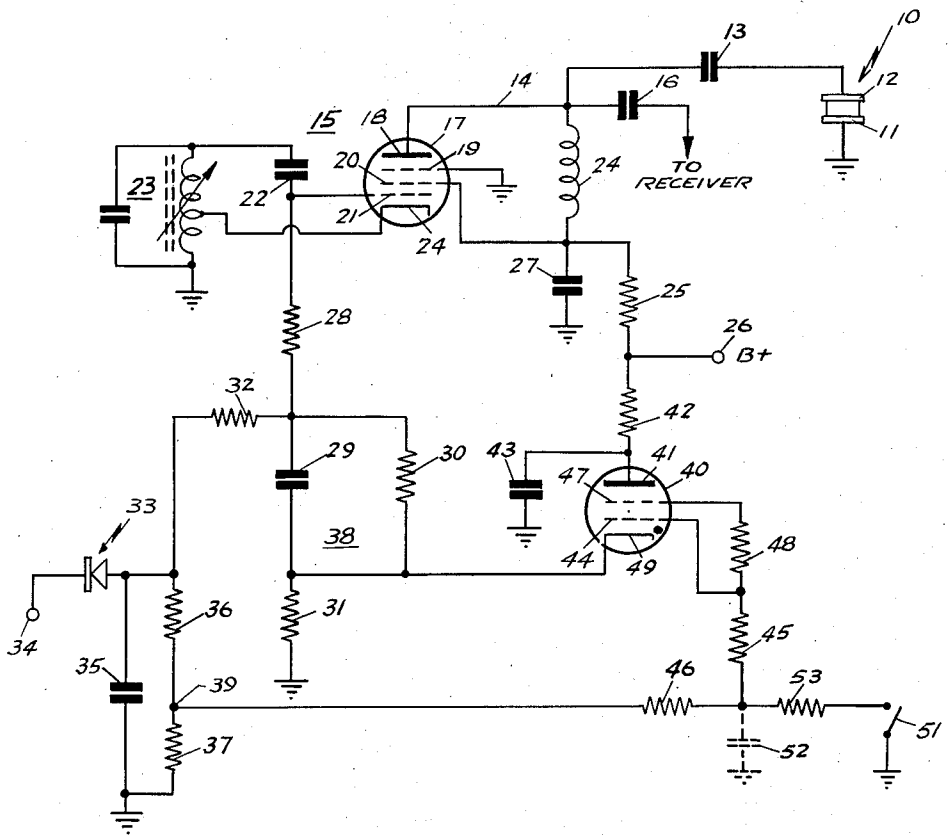
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PULSED OSCILLATOR HAVING OSCILLATION TERMINATING MEANS INDEPENDENT OF INITIATING PULSE

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# PULSED OSCILLATOR HAVING OSCILLATION TERMINATING MEANS INDEPENDENT OF INITIATING PULSE

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This invention relates to electronic switching circuits for the control of electrical energy and more particularly to an electronic switching or keying circuit wherein the passage of a relatively small current between a pair of spaced terminals or keying contacts may be utilized to control a relatively larger current for the energization of oscillators, transducers, and the like.

In keying or switching systems of the type in which an energy or excitation pulse is provided for periodically controlling the conductivity of electron tubes or similar devices in response to the closing of a pair of keying contacts, it has heretofore been difficult, if not impossible, to provide a keying system which will permit consistent keying over short pulse intervals for use with pulse-producing devices, such as short range depth sounders and the like, and at the same time insure that the current passing the keying contacts is of a sufficiently small quantity that an arcing, which may occur when said contacts either open or close, is negligible. In addition, the difficulty involved in inserting a current-limiting resistor in series with said keying contacts, or in shunting said contacts with a capacitor in an effort to reduce arcing and erosion of the contacts, is more readily understood when it is desired to key in a customary manner the grid bias voltage of a conventional blocking oscillator, in which, in order to initiate oscillation independently of the keying rate, it is necessary that the keyed energy supplied to control said oscillator or associated circuitry must be active for relatively short but accurate intervals of time. With this arrangement, the time constant of the current-limiting resistor and its shunting capacitor must be smaller than the dwell time of the keying contacts or complete discharge of the shunting capacitor will not result and arratic oscillation of the blocking oscillator will ensue. Additionally, if a resistance is shunted across the keying contacts in addition to a shunting capacitor, the resistance, for adequate pulse width of the keyed energy, must of necessity be of so large a value that shunt leakage across the contacts, particularly under moist conditions, will tend to result in "free running" of the oscillator and production of pulses at a rate higher than the keying rate. The desirability of being able to provide accurate keying control of a high amplitude pulse of fixed duration which is independent of both the keying rate and the dwell time of the key and which imposes the least amount of erosion on the keying contacts, therefore, is readily appreciated.

In accordance with the present invention, erosion due to arcing at the keying contacts during the keying of a conventional electronic oscillator is overcome and other objects and advantages are obtained, first, by utilizing a gaseous discharge tube having a conventionally high-impedance grid-control circuit and by inserting the keying contacts in this circuit to control the discharge of a capacitor in the anode circuit of said discharge tube to produce a pulse of fixed energy content independently of the dwell time of the keying contacts, and then, using



this fixed energy pulse to initiate oscillation of the associated electronic oscillator by momentarily overcoming the preset bias level of its bias control circuit. In addition, an energy storage device or capacitor is connected in the bias-control circuit for the oscillator, and is charged in response to such oscillation to change the bias level of the control circuit and terminate oscillation independently of the duration of the initiating pulse. As a result, a high-amplitude pulse of fixed duration is produced by the keying circuit which avoids erosion of the keying contacts by limiting the flow of current therethrough and which, to an unexpected degree, is independent of the keying rate and of the dwell time of the key.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawing, wherein the single figure is a circuit diagram showing a keying system for a blocking oscillator and a transducer arranged in accordance with the invention.

Referring now to the accompanying drawing, the keying system of this invention is shown connected to a crystal transducer **10** mounted between an electrode **11**, which is connected to ground, and electrode **12**, which is connected in series with a conventional storage capacitor **13** to a source of oscillatory electrical energy in the output line **14** of a blocking oscillator **15**. The upper electrode **12** of transducer **10** is also connected through a capacitor **16** to a receiver (not shown) which may be of a design customarily used with depth-sounding and ranging equipment. The blocking oscillator **15** is provided with a suitable oscillator tube **17** having an anode **18**, a grounded shield **19**, a screen **20**, and a control grid **21** connected through a blocking capacitor **22** and a tuned circuit **23** to cathode **24**. In the present circuit, tube **17** has a potential at the anode **18** and at the screen **20** of approximately 350 volts by way of a coupling coil **24**, resistor **25** and terminal **26**. The screen **20** is operated at substantially ground potential for oscillatory energy by means of a relatively large shunting capacitor **27**. For periodically controlling the oscillation time of blocking oscillator **15**, a timing or control circuit **38** is employed to vary the bias potential on grid **21**. This circuit consists of a grid leak resistor **28**, a timing capacitor **29**, a shunting resistor **30**, and a bias or discharge resistor **31**.

In the present embodiment of this invention, the value of timing capacitor **29** and shunting resistor **30** is chosen to provide a "free running" pulse rate of several pulses per second in the absence of an additional negative bias voltage introduced into the control circuit through resistor **32**, rectifier **33**, and bias terminal **34**. The timing capacitor **29** and shunting resistor **30**, which control the "free-running" pulse rate of the blocking oscillator, have values of .01 microfarad and 13 megohms, respectively. The oscillator tube **17** is biased slightly beyond cutoff by an alternating current potential of 55 volts at terminal **34** and is rectified by a selenium rectifier **33**, poled to provide a negative potential with respect to ground across capacitor **35** and bias voltage divider resistors **36** and **37**. Thus, as noted, the negative-bias voltage introduced through resistor **32** is of a value slightly more than cutoff, and tube **17** will not oscillate until a sharp positive pulse is introduced to trigger or drive the control grid **21** momentarily to a value less than cutoff, thereby to initiate oscillation. As is well known, in an oscillator circuit of this sort, once tube **17** has started oscillation to cause a plate current to flow, the tube will oscillate continuously until either the plate current is interrupted or the bias voltage is raised to a value several times the cutoff or nonconduction value.

Thus, in accordance with the invention, a positive pulse is used to drive grid 21 momentarily less than cutoff to initiate oscillation. However, the oscillation so produced will not stop at the completion of the initiating pulse, but will continue until the charge on timing capacitor 29, resulting from the flow of grid current during conduction of tube 17, reaches a negative value substantially greater than that of the fixed bias voltage from terminal 34. At this time, oscillation ceases in an abrupt manner, and the timing capacitor 29 remains charged with this relatively high negative potential, which is then dissipated by means of resistors 30 and 32 to a value equal to the fixed bias voltage, which is large enough to prevent oscillation. In this manner, the blocking oscillator 15 is periodically energized to provide an output pulse of fixed duration independently of the length of time of an initiating pulse.

To provide an initiating pulse of fixed energy content for accurate timing of the start of oscillation of tube 17, a thyratron or other gaseous discharge device 40 is provided, having an anode 41 connected through a relatively large resistor 42 to a source of positive potential of approximately 350 volts at terminal 26. This potential at the anode 41 of tube 40 will charge the .01 microfarad capacitor 43 substantially to its full value during the period when the thyratron 40 is maintained non-conductive by a negative potential being impressed upon control electrode 44 by means of bias resistors 45 and 46 and a negative source of voltage produced at the junction 39 of voltage divider resistors 36 and 37. The discharge tube 40 may be a thyratron type 2D21 which has its screen 47 connected to bias resistor 45 through a suitable screen resistor 48. The cathode 49 of tube 40 is connected to the grid control circuit 38 at the side of timing capacitor 29 which is adjacent to discharge resistor 31. A negative bias potential of approximately —4 to —5 volts is provided at junction point 39 of the voltage divider resistors 36 and 37, which is connected to ground through resistors 46 and 53 and normally open switch or key 51. The thyratron tube 40 is initially biased to a cutoff condition by the negative potential from the junction point 39 applied to control grid 44. However, when the key 51 is depressed, this bias potential is removed, the grid 44 is returned toward ground potential through resistors 45 and 53, and tube 40 becomes conductive and discharges the charging capacitor 43. The discharge of capacitor 43 forces tube 40 to cutoff and produces a sharp pulse of fixed energy content which, as noted, is introduced by means of cathode 49 and resistor 31 into the control circuit 38 to drive the grid 21 of oscillator tube 17 above cutoff and initiate oscillation in a manner which is independent of the dwell time of key 51. In accordance with the invention, the high resistance of the thyratron input circuit prevents the handling of heavy currents by the key 51 and avoids harmful erosion of the keying contacts.

It should be understood that while the time constant of the thyratron discharge circuit is not critical, it should be in the order of the period of the fastest keying rate. Accordingly, for typical echo-ranging applications, the capacitance of the charging capacitor 43, as noted, may be approximately .01 microfarad, or sufficiently large to provide a sharp positive voltage when discharged through the 1,000-ohm resistor 31 to cutoff tube 40, while the value of the anode resistor 42 is approximately 2.0 megohms which, after cutoff of tube 40, will charge capacitor 43 prior to a second closing of the key 51. It should be noted, however, that when the key 51 is closed there is a small current surge due to the discharge of the internal capacity of the keying circuit, particularly when long keying leads are used. In this instance, circuit capacity due to the keying leads, which may be represented by a capacitor 52, can be readily limited to an extremely low value by means of a resistor 53 inserted in the keying lead and mounted as close to the key as possible. This resistor 53 would normally be of a low resistance value of a 1,000 ohms or less in comparison to resistors 45, 46 and 48 which, in this circuit application, are approximately 100,000 ohms. Moreover, resistor 53 can usually be omitted from the keying circuit when keying leads of average length are used. Thus, as noted, when key 51 is depressed, a high amplitude pulse of fixed length is provided for the transducer 10, independently of the keying rate and the dwell time of the key.

In addition, it will be appreciated that many variations of the features shown and described herein in connection with a single embodiment of the invention illustrated will occur to those who are skilled in the art to which the invention relates. For example, the key 51 could be of the momentary-contact-type, actuated by a rotating cam disk which periodically closes the key against the action of a retaining spring which tends to hold the key open. Furthermore, a source of direct current of suitable value could be connected to terminal 34 and the selenium rectifier 33 could be omitted. Furthermore, other types of thyratron and oscillator tubes may be employed in connection with different values of circuit parameters. Accordingly, it is desired that this invention be not limited to the particular details of the embodiment disclosed herein, except as defined by the appended claims.

What is claimed is:

1. In combination, a keying system comprising an electronic oscillator, a gaseous discharge tube circuit including a gaseous discharge tube, a source of initiating voltage and electrical switching means in said discharge tube circuit for controlling the initiation of conduction of said gaseous discharge tube, said discharge tube circuit including a capacitor coacting with said conduction of said discharge tube to produce a pulse of fixed energy content independently of the continued operation of said electrical switching means, said electronic oscillator having an input circuit responsive to said pulse of fixed energy content to be triggered into oscillation for a predetermined period of time independently of the duration of said pulse, and an energy storage device responsive to said oscillation to inhibit said oscillation independently of the time of termination of said pulse of fixed energy content.

2. An oscillator keying circuit comprising an electronic oscillator, a gaseous discharge tube having an input and output circuit including a gaseous discharge tube, means in said discharge tube input circuit initiating conduction of said gaseous discharge tube, said gaseous discharge tube output circuit having a capacitor therein coacting with said conduction of said discharge tube to produce a pulse of fixed energy content independently of the continued operation of said first recited means, said electronic oscillator having an input circuit responsive to said pulse of fixed energy content to initiate oscillation for a period independent of the duration of said pulse of fixed energy content, and capacitive means connected in said input circuit to terminate said oscillation prior to initiation of the next succeeding pulse of fixed energy content.

3. An oscillator keying circuit comprising a gaseous discharge tube, capacitor means in circuit with said discharge tube for providing a first relatively short pulse of fixed energy content, an electronic oscillator arranged to oscillate over a relatively long period of time compared to said first pulse when triggered by said first pulse, means to trigger said electronic oscillator in response to said first pulse, capacitor means responsive to said oscillation of said electronic oscillator to inhibit after a predetermined time said oscillation independently of the termination of said first pulse, and means active in response to inhibition of said oscillation to restore said electronic oscillator to oscillation upon the production of the next succeeding energy pulse.

4. In combination, an electrical switch provided with electrical contacts, a gaseous discharge tube having an input circuit adapted to render said discharge tube con-

ductive in response to a change in the state of the contacts of said electrical switch, said discharge tube having an output circuit for providing a pulse of fixed energy content in response to conduction of said discharge tube, an electronic oscillator arranged to oscillate in response to said pulse of fixed energy content, and an energy storage device responsive to said oscillation to inhibit said oscillation independently of the time of termination of said pulse of fixed energy content.

5. In combination, a normally free-running oscillator including an electron tube having an anode, a cathode and a control grid, means for producing a pulse of fixed energy content at predetermined time intervals, means biasing said oscillator tube control grid to a first nonconductive level with respect to said cathode, circuit means responsive to the production of said pulse of fixed energy content for momentarily biasing said oscillator control grid to a conductive level, thereby to initiate oscillation of said oscillator tube, capacitor means responsive to said oscillation to bias said control grid of said oscillator tube to a second nonconductive level with respect to said cathode independently of the time of termination of said energy pulse, said capacitor means coacting with said circuit means on termination of said oscillation to change said bias from said second nonconductive level to said first nonconductive level prior to initiation of a second pulse of fixed energy content.

6. In combination, an electronic oscillator having a control circuit arranged to provide oscillation over a predetermined time interval, a gaseous discharge tube having an input and an output circuit, said output circuit having capacitance means for producing a pulse of fixed energy content in response to conduction of said discharge tube, a source of voltage and switching means adapted to open and close for a predetermined time connected in said input circuit of said discharge tube for initiating said conduction of said discharge tube upon closure of said switching means, said capacitance means controlling the duration of conductivity of said discharge tube independently of the time of the closure time of said switching means, said electronic oscillator adapted to be keyed into oscillation by said fixed energy pulse, and an energy storage device responsive to said oscillation to inhibit said oscillation independently of the time of termination of said pulse of fixed energy content.

7. A keying circuit comprising an electrical switch having a pair of interruptable contacts adapted to open and close for a predetermined time, a gaseous discharge tube having a relatively high impedance input circuit as compared to a low impedance output circuit, said electrical switch interposed in said input circuit for controlling the conduction of said discharge tube, said output circuit having a capacitance adapted to provide a pulse of fixed energy content in response to said conduction of said discharge tube, and an electronic oscillator having an energy storage circuit adapted to permit oscillation in response to said fixed energy pulse for a predetermined length of time independently of the duration of said pulse, and an energy storage device responsive to said oscillation to inhibit said oscillation independently of the time of termination of said pulse of fixed energy content.

8. A keying circuit comprising an electrical switch having a pair of interruptable contacts adapted to open and close for a predetermined time, a gaseous discharge tube having an input circuit and an output circuit, said contacts of said electrical switch interposed in said input circuit for controlling the conduction of said discharge tube, said output circuit having a capacitance adapted to provide a pulse of fixed energy content in response to said conduction of said discharge tube, and an electronic oscillator having a grid control circuit including a bias charging capacitor responsive to oscillation of said electronic oscillator to terminate oscillation independently of the dwell period of said interruptable contacts.

9. An oscillator keying circuit comprising an electrical switch having a pair of interruptable contacts adapted to open and close for a predetermined time, a gaseous discharge tube having a relatively high impedance input circuit as compared to a low impedance output circuit, a source of voltage connected in circuit with said contacts of said electrical switch and interposed in said input circuit for controlling the conduction of said discharge tube in response to the closure of said contacts, said output circuit having a capacitance adapted to provide a pulse of fixed energy content in response to conduction of said discharge tube, and an electronic oscillator having a biased circuit adapted to initiate oscillation in response to said fixed energy pulse for a predetermined length of time independently of the duration of said fixed energy pulse and independently of the closure time of said interruptable contacts.

10. In combination, an oscillator including an electron tube having an anode, a cathode and a control grid, a gaseous discharge tube having an anode, a cathode, and control electrode, means connecting said gaseous discharge tube cathode in circuit with said electron tube control grid, switch means in the grid-to-cathode path of said discharge tube for rendering said discharge tube conductive, capacitor means in the anode-to-cathode path of said discharge tube for producing a pulse of fixed energy content in response to said conductivity of said discharge tube, means normally biasing said electron tube grid to a first nonconductive level with respect to said electron tube cathode, means responsive to the conductivity of said discharge tube for momentarily biasing said electron tube to a conductive level to initiate oscillation therein, energy storage means responsive to oscillation of said electron tube for biasing said electron tube grid to a second nonconductive level with respect to said electron tube cathode, and resistance means coacting with said energy storage means to change said bias from said second nonconductive level to said first nonconductive level prior to initiation of the next succeeding energy pulse.

11. An oscillator keying circuit comprising an electrical switch having a pair of interruptable contacts adapted to open and close for a predetermined time, a gaseous discharge tube having an anode, cathode and a control electrode, a source of voltage connected to said contacts of said switch and connected in circuit with said cathode and control electrode of said discharge tube, a capacitance in the anode circuit of said discharge tube for providing a discharge of fixed energy content independently of the dwell time of said interruptable contacts, a free-running oscillator adapted to be triggered into oscillation by said discharge for a predetermined period of time independently of the duration of said discharge.

12. An oscillator keying circuit comprising an electrical switch having a pair of interruptable contacts adapted to open and close for a predetermined time, a gaseous discharge tube having an anode, a cathode and a control electrode, said contacts of said switch connected in circuit with said cathode and said control electrode of said discharge tube, a capacitance in the anode circuit of said discharge tube providing a discharge of fixed energy content independently of the dwell time of said interruptable contacts, an oscillator including an electron tube having a cathode, an anode and a control electrode, said cathode of said discharge tube connected in circuit with said control grid of said oscillator tube, means normally biasing said electron tube grid to a first nonconductive level with respect to said cathode, circuit means responsive to said discharge of fixed energy content from said discharge tube to initiate oscillation of said electron tube, and energy storage means in said oscillator control grid circuit for changing said bias to a second nonconductive level in response to oscillation of said electron tube, thereby terminating said oscillation, and means discharging said energy storage means to said first

nonconductive level after termination of oscillation and prior to production of the next succeeding discharge.

13. An oscillator keying system comprising an electron tube having at least a cathode, an anode and a control grid, a grid-to-cathode control circuit for said tube including a resistor and a capacitor, a source of grid bias potential maintaining said capacitor and said control grid of said electron tube at a first nonconductive level with respect to said cathode, keying circuit means to apply a pulse of fixed energy content for momentarily biasing said control grid to a conductive level, thereby to initiate oscillation, means responsive to conduction of said electron tube to charge said capacitor to a second nonconductive level with respect to said cathode, and resistor means dissipating said charge on said capacitor to said first nonconductive level prior to initiation of a second energy pulse.

14. An oscillator keying circuit comprising an electron tube having at least a cathode, an anode and a control grid, a grid-to-cathode control circuit for said tube including a resistor and a capacitor, a source of grid bias potential maintaining said capacitor and said control grid



of said electron tube at a first nonconductive level with respect to said cathode, a keying circuit comprising a pair of interruptable contacts, means responsive to said keying circuit to apply a pulse of fixed energy content for momentarily biasing said control grid to a conductive level, thereby to initiate oscillation, means responsive to conduction of said electron tube to charge said capacitor to a second nonconductive level with respect to said cathode, and resistor means dissipating said charge on said capacitor to said first nonconductive level prior to initiation of a second energy pulse, and resistive means in circuit with said keying means limiting current through said interruptable contacts.

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