

Sept. 14, 1937.

D. T. OSGOOD

2,092,851

RESETTING CIRCUITS FOR GAS-FILLED TUBES

Filed June 21, 1935

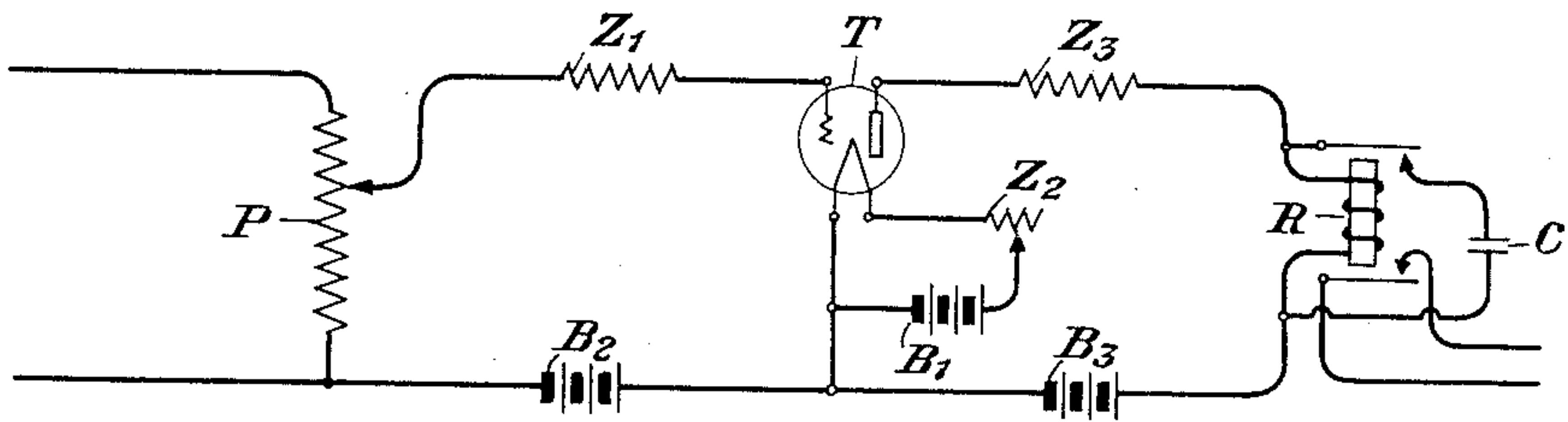


Fig. 1

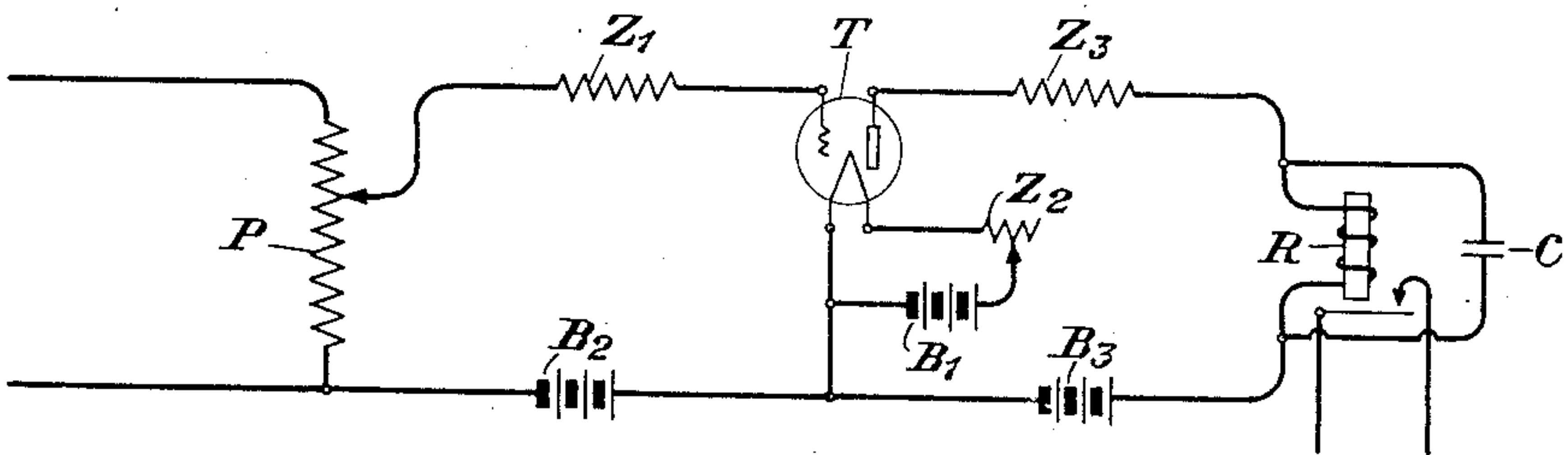


Fig. 2

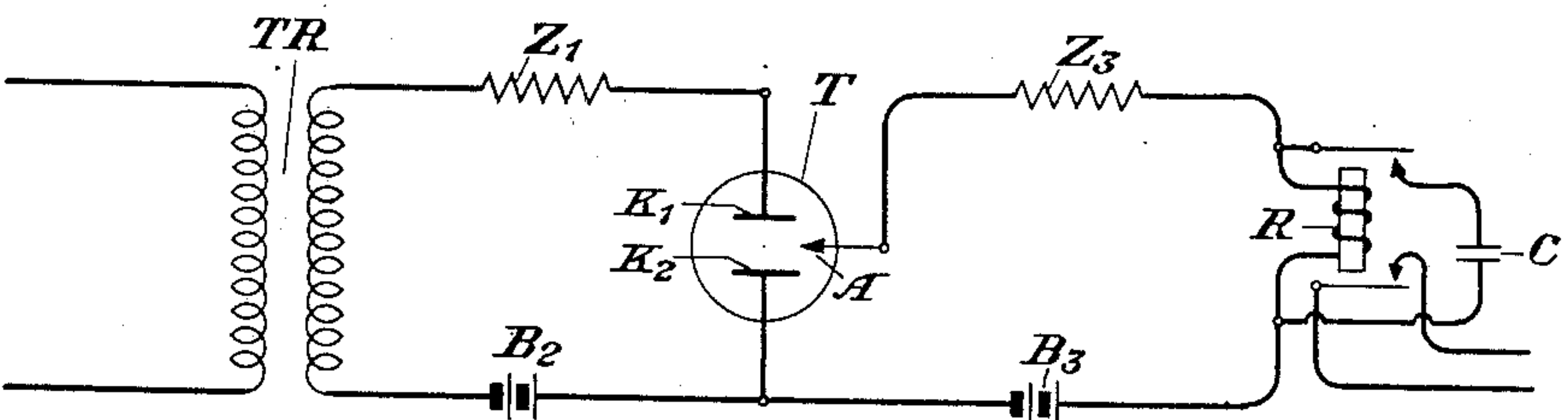


Fig. 3

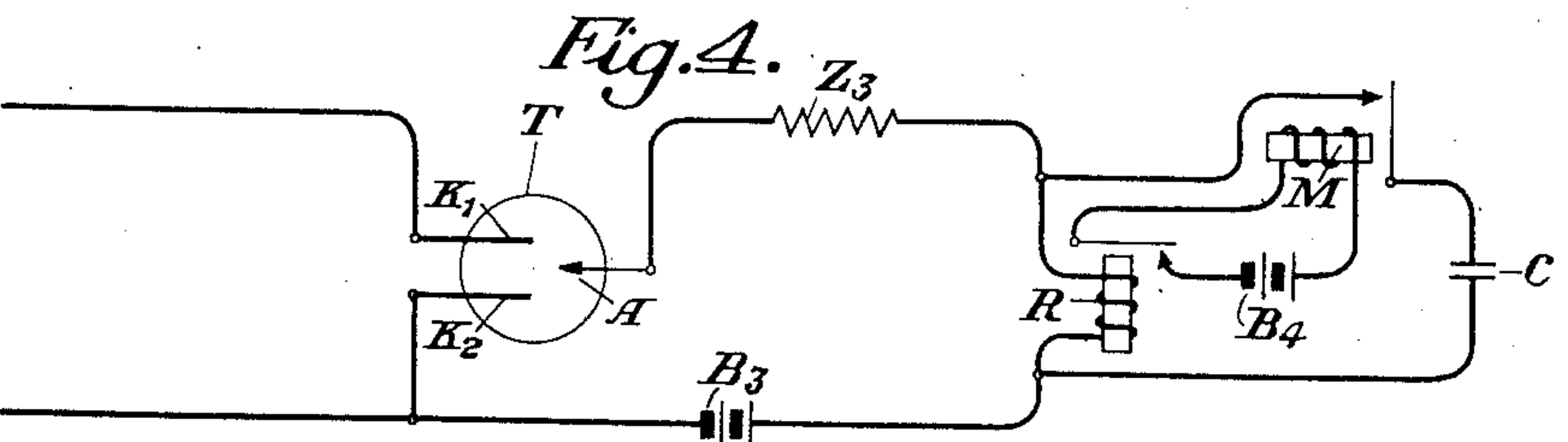


Fig. 4

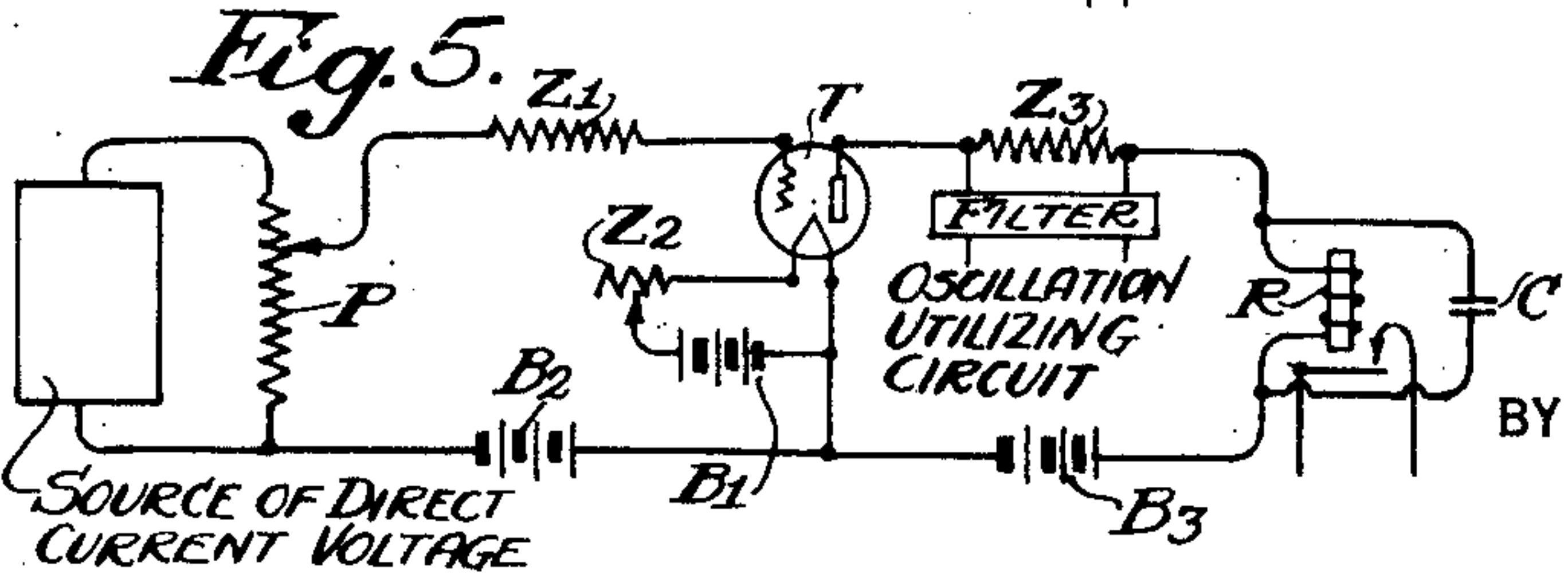


Fig. 5

INVENTOR
D. T. Osgood
BY
ATTORNEY

UNITED STATES PATENT OFFICE

2,092,851

RESETTING CIRCUITS FOR GAS-FILLED TUBES

Dexter T. Osgood, Jackson Heights, N. Y., assignor to American Telephone and Telegraph Company, a corporation of New York

Application June 21, 1935, Serial No. 27,793

16 Claims. (Cl. 175—320)

This invention relates to electrical circuits and to circuits for gas-filled tubes. More particularly, this invention relates to methods and apparatus for restoring gas-filled tubes after operation to their initial condition prior to operation. Stated in other words, this invention relates to methods and apparatus for unlocking or resetting operated gas-filled tubes.

When two or more electrodes are enclosed within a suitable vessel filled with a gaseous medium, the application of a voltage in excess of a predetermined value will ionize the gas within the tube and the gas will continue to remain ionized as long as a potential is applied between the electrodes which is above a certain lower predetermined value frequently referred to as the sustaining voltage. If a direct potential remains impressed across the electrodes of the tube, and if this direct potential is uninterrupted and of a value equal to or greater than the sustaining voltage, the gas within the tube will continue to be ionized and the persistence of ionization will render it difficult, if not impossible, to operate the tube as a relay for the control of associated circuits.

It is one of the objects of this invention to ionize the gas within a gas-filled tube and maintain the enclosed gas in an ionized condition as long as, and only as long as, a voltage impressed across its input or control electrodes exceeds a sufficient predetermined value.

This invention will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing, in which Figure 1 illustrates one modification of the invention embodying a hot cathode gas-filled tube and a relay and condenser therefor; Fig. 2 represents a somewhat different modification; Fig. 3 illustrates still another modification embodying a cold cathode gas-filled tube; Fig. 4 illustrates still another modification of the invention; and Fig. 5 illustrates one form of oscillation generating circuit embodying the principles of this invention.

Referring to Fig. 1 of the drawing, the reference character P designates a potentiometer the outer terminals of which are connected to a source of voltage which, for instance, may vary over wide limits and which, furthermore, may at times be supplied with no voltage whatever. The movable arm of the potentiometer is connected through a resistor Z_1 to the grid electrode of a hot cathode gas-filled tube T which includes, in addition to the grid electrodes, a plate electrode and a cathode. The tube is, in general, any form of gas-filled device and it may include neon, argon, helium or krypton, or combinations of these gases, or combinations of these gases and other gases. The cathode of the tube is supplied with current by battery B_1

or by any other suitable source of power, the magnitude of the current being regulated by a rheostat Z_2 . The cathode of the tube is also connected to the terminal common to two sources of direct current potential designated B_2 and B_3 , but it will be understood that these sources may be of any well-known types of batteries. The source B_2 thus interconnects the lower terminal of the potentiometer P with the cathode of the tube T. The source B_3 is connected in the circuit which includes the winding of a relay R and a resistor Z_3 . The upper armature and contact of the relay R are in a circuit which includes a condenser C which bridges the winding of the relay R. The lower armature and contact of this relay may be connected to any operating circuit which may, for example, include a message register device as will be described in connection with Fig. 4. It will be understood, of course, that the tube T may be replaced by any other gas-filled tube such, for example, as one having a heater and cathode of well-known form.

It will be apparent that the source B_2 is employed for biasing the grid electrode of the tube T to a suitable potential with respect to its cathode so as to predetermine the voltage at which ionization of the gas within the tube may occur by application through the potentiometer P to the grid electrode of the tube T. The resistor Z_1 limits the flow of current through the circuit of the tube and this resistor will ordinarily be one of large magnitude.

The source B_3 is one which normally provides a voltage which is above the value required to sustain ionization of the gas between the plate and filament electrodes of the tube T, but the voltage of B_3 is, of course, lower than that required to initiate gaseous ionization between the latter electrodes of the tube. The resistor Z_3 is employed for limiting the flow of current through the plate circuit of the tube.

Fig. 2 represents a modification of the arrangement of Fig. 1. In this arrangement the condenser C is permanently connected across the winding of relay R.

Under normal conditions, i. e., with no voltage applied through potentiometer P, the condenser C is uncharged and no current will flow in any part of the circuit (except, of course, in the cathode circuit). If a voltage now is applied through potentiometer P between the grid and cathode of the tube sufficient to cause ionization of the gas within the tube, a path will be formed between the anode and the cathode through which current will flow from the battery B_3 and through the elements of the circuit connected to the anode of the tube. Since the condenser C is uncharged, a momentary short circuit will be placed around the winding of relay R and all the current will initially flow through the

condenser C. The condenser will then acquire a charge which will cause a voltage to build up across its terminals as well as across the terminals of the winding of relay R which it shunts.

5 However, since the relay winding contains inductance as well as resistance, the current through it will build up slowly and the relay winding will have little effect at the start on the increase of voltage due to the charge of the con-

10 denser. This is predicated, of course, on the fact that proper values of inductance, capacity and other circuit constants are chosen. This voltage across the condenser terminals during charge, however, will be poled in opposition to

15 the voltage of the battery B₃ and, therefore, will act to reduce the resultant voltage applied across the anode and cathode of the tube T. Assuming again that proper circuit constants have been used, this resultant voltage will fall below the

20 value necessary to sustain gaseous ionization in the tube and the current in the anode circuit of the tube will cease. The condenser C having a charge on its plates will subsequently discharge current into the winding of relay R until the

25 voltage across its terminals is reduced to a value such that the combination of this voltage, i. e., the voltage across the condenser, and the battery voltage has been increased to a value sufficient to reionize the gas within the tube T provided

30 that sufficient voltage is still applied between the grid and cathode of the tube. It should be noted that in general the voltage necessary to ionize the gas within the tube is higher by a finite amount than that necessary to sustain ioniza-

35 tion after this condition has been initiated. If at this time the voltage at the input of the tube is still present, the gas within the tube will reionize and the process will be repeated until the applied voltage eventually disappears

40 or is reduced to a value below which gaseous ionization will take place. If the latter condition eventuates, the gas within the tube will remain in a deionized condition and the condenser C will continue to discharge current through the

45 winding of relay R until the voltage across its terminals has been reduced to zero. The circuit will then be in a condition similar to that existing prior to the application of voltage to the grid and cathode of the tube.

50 As mentioned above when the voltage increases across the winding of relay R, current will start to flow and increase gradually. Also, after deionization of the gas in the tube has taken place, current will continue to flow in

55 the same direction through the winding of the relay due to the discharge of the condenser C. As the condenser loses its charge, this current will decay and soon disappear.

It will be seen therefore that the current

60 through the relay winding is substantially of a pulsing unidirectional form. If a relay has been chosen which is not sufficiently quick acting to follow these pulses, the frequency of which depends upon the constants of the circuit, this re-

65 lay will operate and remain operated continuously until the input voltage has disappeared and the circuit has returned to its normal condition as described above.

In using the circuit shown in Figs. 1 and 2 of

70 the drawing, it has been found that the capacity of the condenser C directly determines the time required for the tube T to become extinguished after removal of the voltage from the potentiometer P. Thus, as the capacity of the condenser

75 C is increased, the time required to charge the

condenser will also be increased, and the time required to extinguish the tube will be similarly increased.

It will be noted that the direct current pulsations in the anode circuit of Fig. 2, for example, may be employed as a source of oscillations. This is illustrated in Fig. 5. In this arrangement these oscillations may be utilized in any circuit connected or otherwise coupled to the anode circuit of the arrangement. If desired, a filter

10 of any well-known form may be connected to any part of this anode circuit as, for example, across resistor Z₃, as shown, and the direct current pulsations will be smoothed out thereby into current somewhat sinusoidal in form. It will be

15 understood that the frequency of these alternations will be governed by the constants of the circuit and that they will continue as long as voltage is applied to the input circuit of the tube. Hence, the duration of this alternating

20 current may be made permanent by the permanent connection of a source of direct current voltage across the outer terminals of the potentiometer P.

Direct current pulsations occur in the anode

25 circuit of tube of Fig. 5. The filter connected to resistor Z₃ will supply alternating current to the oscillation utilizing circuit.

It will be further understood that the relay R may be replaced by an inductance or choke

30 coil of similar electrical characteristics without in any way affecting the operations already described.

Fig. 3 illustrates another modification of the arrangement shown in Fig. 1 in which the tube

35 T is of a type generally designated as a cold cathode tube. The electrodes K₁ and K₂ of the tube T form its input electrodes and they are connected to each other through a circuit which includes a current limiting resistor Z₁, the sec-

40 ondary winding of the transformer TR and the source of potential B₂, the primary winding of the transformer TR being connected to the source which supplies voltage for initiating ionization of the gas within the tube T. The anode

45 A of the tube T is connected through a current limiting resistor Z₃ and through the winding of the relay R and the source B₃ to the electrode K₂ of the tube. The upper armature and contact of the relay shunt the condenser C across

50 the winding of the relay, and the lower armature and contact of the relay control any load circuit or a circuit which may, for example, include one or more message registers.

In Fig. 4 the electrodes K₁ and K₂ of the tube

55 T are connected to the source which supplies the voltage for initiating gaseous ionization within the tube. The anode A of the tube is connected through a current limiting resistor Z₃, through the winding of the relay R and a source B₃ to

60 the electrode K₂ of the tube T. The relay R may, for instance, be similar to the one illustrated in Figs. 1, 2 and 3. The armature and contact of this relay are shown connected to a circuit which may, for example, include a mes-

65 sage register relay M, current for which may be supplied by a source B₄. The armature and contact of the relay M may be employed to connect the condenser C across the winding of the relay R.

70

In Fig. 4 the condenser C will be connected to shunt the winding of the relay R only after both of the relays R and M have become oper-

75 ated. Thus, the condenser may be arranged to function in resetting the tube T to its normal

deionized condition only after sufficient time has elapsed to permit the circuit of the message register M to operate.

It will be understood that the tube T of Fig. 4 need not be a cold cathode type of tube, but it may be, for instance, of the hot cathode type in which a grid will take the place of the electrode K₁, a plate would replace the anode A and a filament would replace the electrode K₂, but the filament would necessarily be connected to a source of current as is well known in the art.

Assume now that the condenser C of Fig. 4 is uncharged and no current is flowing in any part of the circuit. A voltage applied between the grid and cathode of the tube T will produce ionization of the gas enclosed therein and current will start to flow from the battery B₃ through the winding of relay R, resistance Z₃ and the anode circuit of the tube T. This current will build up until the relay R operates. The contact of this relay will be closed and the circuit to the message register M completed so that the latter function to bridge the condenser C across the winding of relay R as above described. When the condenser C is thus connected, a momentary short circuit will be placed around the winding of relay R with the result that the current through the condenser C will suddenly start to flow and that through the winding of relay R will decrease. The voltage across the condenser C will then build up as before described and current will at the same time start to build up again in the winding of the relay R. Assuming as before that proper constants have been chosen, the resultant voltage applied between the anode and the cathode of the tube T will fall below the sustaining voltage of the tube. The tube will then be extinguished and the condenser C will discharge through the winding of relay R. From this point the operation of the circuit continues substantially as described in connection with Fig. 2 above.

In Fig. 5 it may be assumed that the system is in equilibrium with the condenser C uncharged and no current flowing in any part of the circuit except, of course, in the filament of the tube T. It may be further assumed that the movable arm of the potentiometer P is at its lower extremity, so that the only voltage applied to the grid of the tube T is supplied from the negative bias of the battery B₂. If now the movable arm of the potentiometer P is adjusted so that the voltage across this potentiometer overcomes the negative bias sufficiently to initiate ionization of the gas of tube T, current will immediately will flow between the anode and cathode of tube T and through the elements of the circuit connected to the anode of tube T, and this current will be supplied by the battery B₃.

Immediately after battery B₃ begins to supply current to the anode circuit, the condenser C, previously uncharged, will receive nearly all the current flowing in the anode circuit and will, therefore, acquire a charge by virtue of a voltage built up across the terminals of this condenser. This voltage at charge will be so poled as to oppose that of the battery B₃, and thereby increasingly reduce the potential applied to the anode of the tube T. When the net voltage on the anode has become reduced below the value necessary to sustain gaseous ionization within the tube, the gas within the tube will become deionized and current will then cease to flow in the anode circuit.

The condenser C will thereafter discharge

through the winding of the relay R and, as this discharge progresses, the voltage at the terminals of the condenser will be accordingly decreased. This will continue until the net voltage of the battery B₃ and that across the condenser C are sufficiently different so as to bring the anode of the tube T to the reionizing potential—assuming that the voltage across the potentiometer has in no wise been disturbed. When the gas within the tube reionizes, current will again flow in the anode circuit and the processes already outlined will be repeated again and again until the voltage at the grid of the tube is intentionally reduced below the value necessary to bring about ionization of the gas within the tube.

The current through the winding of the relay R begins to flow soon after the gas of the tube T becomes ionized and increases to some extent as the condenser C becomes charged. During discharge of the condenser C the current through the relay winding will be in the same direction as during the charging period, but will gradually decrease in magnitude until the gas within the tube reionizes and the condenser C again starts to charge.

Current will flow through the resistor Z₃ approximately during the time when the gas within tube T is ionized. This current will be a pulsating direct current. A properly designed filter or its equivalent connected or coupled to this resistor will deliver alternating current into the oscillation utilizing circuit. This oscillation utilizing circuit may, of course, be connected across the condenser C, if so desired.

While the current through the winding of relay R is always in the same direction, it is not constant, however, since its value varies with the voltage across the terminals of the condenser C. If the constants of the relay are properly selected, this relay will remain operated as long as the anode circuit becomes supplied with current.

The frequency of the direct current pulsations will be controlled in large part by the values of the relay winding, condenser C and the resistor Z₃, as well as by the potential of battery B₃ and that supplied by potentiometer P. The condenser C will have a definite time in which to discharge since the anode voltage required to initiate ionization of the gas within the tube is higher than that necessary to sustain ionization once it has been initiated.

The source of "direct current voltage" across the potentiometer P may be replaced by a source of alternating current, if so desired. If this is done, the frequency of the pulsations in the anode circuit will somewhat depend upon the frequency of this source. This is so, because the gas within the tube can ionize only when the instantaneous value of the alternating current voltage is positive and above a predetermined magnitude.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. Means for deionizing the gas contained within a gas-filled tube having input and output circuits, comprising a condenser and a coil con-

nected in parallel relationship across the output electrodes of the tube.

2. An arrangement for resetting a gas-filled tube having input and output circuits, comprising means responsive to the ionization of the gas within the tube to bridge a condenser across its output circuit, and means for periodically charging and discharging said condenser as long as sufficient voltage is present in the input circuit of the tube.

3. The combination of a gas-filled tube having input and output circuits, means for ionizing the gas within the tube and means for deionizing the gas within the tube, said deionizing means comprising a relay having its winding in series with the output circuit of the tube, and means responsive to the operation of the relay to connect a condenser across the relay winding.

4. The combination of a gas-filled tube, means connected to two of the electrodes of the tube for initiating ionization of the gas within the tube, means connected to the third electrode and one of the other electrodes for periodically deionizing the gas within the tube, said latter means including a relay the winding of which is connected to the third electrode and a condenser in shunt with the relay winding.

5. The combination of a gas-filled tube having input and output circuits a first relay having its winding connected in the output circuit of the tube, a second relay operatively controlled by the first relay, and means responsive to the operation of the second relay for connecting a condenser in shunt with the winding of the first relay.

6. Apparatus for recording steep wave front voltages lasting for extremely short intervals, comprising a gas-filled tube upon the input circuit of which said voltages may be impressed, a plurality of relays progressively coupled to the output circuit of the tube, and means responsive to the operation of the last operated relay for shunting a condenser across the output circuit of the tube.

7. The combination of a gas-filled tube having a continuous input circuit and an anode circuit, an inductance, a capacitance permanently connected to said inductance and in the anode circuit of said tube, means for applying voltage to the input circuit of the tube, and means for utilizing the pulsating current flowing in the anode circuit.

8. Apparatus for recording voltages lasting longer than a predetermined interval comprising a gas-filled tube upon the input circuit of which said voltages are impressed, a relay the winding of which is connected to the output circuit of the tube and responsive to the operation of said tube, and a condenser shunting the winding of the relay, said relay being of a slow acting type so that it will operate only after a predetermined interval after the operation of the tube.

9. The combination of a gas-filled discharge tube having input and output circuits, a source of direct current potential connected in the input circuit, and a tuned circuit connected in the output circuit, said input circuit receiving substantially no voltage from the output circuit, said source and said tuned circuit having such constants that gaseous ionization within the tube will be interrupted at a predetermined frequency.

10. An oscillation generator comprising a gas-discharge tube having input and output circuits,

the output circuit transferring substantially no voltage to the input circuit, a source of direct current potential connected across the input circuit, a parallel circuit of inductance and capacity connected across the output circuit, the constants of the parallel circuit being such that gaseous ionization within the tube will be interrupted at a fixed rate.

11. Means for generating alternating current of a predetermined frequency comprising a three-electrode gas-discharge tube, a source of direct current potential connected to two of the tube's electrodes, a circuit of inductance and capacitance connected to the third electrode and one of the other electrodes, said circuit connected to the third electrode producing substantially no potential in the circuit connected to the first mentioned two electrodes of the tube, and a filter coupled to the circuit of the third electrode for smoothing out the generated oscillations into current somewhat sinusoidal in form.

12. An oscillation generator not employing energy feedback for the generation of oscillations, comprising a gas-discharge tube having three electrodes, a source of potential connected to two of the tube's electrodes, the potential of said source exceeding the value required to initiate gaseous ionization within the tube, and a tuned circuit connected to the third electrode and one of the other electrodes of the tube, the constants of the tuned circuit being such as to interrupt gaseous ionization within the tube at a predetermined rate.

13. A continuous oscillation generator including a gas tube, an aperiodic input circuit for said tube, an output circuit for said tube, said output circuit feeding substantially no voltage to the input circuit, means in the input circuit for ionizing the gas of the tube, and means in the output circuit responsive to gaseous ionization within the tube for periodically deionizing the gas of the tube.

14. Oscillation generating apparatus comprising a condenser, a source of voltage, means for periodically charging said condenser by voltage obtained from said source, means for discharging said condenser, said charging means including a gas tube having electrodes in circuit with said source and said condenser, and non-reactive means for ionizing the gas within the tube.

15. The combination of a three-element gas tube having two of its electrodes forming an input circuit and the third electrode and one of the other electrodes forming an output circuit, a source of voltage connected to the input circuit electrodes, the magnitude of the voltage of said source being greater than that required to ionize the gas between said input circuit electrodes, a coil, and a condenser connected in shunt with said coil to the output circuit electrodes of the tube, the output circuit supplying substantially no voltage to the input circuit.

16. A continuous oscillation generator comprising a gas tube having electrodes forming an input circuit and electrodes forming an output circuit, aperiodic means for continuously supplying voltage to the input circuit electrodes of a value exceeding the gas ionizing value between said electrodes, a source of voltage for the output circuit, and means for periodically varying the effective voltage of said source, said latter means including a condenser.

DEXTER T. OSGOOD.

DISCLAIMER

2,092,851.—*Dexter T. Osgood*, Jackson Heights, N. Y. **RESETTING CIRCUITS FOR GAS-FILLED TUBES.** Patent dated September 14, 1937. Disclaimer filed June 19, 1940, by the inventor; the assignee, *American Telephone and Telegraph Company*, consenting.

Hereby enters this disclaimer to claims 14 and 15 of said Letters Patent.
[Official Gazette July 9, 1940.]