional alternating-current line. The rectifier unit **27** may be filtered at its output by means of a choke input filter **29**, which provides grid voltage regulation across the bleeder **24**. The control electrode **30** of the valve **20** is connected to a point **31** on the bleeder **24** which is more positive than the negative terminal point **26**. The junction point **17** is connected to a point **25** on the bleeder **24** which is more positive than the point **31**. Accordingly, the total voltage existing between the points **31** and **25** on the bleeder **24**, and corresponding with a voltage E_3, is connected between the control electrode **30** and the cathode **22** of the valve **20** via the voltage dropping resistance **23**. The voltage E_3 is normally adequate to maintain the valve **20** in the cutoff condition.

A control tube for the valve **20** may be provided in the form of a grid controlled gaseous conduction device or thyratron **33** having an anode **34**, a cathode **35**, and a control electrode **36**. Control electrode **36** of the thyratron **33** may be connected via a conventional current limiting resistor **60** and the secondary winding **37** of a transformer **38** to the negative terminal **26** of the bleeder **24**. The anode **34** of the thyratron **33** may be connected via the secondary winding **39** of a transformer **40** to a positive potential point **32** on a second bias source **52**, the latter point being adjustable, if desired. The second bias source **52** is supplied with voltage from a second rectifier unit **54**, which is energized from transformer **28**. The rectifier unit **54** may be filtered at its output by means of a choke input filter **56**. The cathode **35** of the thyratron **33** may be connected directly to the control electrode **30** of the valve **20**. Accordingly, the total voltage available between cathode **35** and anode **34** for firing the thyratron **33** consists of the sum of the voltages E_2 and E_3, the former subsisting between points **25** and **32**, and the latter between points **31** and **32**. The voltage E_2 is made of greater magnitude than the voltage E_3, and can be varied accordingly to set the bias on the oscillator **1** for any operating condition desired.

Negative bias voltage for the thyratron **33** consists of the voltage E_4, existing between the points **31** and **26** of the bleeder **24**. Since negative bias is normally provided for the thyratron **33** the latter normally remains unfired. While the thyratron **33** is unfired the valve **20** is biased to cut-off, establishing substantially infinite resistance across the output resistance **16** of the high voltage bias supply **11**, which then supplies cut-off bias for the control electrode **10** of the triode **2**, maintaining the oscillator **1** in keyed or non-oscillating condition.

The transformer **38** is provided with a primary winding **41**, one terminal **42** of which is connected to one side **43** of an alternating-current line **44** and the other terminal **45** of which is connected to a contact **46** of a two position momentary contact type switch **47**, having an additional contact **48**, and a switch arm **49**. The latter is connected permanently to the other side **50** of the line **44**, and may be disposed in contact with either of the contacts **46** or **48**.

The transformer **40** similarly has a primary winding **51**, one terminal of which is connected to the line **43** via a

limiting resistance 53, and the other terminal of which is connected to the contact 48. Accordingly, the primary windings 41 and 51 may be selectively energized by throwing the switch arm 49 into contact with the contacts 46 and 48 respectively.

When the switch arm 49 is thrown over to the contact 46, the primary winding 41 is energized and alternating voltage is applied between the cathode 35 and the control electrode 36 of the thyratron 33. The magnitude of this alternating-current voltage is sufficient to overcome during each cycle of alternating voltage, the direct-current bias established between the points 31 and 26 of the bleeder 24. Since the anode 34 of the thyratron 33 is permanently connected to a point 32 on the second bias source 52 which is positive with respect to the cathode 35 of the thyratron 33, the thyratron 33 fires in response to contact between the arm 49 and the switch contact 46 of the switch 47. When the thyratron 33 fires, it presents essentially a short circuit between the most positive point 32 on second bias source 52, and transfers that voltage to the control electrode 30 of the valve 20. Since voltage E_2 is greater than the voltage E_3, the net effective bias on the control electrode 30 of the valve 20 becomes positive, and the valve 20 accordingly becomes conductive. When the valve 20 becomes conductive, it establishes a relatively low resistance in shunt to the high resistance 16 and reduces the negative bias on the control electrode 10 of the triode 2, by establishing greater current drain and consequently greater voltage drop across resistance 15. Triode 2 then oscillates. Effectively, bias on the grid or control electrode 10 of triode 2 may be considered to be controlled to provide on-off keying by virtue of the poor regulation of the high voltage bias supply 11, the output circuit of which consists of a voltage divider having two series connected arms, one of which consists of the resistance 15, and the other of which consists of the resistance 16 and the valve 20 connected in parallel. As the resistance of the valve 20 varies, the total resistance of the resistance 16 and internal resistance of valve 20, connected in shunt, varies accordingly, and the potential of the junction point 17 is shifted.

It will be evident that the plate current of the valve 20 consists of the grid current of the triode 2. This grid current, further, flows through the voltage dropping resistance 23, which is connected in series with the cathode 22 of the valve 20. Accordingly, the total bias on the valve 20 depends upon the grid current of the triode 2. As the grid current of the triode 2 increases, the total voltage drop across resistance 23 similarly increases, and the increase is in such sense as to reduce the positive bias voltage existing between cathode 22 and the control electrode 30 of keying and grid current regulating valve 20. As the grid current of triode 2 decreases, the total voltage across resistance 23 decreases, and the total bias existing between the cathode 22 and control electrode 30 of valve 20 goes more positive. A decrease of negative bias on the valve 20 results in a decrease in its internal resistance. If, on the other hand, grid current of triode 2 should increase, the total negative bias on valve 20 becomes greater, and the internal resistance of the valve 20 becomes greater, which tends to decrease grid current.

Thus, the action of the valve 20 and its series connected resistance 23 is to stabilize the grid current of the triode 2, and accordingly the output of the oscillator 1.

Once the thyratron 33 has fired, its grid or control electrode 36 loses control and opening of the switch arm 49 has no effect. In order to effect deionization or blocking of the thyratron 33, it is necessary either to open the anode circuit thereof or to apply between the anode and cathode thereof a negative voltage. The latter is accomplished by throwing the switch arm 49 over to contact 48, which applies alternating current to the transformer 40. The magnitude of this alternating current is sufficient so that during each cycle thereof the anode 34 is driven to a zero or negative potential for a short time, enabling the thyratron 33 to de-ionize or block. For this purpose, it is essential merely that the maximum voltage across the secondary winding 39 of the transformer 40 exceed the sum of the voltages E_2 and E_3.

It should be noted that the transformer 40 is provided with a saturable core, which saturates in response to direct-current secondary current. As soon as the thyratron 33 has been fired, then, the transformer 40 becomes saturated. When it is desired to cut off the thyratron 33, switch arm 49 is thrown over to contact 48, in order to apply negative voltage to anode 34. Since, however, the switch arm 49 is thrown at a time which is random with respect to the alternating-current voltage, either positive or negative voltage may be instantaneously applied to the anode 34. If positive, additional positive voltage would be applied to the control grid of valve 20, if transformer 40 were conventional, which would cause it to overload. With the transformer 40 saturated, however, no additional positive voltage will be applied to anode 34, in response to a positive cycle of alternating-current, provided the exciting current of the primary winding 51 of transformer 40 is limited. To so limit the exciting current is the function of resistance 53.

Reviewing now briefly the operation of the system of the present invention, we assume the thyratron 33 to be initially unfired. The oscillator 1 is keyed off by virtue of the fact that the keying valve 20 is maintained in cut-off condition, while the thyratron 33 is unfired, by the bias voltage E_3 impressed thereon. While the keying valve 20 is in cut-off condition, maximum bias voltage is available across the resistance 16, which constitutes one portion of a voltage divider, and an output circuit of the high voltage bias source 13. Thyratron 33 may be fired by applying in its grid circuit alternating voltage of sufficient magnitude to overcome a normally negative bias E_4 supplied to the control electrode 36 of thyratron 33. When the thyratron 33 fires, a positive voltage E_2, which is greater than the normal negative bias E_3 applied to the valve 20, is impressed on the control electrode 30 of the valve 20, and the latter becomes conductive. The latter remains conductive so long as the thyratron 33 is fired. When the keying valve 20 is conductive, it provides a relatively low resistance in shunt to the normal grid resistor 16, and in series with resistor 15, and thus effects a reduction in bias voltage applied to the oscillator triode 2 sufficient to enable the latter to oscillate.

Grid current of the triode 2 flows through the valve 20 and serves to determine the bias of the latter. Variations in grid current have such effects on the bias voltage of the valve 20 as to stabilize the grid current of the oscillator triode 2, the valve 20 operating, then, as a grid resistance of variable magnitude responsive to oscillator grid current.

When it is desired to terminate a period of oscillation of the oscillator 1 the thyratron 33 is de-ionized by applying in its plate circuit an alternating voltage having negative peaks sufficiently great to overcome the normal direct-current voltage applied to the anode of the thyratron. When the thyratron de-ionizes normal high negative bias is reapplied to the keying triode 20, the latter becomes blocked, and the maximum negative bias for the oscillator triode 2 is reapplied, blocking the latter.

While I have described one specific embodiment of the present invention, it will be clear that variations in detail of the circuit described and illustrated, as well as of the general arrangement thereof, may be resorted to without departing from the true spirit and scope of the invention.

I claim as my invention:

1. A modulating circuit for an oscillator comprising a source of adjustable negative bias, said source of adjustable negative bias comprising a source of voltage, a voltage divider connected across said source of voltage, said voltage divider comprising at least two resistors, a triode vacuum tube having a grid connected to a point intermediate said resistors and a cathode connected to

the positive terminal of said voltage divider, and means in shunt with one of said resistors for controlling the internal resistance of said vacuum tube.

2. A modulating circuit for an oscillator, said oscillator comprising a vacuum tube having a control electrode and a cathode, said modulating circuit comprising a source of steady direct-current voltage, a voltage divider connected across said source of steady direct-current voltage and comprising two resistances, means for connecting said cathode to the positive terminal of said voltage divider and said control electrode to the voltage divider intermediate said resistors, means for connecting in shunt with one of said resistors a further vacuum tube having a cathode and an anode and a control electrode, said last named anode being connected to the positive terminal of said one resistor and said last named cathode to the negative terminal of said one resistor, and means for controlling the voltage on said last named control electrode to vary the internal resistance of said further vacuum tube and thereby the voltage between said first mentioned control electrode and cathode.

3. In a circuit for stabilizing grid current of an oscillator having an oscillating vacuum tube comprising an anode, a cathode and a grid, a source of adjustable negative bias for said grid, said source of adjustable negative bias comprising a source of steady direct-current voltage having its positive terminal connected to said cathode, and having a voltage divider comprising two series connected resistors connected between its negative and positive terminals, means connecting said grid to the junction point of said resistors, a control vacuum tube having an anode, a cathode and a control electrode, means connecting said last named anode to said positive terminal and said last named cathode to said junction point, a voltage dropping resistor in series between said last named cathode and said junction point, and means for applying positive bias for said control electrode between said control electrode and said junction point.

4. In a keying circuit for an oscillator tube having an anode, a cathode and a grid, a source of negative bias voltage for said grid, said source of negative bias voltage comprising a source of direct-current voltage, a voltage divider comprising a pair of series connected resistors connected across said source of direct-current voltage, said grid being connected to said voltage divider intermediate said resistors, means for deriving said negative bias voltage across only one of said resistors, a variable resistor connected across said one resistor, and means for varying said variable resistor to vary said negative bias.

5. In a keying circuit for an oscillator tube having an anode, a cathode and a grid, a source of negative bias voltage for said grid, said source of negative bias voltage comprising a source of direct-current voltage, a pair of resistances connected across said source of direct-current voltage, a connection between said grid and a point intermediate said resistors, and means for deriving negative cut-off bias for said grid across only a portion of said voltage divider, a keying vacuum tube connected across said portion of said voltage divider in current transmitting relation in response to voltage across said portion of said voltage divider, means normally biasing said keying vacuum tube normally negatively to cut-off, a normally unfired grid controlled gaseous conduction device, and means responsive during firing of said grid controlled gaseous conduction device for reversing the bias polarity of said keying vacuum tube.

6. In a keying circuit for an oscillator tube having an anode, a cathode and a grid, a source of negative bias voltage for said grid, said source of negative bias voltage comprising a source of direct-current voltage, a voltage divider connected across said source of direct-current voltage, and means for deriving negative cut-off bias for said grid across only a portion of said voltage divider, a keying vacuum tube having an anode, a cathode and a grid, said keying vacuum tube connected across said portion of said voltage divider in current transmitting relation in response to voltage across said portion of said voltage divider, a further voltage divider having a positive point, a less positive point and a still less positive point, means connecting said cathode and said control electrode of said keying vacuum tube between said positive point and said less positive point of said further voltage divider, a grid controlled gaseous conduction device having an anode, a cathode and a control electrode, a bias voltage source for said last named device having a positive point and a negative point, means for connecting said anode and said cathode of said grid controlled gaseous conduction device between the last said positive point and negative point, the voltage difference between the last said positive and negative points being greater than the voltage difference between the positive point and the less positive point of said further voltage divider, and means for selectively firing and blocking said grid controlled gaseous conduction device.

7. In a keying circuit for an oscillator tube having an anode, a cathode and a grid, a source of negative bias voltage for said grid, said source of negative bias voltage comprising a source of direct-current voltage, a voltage divider connected across said source of direct-current voltage, and means for deriving negative cut-off bias for said grid across only a portion of said voltage divider, a keying vacuum tube having an anode, a cathode and a grid, said keying vacuum tube connected across said portion of said voltage divider in current transmitting relation in response to voltage across said portion of said voltage divider, a second bias voltage source comprising a further voltage divider having a positive point, a less positive point and a still less positive point, means connecting said cathode and said control electrode of said keying vacuum tube between said positive point and said less positive point of said further voltage divider, a grid controlled gaseous conduction device having an anode, a cathode and a control electrode, a third bias voltage source having a positive point and a less positive point, means for connecting said anode and said cathode of said grid controlled gaseous conduction device between said positive point and said less positive point of the third bias voltage source, the voltage difference between the positive point and less positive point of the third bias voltage source being greater than the voltage difference between said positive point and less positive point of the second bias voltage source, means for selectively firing and blocking said grid controlled gaseous conduction device, said means for selectively firing and blocking comprising a first source of alternating voltage, a second source of alternating voltage, and means for selectively connecting said first source of alternating voltage between said control electrode and cathode, and said second source of alternating voltage between said cathode and said anode, of said grid controlled gaseous conduction device.

8. In a keying circuit, a keying vacuum tube having a cathode, an anode and a grid, a first bias voltage source including a voltage divider having a positive point, a less positive point and a still less positive point, means connecting said cathode to said positive point, means connecting said grid to said less positive point, a gaseous conduction device having a further anode, cathode and control electrode, a second bias voltage source having a positive point and a less positive point, means connecting said further anode to the last said positive point, means connecting said further cathode to said less positive point of the first bias voltage source, means for connecting said control electrode to said still less positive point, the voltage difference between said positive point and said less positive point of the second bias voltage source being greater than the voltage difference between said positive point and said less positive point of the first bias voltage source, and means for selectively firing and blocking said gaseous conduction device.

9. In a keying circuit, a keying vacuum tube having a

cathode, an anode and a grid, a voltage divider having a positive point, a less positive point and a still less positive point, means connecting said cathode to said positive point, means connecting said grid to said less positive point, a gaseous conduction device having a further anode, cathode and control electrode, a bias voltage source having a positive point and less positive point, means connecting said further anode to the last said positive point, means connecting said further cathode to said less positive point of the voltage divider, means for connecting said further control electrode to said still less positive point, the voltage difference between said positive point and said less positive point of the bias voltage source being greater than the voltage difference between said positive point and said less positive point of the voltage divider, means for selectively firing and blocking said gaseous conduction device, and said means for selectively firing and blocking said gaseous conduction device comprising a winding in series with said further anode, a winding in series with said control electrode, and means to selectively apply alternating voltage to said windings of sufficient magnitude to fire or block said gaseous control device.

10. In combination, a grid controlled gaseous conduction device having a grid, a cathode and an anode, a source of negative bias of predetermined magnitude connected between said grid and said cathode, a source of positive anode voltage of predetermined magnitude connected between said anode and said cathode, a first transformer having a secondary winding connected in series between said grid and cathode, a further transformer having a secondary winding connected in series between said anode and cathode, and means for applying

alternating current selectively to said first and further transformers selectively to overcome said negative bias and said positive anode voltage.

11. In a circuit for stabilizing grid current of an oscillator having an electron valve equipped with an electrically responsive control element, the combination of a source of bias voltage for said control element, a pair of impedance elements connected in series directly across the positive and negative terminals of said voltage source, an electron valve connected in shunt with one of said impedance elements, an anode and cathode for said latter-mentioned electron valve, a connection between the anode of said latter-mentioned electron valve and the positive terminal of said voltage source, a connection between the cathode of said latter-mentioned electron valve and the junction of said impedance elements, and means for controlling the internal impedance of said latter-mentioned electron valve.

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