GAS TUBE CIRCUITS

Filed July 3, 1936

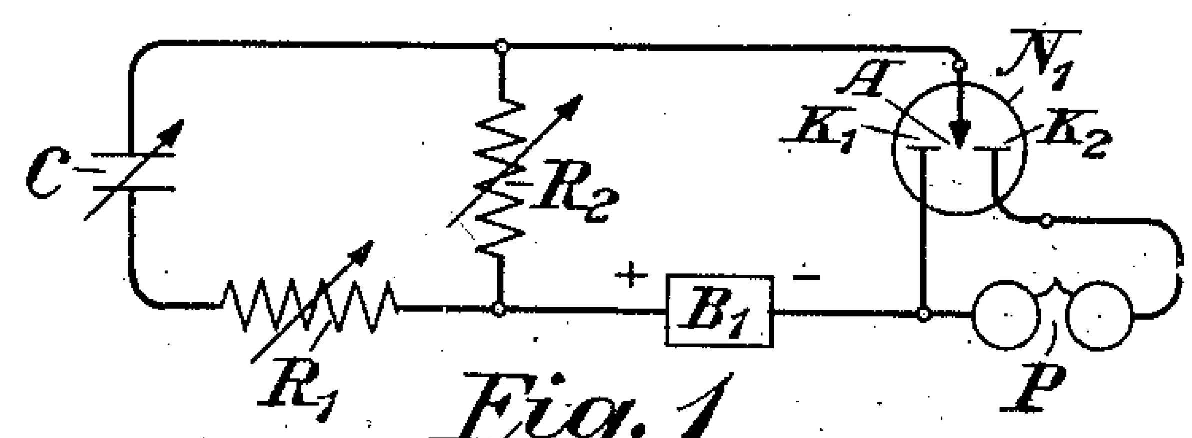

Fig. 1

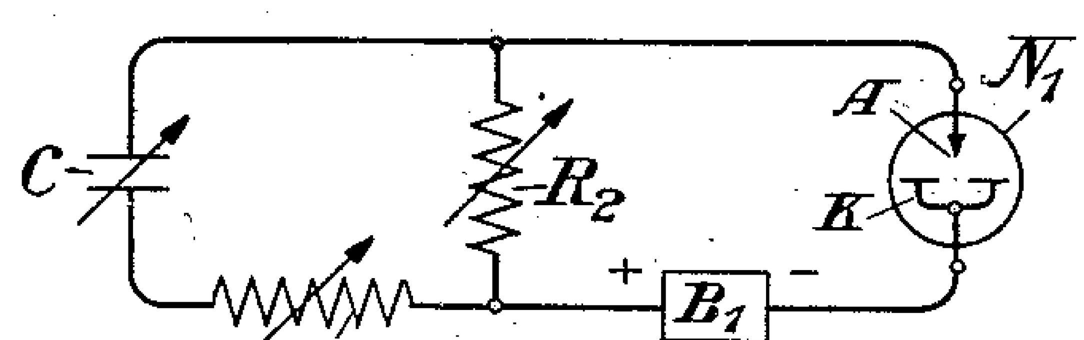

Fig. 2

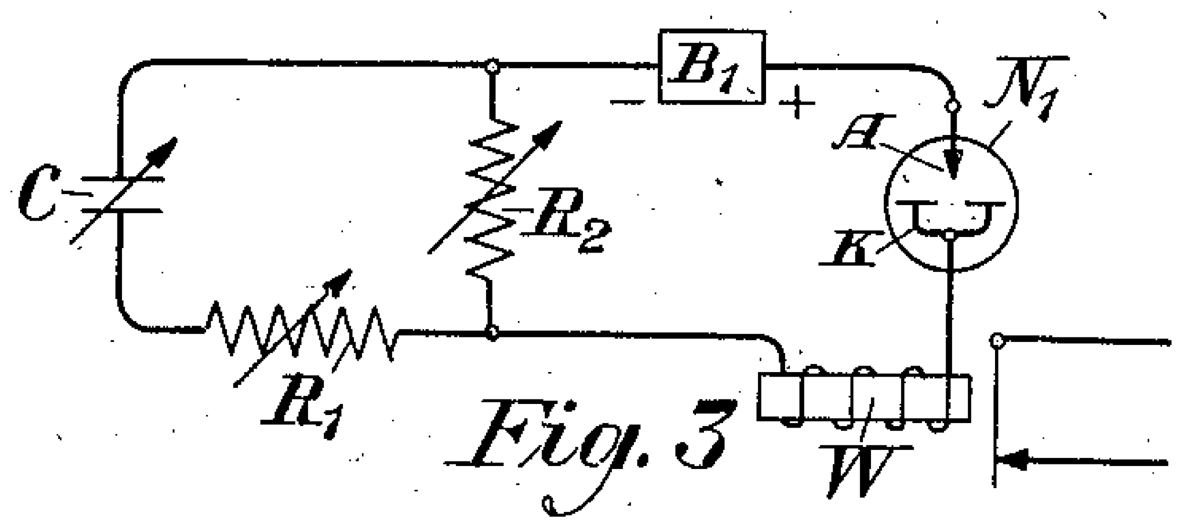

Fig. 3

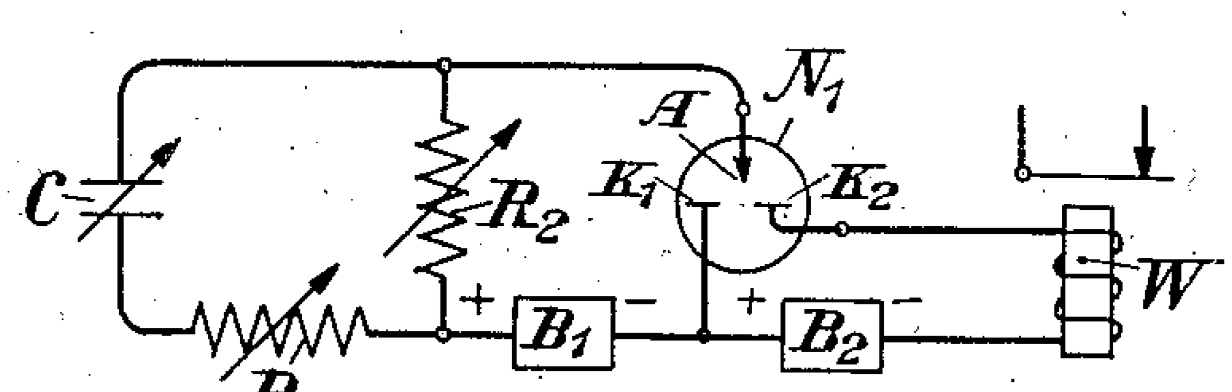

Fig. 4

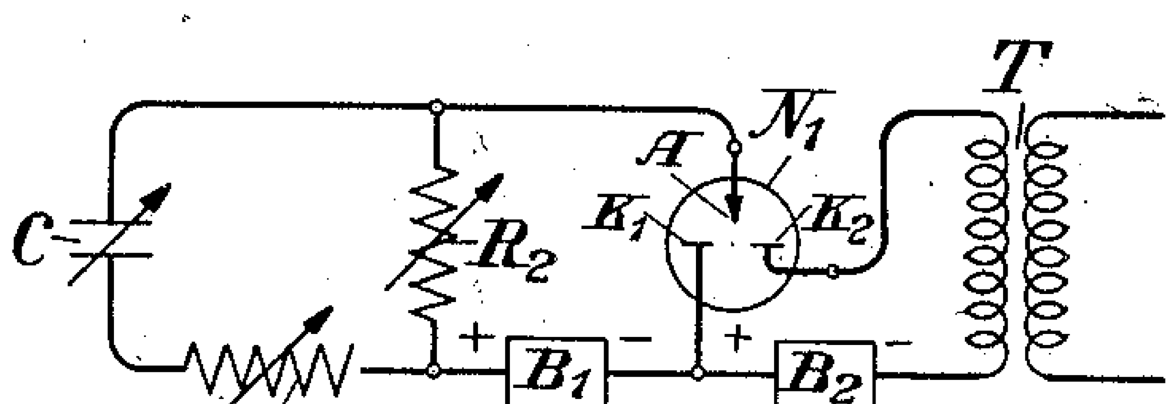

Fig. 5

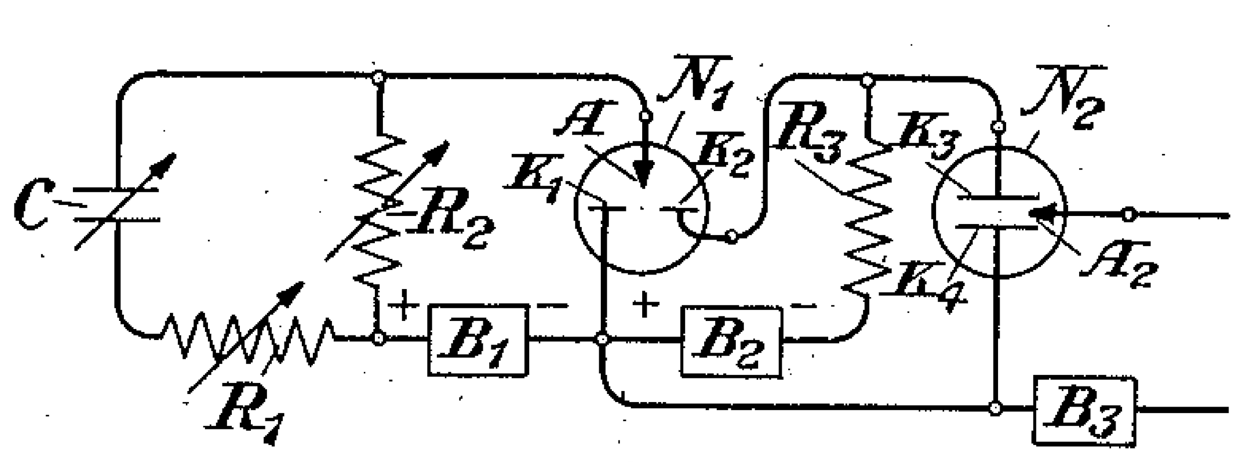

Fig. 6

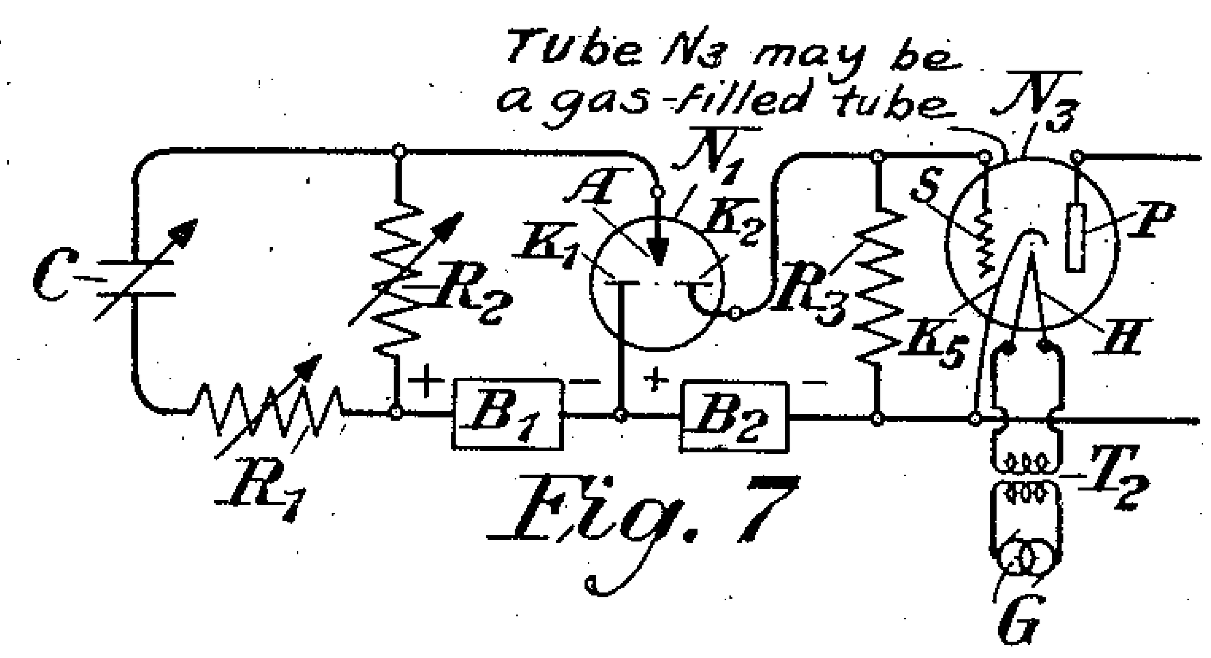

Fig. 7

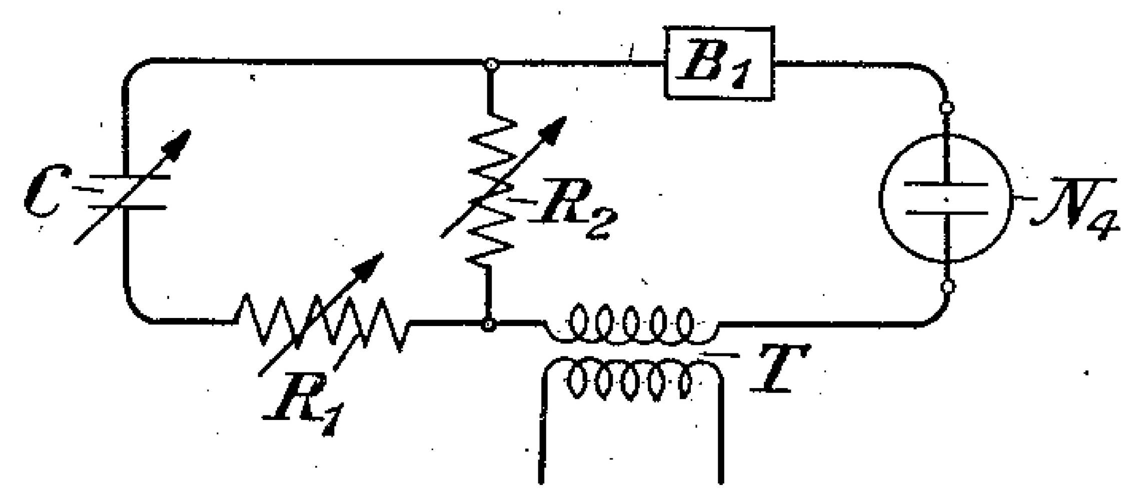

Fig. 8

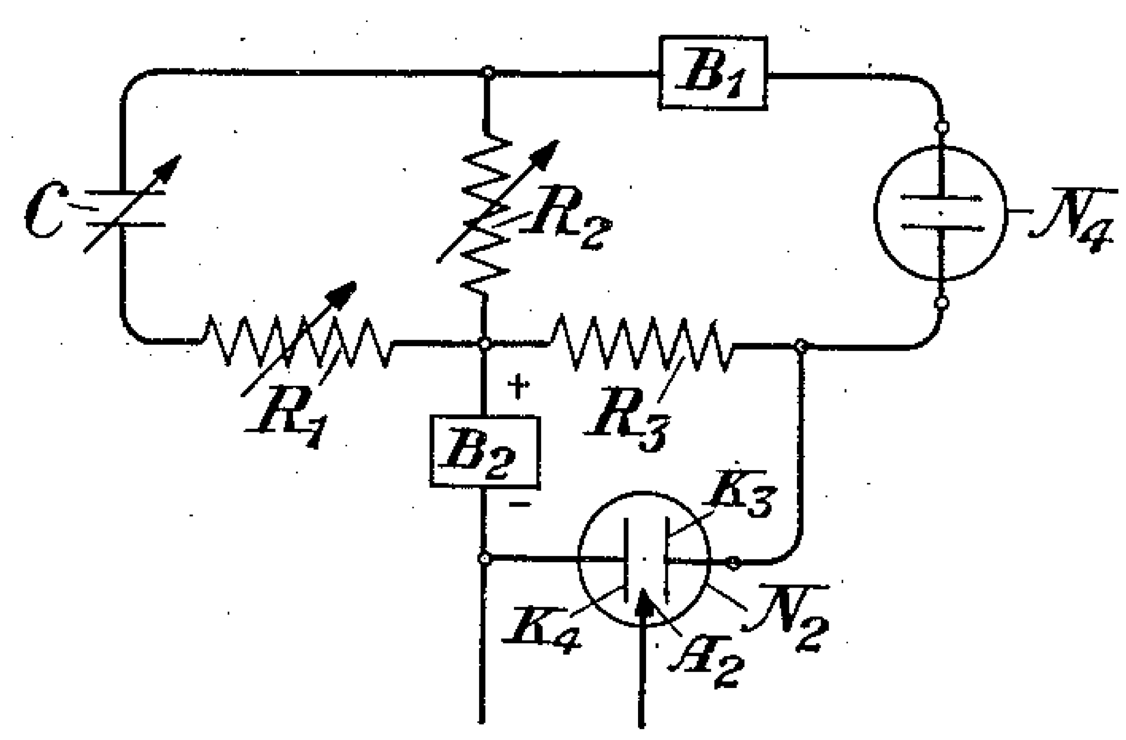

Fig. 9

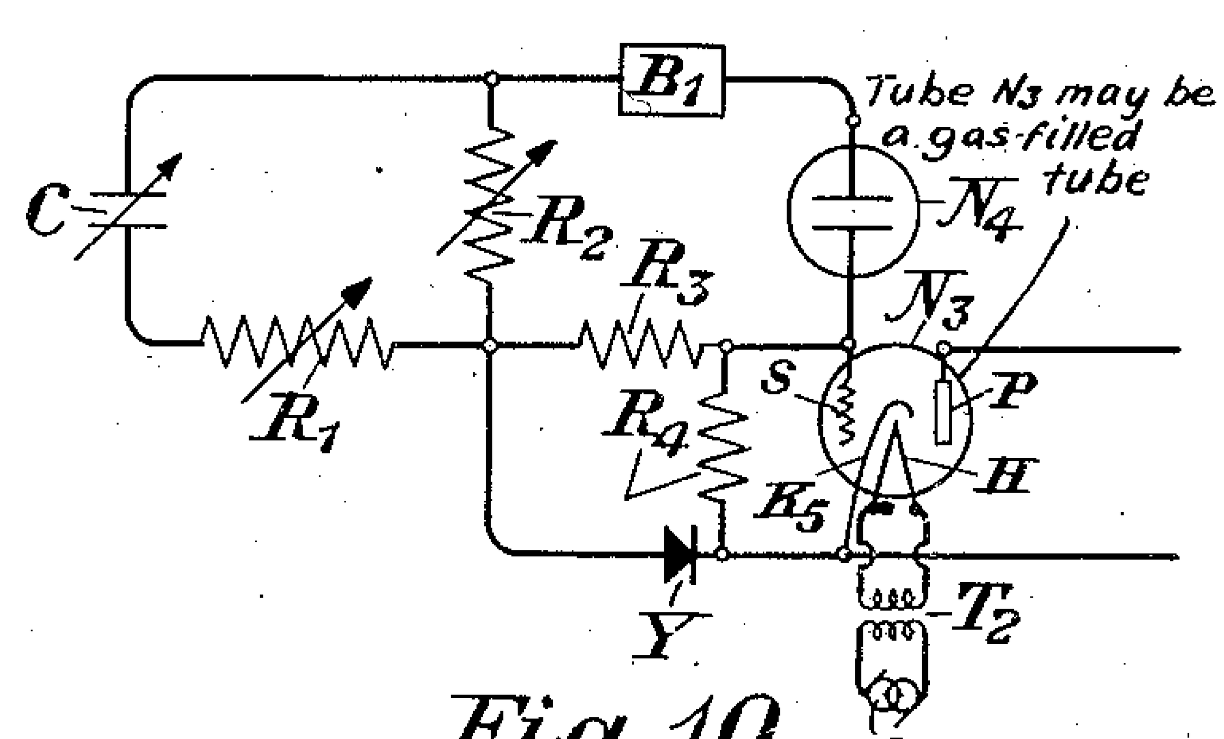

Fig. 10

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2,108,219

GAS TUBE CIRCUITS

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Application July 3, 1936, Serial No. 88,905

6 Claims. (Cl. 250—36)

This invention relates to gas-filled tubes and to circuits for gas-filled tubes.

More particularly, this invention relates to circuits employing gas-filled tubes for the production of oscillating or pulsating currents.

Still more particularly, this invention relates to circuits employing gas-filled tubes in which a source of potential such as a battery, and a condenser and resistor are connected to the electrodes of the tube or tubes for the purpose of producing tones or pulses for the timed operation of an electrical or other device.

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 embodiment of the invention for producing tones; Fig. 2 is a modification in which only flashes are produced in the gas-filled tube of the circuit; Fig. 3 illustrates how a relay may be periodically operated by the circuit; Fig. 4 shows another modification for the periodic operation of a relay; Fig. 5 illustrates a transformer arrangement through which are transmitted tones or electrical pulses; Fig. 6 shows two gas tubes arranged in tandem, the second tube of which may be connected to a load or electrical circuit; Fig. 7 illustrates a gas tube in tandem with a vacuum tube or hot cathode type of gas-filled tube; Fig. 8 shows an arrangement of a two-electrode gas-filled tube; Fig. 9 is a modification of Fig. 8 having an additional tube, the additional tube being of the three-electrode type; and Fig. 10 illustrates how the second tube may be a vacuum tube or a hot cathode type of gas-filled tube.

In Fig. 1 of the drawing, the condenser C is connected to a battery B_1 or other source of direct current potential through a resistor R_1 and the anode A and cathode K_1 of the tube N_1. The resistor R_2 is connected across these same two electrodes A and K_1 of the tube N_1 through the battery B_1. A pair of phones P—or other indicating device—may be connected between the cathodes K_1 and K_2 of the tube N_1.

The battery B_1 may have a terminal voltage exceeding the breakdown voltage between electrodes A and K_1 of the tube. This battery sends current through the resistor R_2 and over the path between the electrodes A and K_1 of the tube, thereby ionizing the gas within the tube. As current flows through resistor R_2 a corresponding voltage will be established thereacross and this voltage will be applied to the condenser C through the resistor R_1, the size of the latter resistor controlling the charging rate of the condenser. As a voltage becomes applied to the condenser C upon charge, this voltage will be transmitted to the electrodes A and K_1 of the tube N_1 in a direction which is the reverse of that produced by battery B_1. In other words, the voltage of the condenser C will oppose and diminish the effect of the voltage of battery B_1 upon electrodes A and K_1.

As the voltage across the condenser C reaches a value such that the voltage of battery B_1 is greater in its effect on electrodes A and K_1 than that of the condenser C by an amount which is less than the sustaining voltage value of the gas between these electrodes of the tube, the gas will become deionized. The gas will remain deionized until the voltage across electrodes A and K_1 again reaches the breakdown voltage between these electrodes.

When the gas within the tube N_1 becomes deionized, the impedance between electrodes A and K_1 will become very high—in fact, so high that battery B_1 will be unable to transmit current over resistor R_2 and through the tube. The only voltage across resistor R_2 will then be that produced by the discharge of condenser C which is in the direction opposing that of battery B_1, as already pointed out.

When the condenser C has discharged to such an extent that the voltage effect of battery B_1 on electrodes A and K_1 exceeds that produced by the condenser C by an amount equal to the breakdown voltage value between these electrodes, the gas of the tube will be again ionized. The condenser C will be recharged and when recharged to a sufficiently high voltage, the gas within the tube N_1 will become deionized again, as already explained. This ionization and deionization of the gas within the tube will recur regularly and periodically at an interval (or intervals) determined by the constants of the elements of the circuit.

The phones P are connected between the cathodes K_1 and K_2 of the tube N_1. When the gas of the tube is ionized, current will be transmitted from the battery B_1 through these phones over the path which includes the resistor R_2 and the anode A and catode K_2 of the tube. When the gas becomes deionized, the flow of current through phones P will cease. Thus tones will be heard in the phones P at regular and predetermined intervals.

In Fig. 2, the two cathodes of tube N_1 of Fig. 1 are connected together and are designated K. This tube N_1 may be replaced by any gas-filled tube of the two-electrode type, if so desired. No phones are connected in the arrangement of Fig. 2.

As in Fig. 1, the battery B_1 supplies a voltage between electrodes A and K through to resistor R_2 and this voltage will be sufficient to ionize the gas within the tube. The battery B_1 also supplies current to charge the condenser C. During gaseous ionization, the tube will be illuminated.

After condenser C becomes charged to a sufficient voltage, it will reduce the voltage effect of battery B_1 below the sustaining value of the tube. When this occurs, the gas of the tube will become deionized and the luminous glow of the tube extinguished. Thus the tube N_1 will flash at regular and predetermined intervals according to the ionization and deionization within the tube N_1.

Fig. 3 is a modification of Fig. 2 in which the battery B_1 is interposed between the upper terminal of resistor R_2 and the anode A of tube N_1 and, moreover, the winding of the relay W is connected between the lower terminal of the resistor R_2 and the cathode K of the tube.

While the battery is impressing a voltage between the electrodes of the tube, which is so much greater than that of the voltage at discharge of the condenser C that the gas of the tube becomes ionized, current will flow from the battery through the relay winding and operate the relay. As the net voltage across the electrodes of the tube becomes reduced below the sustaining voltage of the tube, the gas of the tube will become deionized and the relay will be released. Hence the armature of the relay will follow the ionization and deionization of the gas of the tube.

Fig. 4 is a modification of the arrangement of Fig. 3 in which the winding of the relay W is connected in the circuit between cathodes K_1 and K_2 of the tube N_1. Two separate batteries B_1 and B_2 are connected to the circuit, the battery B_1 being employed for supplying positive voltage to the anode A of tube N_1, the battery B_2 being placed in series with the relay winding and the electrodes K_1 and K_2 of the tube. It will be understood that the two batteries B_1 and B_2 may be but a single battery tapped in such a way as to exhibit the effect of the two individual batteries illustrated.

The battery B_1 will initiate ionization of the gas within the tube N_1 by applying a sufficiently high voltage between the electrodes A and K_1 of the tube and thereafter cause the condenser C to become charged to a progressively higher voltage. As the voltage charge of the condenser reaches a predetermined value, the voltage between the electrodes A and K_1 will then become insufficient to sustain ionization of the gas therebetween and the battery B_1 will therefore cease to supply further current to the circuit. During the interval when the gas of the tube is ionized, the battery B_2 will supply current through the winding of the relay W and over the path of the electrodes K_1 and K_2 of the tube and the relay will operate. Upon deionization of the gas, the battery B_2 will be of insufficient voltage to maintain the relay W operated and thereafter the latter relay will release. The two voltages derived from batteries B_1 and B_2 are insufficient per se to maintain gaseous ionization within the tube after deionization has occurred.

Fig. 5 is a modification of Fig. 4 in which a transformer T replaces the relay W. The primary of the transformer will be energized according to the ionization of the gas within the tube. Current will flow through the secondary winding of the transformer only when the primary winding becomes energized and this current will cease immediately after deionization of the gas has occurred.

Fig. 6 is a modification of the arrangements of Figs. 4 and 5 in which two tubes N_1 and N_2 are connected in tandem. The battery B_2 is connected in series with the resistor R_3 and cathodes K_1 and K_2 of the tube N_1. The resistor R_3 and battery B_2 are also connected across the electrodes K_3 and K_4 of the tube N_2. Anode A_2 of the tube N_2 is connected in a load or other circuit which may be supplied with current from the battery B_3 or other source.

In Fig. 6, the battery B_1 will initiate ionization of the gas within tube N_1 and at the same time cause the condenser C to become charged. Upon reaching a predetermined voltage at charge, the condenser C will so oppose and diminish the effect of the battery B_1 as to reduce the voltage between electrodes of A and K_1 below that required to sustain ionization of the gas therebetween.

During ionization of the gas within tube N_1, the battery B_2 will supply current over the path of resistor R_3 and the electrodes K_1 and K_2 of the tube N_1. The voltage across resistor R_3 and battery B_2 will also ionize the gas between cathodes K_3 and K_4 of the tube N_2 and the load circuit of anode A_2 will become operated.

During the interval when the gas of tube N_1 is deionized, no current will flow through the resistor R_3, the gas of tube N_2 will become deionized and the load circuit connected to the anode A_2 will not be operated.

As in Fig. 4, the batteries B_1 and B_2 may be a single source of potential and tapped, if desired, so as to exhibit the effect of two individual batteries or sources of potential. Moreover, a transformer of well-known type may replace the resistor R_3, as will be readily understood. Such a transformer may, for instance, include two windings as in Fig. 5, one of which is in series with the battery B_2 and the electrodes K_1 and K_2 of the tube N_1 and the other of which is connected across the electrodes K_3 and K_4 of the tube N_2 in series with the battery B_2. Furthermore, an audible or other signaling device may be connected in series with the anode A_2 of the tube N_2 for the purpose of audibly indicating the periodic operation of the tube N_1.

In Fig. 7, a hot cathode tube N_3 is substituted for the cold cathode, gas-filled tube N_2 of Fig. 6. Tube N_3 may be a vacuum tube or a gas-filled tube. The tube N_3 may include a grid S, a plate or anode P, a cathode K_5 and a heater H which is connected to one of the windings of the transformer T_2, the other winding of which may be connected to a source of alternating current G.

In Fig. 7, the resistor R_3 is connected between the grid S and the cathode K_5 of the tube N_3. The output or load circuit may be connected between the anode or plate P and the cathode K_5 of the tube.

When ionization of the gas of the tube N_1 takes place, the battery B_2 will send current through the resistor R_3 over the path of cathodes K_1 and K_2 of tube N_1. The potential across the resistor R_3 will result in ionization of the gas within tube N_3. Thereafter, current will freely flow through the load or output circuit of the tube N_3.

Fig. 8 is a modification of the arrangement shown in Fig. 2, in which a two-electrode gas-filled tube N_4 is employed, the electrodes of which are connected in series with the battery B_1 and the primary winding of transformer T, the latter series circuit being connected to the terminals of resistor R_2. The secondary winding of the transformer T may be connected to a load or other circuit. The tube N_4 will periodically flash as the voltage across its electrodes rises above the breakdown voltage of the tube and is thereafter lowered below the sustaining voltage of the tube. As in the case of Fig. 2, this flash will recur at regular and predetermined intervals. The load circuit may include a tone-producing device such as a pair of phones or any other translating device (not shown).

In Fig. 9 the resistor R_3 replaces the transformer T of Fig. 8. The resistor R_3 is connected through the battery B_2 to the cathodes K_3 and K_4 of the gas tube N_2. The anode A_2 and the cathode K_4 may be termed the output or load circuit of the tube N_2.

In Fig. 9 the tubes N_2 and N_4 will flash almost simultaneously, at regular and predetermined intervals, according to the constants of the circuits. Thus the load circuit of the tube N_2 may be operated periodically, according to the ionization and deionization of the gas within tubes N_2 and N_4.

Fig. 10 is a modification of the arrangement of Fig. 9, in which the tube N_2 is replaced by the hot cathode type of tube N_3. The resistor R_3 is connected between the grid S and the cathode K_5 through a rectifier Y which permits the grid or input circuit of the tube N_3 to be energized only by unidirectional current. A resistor R_4 is also connected between grid S and cathode K_5 as illustrated. The grid will be periodically polarized by the unidirectional current flowing through rectifier Y. The output or load circuit of the tube N_3 may be operated only when the grid S is properly polarized.

In all of the figures of the drawing, the operations are primarily governed by properly proportioning the condenser C, the resistances R_1 and R_2 and the value of the potential of the battery B_1 or other direct current source. When these elements are correctly proportioned, the gas tube N_1, for instance, whether it be of the two-element or three-element type, may be made to automatically reset itself at regular intervals.

In all of the arrangements shown, a glow is produced in the tube N_1 (or tube N_4). This glow disappears periodically. If the resistor R_1 is reduced to a practical nullity, the time of flash, as indicated by the illumination of the elements of the tube N_1 (or tube N_4), will be very short. The duration of the gaseous ionization or of this illumination may be controlled by increasing the value of the resistance R_1 so that the discharge time across the elements of the tube may be longer drawn out. Moreover, by adjustment of the resistance R_2, the interval between pulses may be regulated for a given value of the condenser C.

In these arrangements, a small amount of apparatus is required for producing tones or pulses or for the operation at periodic intervals of oscillographs or other apparatus which may be connected in the load or other circuits. Simple methods are thus available for the modulation of ringing currents, for example, or for the modulation of carrier frequencies at the rate at which ionization or deionization occurs within a gas tube. These arrangements may be employed for the regulation of the time at which signaling lights for the control of traffic may be operated or for operating other regulating devices or flashing devices and, moreover, these devices are especially applicable for the production of currents of very low frequencies.

The wave form produced by the apparatus is not purely sinusoidal and may be readily employed where the presence of harmonics will not be objectionable. However, a filter (not shown) may be connected to the circuit as, for example, across the secondary winding of transformer T of Figs. 5 and 8 or in the output or load circuits of any of the other figures such as 6, 7, 9 and 10. Such a filter will smooth out the wave form of the current generated by the system.

The battery B_2 may be poled in the direction indicated in the drawing. In other words, the battery B_2 is preferably poled in the same direction as battery B_1 so that both batteries will be in series with each other, the positive pole of battery B_2 being connected to the negative pole of battery B_1. However, such a polarity is not essential to the operation of the apparatus and the apparatus will operate as effectively if the polarity of battery B_2 is reversed, provided the battery B_2 does not produce too great a voltage.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that 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. The combination of a condenser, a resistor shunting the condenser, a three-electrode gas-filled tube, and a source of potential connected in series both with two of the electrodes of the tube and said resistor and having a potential which exceeds the breakdown voltage between said two electrodes of the tube, and an indicating device having a single pair of terminals connected between one of said two electrodes and the third electrode of said tube and responsive to the ionization of the gas within the tube.

2. The combination of a gas-filled tube having a plurality of electrodes, a condenser, a source of direct voltage which exceeds the breakdown voltage of the tube and connected in series with two of the electrodes of said tube and said condenser, means responsive to the application of voltage from said source for producing ionization of the gas within the tube and then for charging the condenser to a progressively higher voltage, means responsive to the attainment of a predetermined voltage at charge across the condenser for deionizing the gas within the tube, a resistor through which the condenser discharges to reduce the voltage across the condenser after the gas has become deionized, and a device connected between one of said two electrodes and a third electrode of said tube for indicating and responding to the ionization or deionization of the gas of said tube.

3. Automatic pulse-producing apparatus comprising parallel elements of resistance and capacitance, a gas tube of three electrodes, a source of potential connected in series with two of the electrodes of said tube and with said elements and having a voltage which exceeds the breakdown voltage of the tube, said condenser being periodically charged by said source to a predetermined voltage, said resistor forming a path to periodically discharge the condenser after the gas within the tube has become deionized, and a pulse responsive indicating device connected between

one of said two electrodes and the third electrode of said tube.

4. The combination of a condenser, first and second resistors which are connected in series with each other and in series with said condenser, a three-electrode gas-filled tube, a source of potential connected in series with two of the electrodes of the tube and said second resistor and having a potential which exceeds the breakdown voltage between said two electrodes of the tube, and an indicating device having a single pair of terminals connected between one of said two electrodes and the third electrode of said tube and responsive to the ionization of the gas within the tube.

5. The combination of a gas-filled tube having a plurality of electrodes, a condenser, a resistor, and a source of direct voltage which exceeds the breakdown voltage of the tube and connected in series both with said condenser and resistor and with two of the electrodes of said tube, means responsive to the application of voltage from said source for producing ionization of the gas within the tube and then for charging the condenser to a progressively higher voltage, means responsive to the attainment of a predetermined voltage at charge across the condenser for deionizing the gas within the tube, a second resistor through which the condenser discharges to reduce the voltage across the condenser after the gas has become deionized, and a device connected between one of said two electrodes and a third electrode of said tube for indicating and responding to the ionization or deionization of the gas of said tube.

6. Automatic pulse-producing apparatus comprising first and second elements of resistance and an element of capacitance all connected in series with each other, a gas tube of three electrodes, a source of potential connected in series with two of the electrodes of said tube and with said first element of resistance and with said condenser, said source having a voltage which exceeds the breakdown voltage of the tube, said condenser being periodically charged by said source to a predetermined voltage, said second element of resistance forming a path to periodically discharge the condenser after the gas within the tube has become deionized, and a pulse-responsive indicating device connected between one of said two electrodes and the third electrode of said tube.

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