

Jan. 25, 1938.

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2,106,286

GAS-FILLED TUBE CIRCUITS

Original Filed Nov. 5, 1935

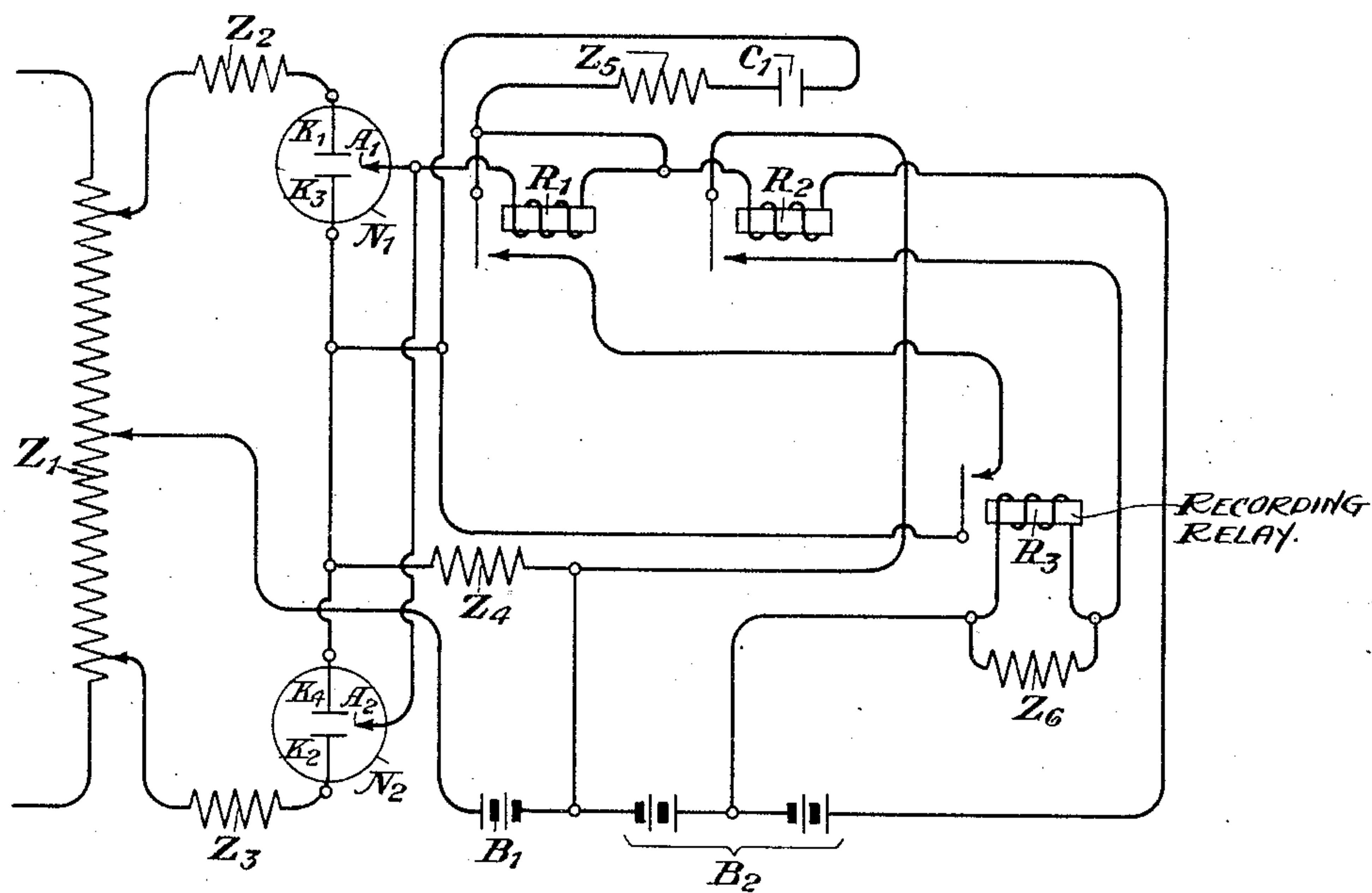


Fig. 1

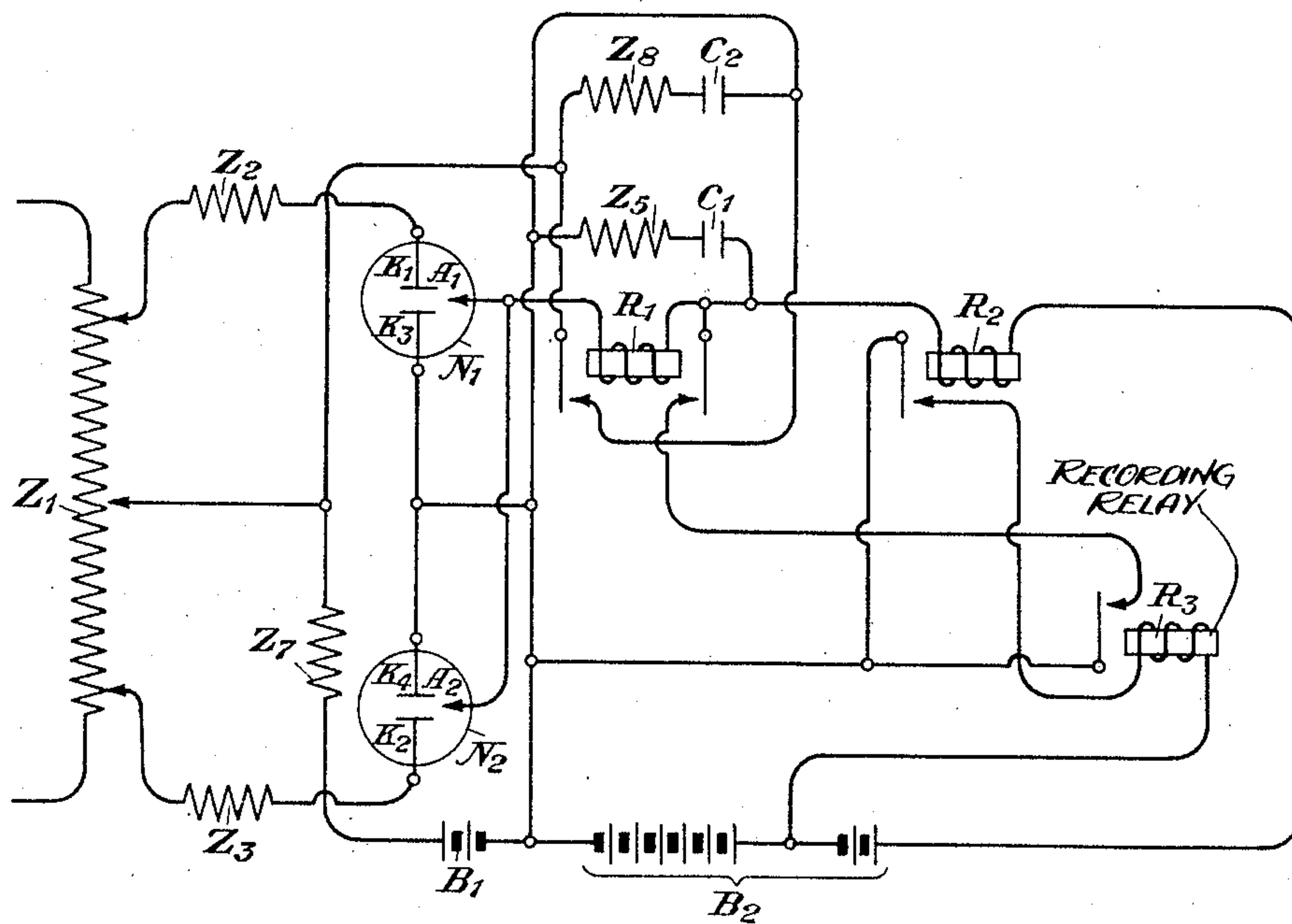


Fig. 2

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2,106,286

GAS-FILLED TUBE CIRCUITS

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Application November 5, 1935, Serial No. 48,379
Renewed November 30, 1937

11 Claims. (Cl. 175—320)

This invention relates to electrical circuits and systems. More particularly, this invention relates to recording systems and is intended to be especially useful for recording electrical voltages. The apparatus and circuits of this invention are applicable to record steep wave front voltages and will record direct voltages as well as alternating voltages of steep wave front.

This invention also relates to gas-filled tubes and to circuits for gas-filled tubes. More particularly, this invention relates to arrangements for measuring voltages or currents and obtaining measurements from low voltages applied to the measuring apparatus through cold cathode gas-filled tubes.

Cold cathode gas-filled tubes generally require fairly high potentials to ionize the gas between their electrodes. Such high potentials may be obtained through the use of input transformers or through biasing sources of potential or both. The use of input transformers in measuring circuits is undesirable especially for measuring or recording steep wave front impulses and transients, due to the change in the wave form the transformer will produce for frequencies outside of its normal operating range, this change arising from the non-linear characteristics of the transformer. If on the other hand biasing potentials are employed to reduce the initial operating voltage, which exceed the sustaining voltage between the input electrodes of the tube, special means must be employed to restore the gas to its deionized condition after withdrawal of the applied voltage. In accordance with this invention, the biasing potentials exceed the sustaining voltage of the tube and the output circuit includes special circuits to restore the gas to its original deionized state. Moreover, even though the output circuit may include arrangements for deionizing the gas, yet where the applied voltage at the input exceeds the sustaining voltage, the invention further provides means for temporarily reducing the voltage in the input circuit of the tube below the sustaining value. To accomplish this latter feature, a resistance or resistance and condenser may be inserted into the input circuit of the tube to produce a potential drop across its terminals upon the passage of current there-through for counteracting the effect of the biasing potential.

The invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing which shows two embodiments of the invention merely for the purpose of illustration.

In Figure 1, an impedance Z_1 is bridged across the input circuit. The outer adjustable terminals are connected to the cathodes K_1 and K_2 of gas-filled tubes N_1 and N_2 which may be of the hot or cold cathode type, the interconnecting circuit including resistors Z_2 and Z_3 which are employed to limit the current applied to these cathodes. The source of potential B_1 is connected between a point approximately midway between the terminals of impedance Z_1 and the cathodes K_3 and K_4 of the two tubes through a resistor Z_4 . The latter source of potential is greater than the sustaining voltage of the tubes but less than the voltages required to start gaseous ionization within these tubes. Source B_1 is employed to bias the cathodes K_1 and K_2 with respect to the corresponding electrodes K_3 and K_4 and it reduces the voltage supplied by the input circuit through impedance Z_1 required to initiate gaseous ionization within the tubes.

The anodes A_1 and A_2 of tubes N_1 and N_2 respectively are connected together and are part of a so-called work circuit which includes the windings of relays R_1 and R_2 , the battery or other source B_2 and the impedance Z_4 . The terminal common to the windings of relays R_1 and R_2 is connected to the cathodes K_3 and K_4 through a resistor Z_5 and a condenser C_1 .

The relay R_1 is a vibrating relay and it operates to suppress the voltage in the work circuit and hence to deionize the gas within both tubes. This is described in more detail in my Patent 1,977,256 issued October 16, 1934. The relay R_2 acts as a work relay and it operates recording mechanism relay R_3 , as will be subsequently described. The relay R_3 has its winding in a circuit which includes the armature and contact of relay R_2 and the source B_2 . The current in the winding of relay R_3 is controlled by the resistor Z_6 . The relay is nevertheless under the control of relay R_2 .

The relay R_3 is of a slow-acting type, its armature closing its associated contact slowly. As the armature and contact of relay R_3 are in the resetting circuit of the tubes N_1 and N_2 , the delay so introduced is for the purpose of providing ample time for the recording mechanism, of which relay R_3 is a part, to operate properly. The resetting circuit just referred to includes the armature and contact of relay R_3 , the armature and contact of relay R_1 and the parallel circuit which includes the winding of the latter relay as one branch and the resistor Z_5 and condenser C_1 as the other branch.

The arrangement of Fig. 1 operates as follows: The potential impressed across impedance Z_1 is

divided into two parts which are applied through resistors Z_2 and Z_3 to the cathodes K_1 and K_3 and K_2 and K_4 respectively of the tubes N_1 and N_2 . The potential impressed upon one of these pairs of cathodes will be aided by the potential of source B_1 and the other potential will be opposed by that of B_1 . If it be assumed that the potential applied to impedance Z_1 is an alternating potential and of a sufficient magnitude, then the gas within both tubes will become alternately ionized by the incoming potential. Upon the ionization of tube N_1 , current will flow through the work circuit which includes, among other things, the windings of relays R_1 and R_2 and the anode A_1 and the cathode K_3 of tube N_1 . Both of the relays R_1 and R_2 will operate and the operation of relay R_2 will cause relay R_3 to operate. The armature and contact of relay R_3 complete a circuit as follows: The armature and contact of relay R_3 , the contact and armature of relay R_1 , the winding of relay R_1 , the anode A_1 and the cathode K_3 of the tube N_1 back to the armature of the relay R_3 . This circuit will withdraw potential from the winding of relay R_1 and hence reduce the potential between the anode A_1 and cathode K_3 to a value less than that required to sustain the glow between these electrodes of the tube. At the same time the current through the winding of relay R_2 is increased because all of the potential B_2 is applied thereto. The latter current also flows through resistor Z_4 and is in a direction to oppose that produced by source B_1 and applied to the cathodes K_1 and K_3 of tube N_1 . As the increased biasing potential exceeds the sustaining voltage at the input electrodes of the tube, this counter voltage of course materially reduced the potential between the cathodes K_1 and K_3 below the sustaining voltage and, in the absence of additional voltage at the input circuit, i. e. applied from the input circuit across the upper half of impedance Z_1 , the glow between electrodes K_1 and K_3 will be extinguished. Upon deionization of the gas within tube N_1 , potential becomes removed from the winding of relay R_1 , the armature of the latter relay will leave its contact and the potentials of sources B_1 and B_2 will be restored to the anode A_1 and cathode K_3 and K_1 of tube N_1 . If, however, potential is still applied across impedance Z_1 , gaseous ionization within tube N_1 will re-occur and the relay R_1 will reoperate.

Thus, relay R_1 vibrates continuously while voltage is applied from the input circuit and holds relay R_2 continuously operated which in turn holds relay R_3 continuously operated. However, when the armature of relay R_1 leaves its contact and on disappearance of the voltage applied by the input circuit, the tube N_1 becomes deionized and remains deionized and relays R_2 and R_3 restore to normal.

The same sequence of events occurs when the potential applied by the input circuit is reversed in polarity except that the electrodes of tube N_2 are brought into the operating circuits.

The resistor Z_5 and condenser C_1 function to absorb the voltage set up by the winding of relay R_2 when the armature of relay R_1 leaves its contact. Absorption of this voltage is required in order to prevent reionization of the gas within either tube on account of the addition of the voltage drop produced across the winding of relay R_2 to that of source B_2 .

In Fig. 2 the relay R_1 includes an additional armature at the left. This armature is connected to the center top of impedance Z_1 . The contact

of this additional armature is connected to the negative terminal of source B_1 . A resistor Z_7 is inserted between the positive terminal of source B_1 and the center top of impedance Z_1 .

Upon the operation of relay R_1 , the closure of the right hand contact of the relay will complete a circuit, such as already described with respect to Fig. 1, to deionize the gas between the electrodes A_1 and K_3 of tube N_1 or between the electrodes A_2 and K_4 of tube N_2 , these electrodes being in the work circuit. Upon the closure of the left hand contact of relay R_1 , the potential applied between the two cathodes of each tube will, in the absence of additional voltage across impedance Z_1 , be reduced practically to zero and the gas between these cathodes will become deionized. The resistor Z_8 and condenser C_2 may be connected across the left hand armature and contact of relay R_1 , as shown, in order to prolong the time in which the voltage across both pairs of cathodes is maintained below the sustaining voltage to insure complete gaseous deionization between these cathodes.

Although 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 appended claims.

What is claimed is:

1. The combination of a gas discharge tube having input and output circuits connected to its electrodes, the electrodes of the tube forming a plurality of discharge paths one of which extends to the input circuit and another to the output circuit, means including sources of voltage connected respectively in the input and output circuits for ionizing the gas between all of the discharge paths of the tube, and means responsive to the discharge of the gas in the output circuit for simultaneously de-ionizing the gas within all of the discharge paths formed by the electrodes to which both circuits are connected, said means being connected to the output circuit.

2. The combination of a gas-filled tube having three electrodes, an input circuit connected to two of the tube's electrodes through which voltage may be applied to ionize the gas within the tube, an output circuit including a source of voltage connected between the third electrode and one of the other electrodes of the tube, and means responsive to ionization of the gas within the tube for feeding voltage in the output circuit back to the input circuit to reduce the effective voltage of the input circuit below the value required to sustain gaseous ionization within the tube.

3. The combination of a gas-filled tube having three normally cold electrodes, an input circuit connected to two of the electrodes, an output circuit connected to the third electrode and one of the other electrodes, two sources of potential one of which is connected to the input circuit and the other to the output circuit, and means connected to the output circuit for periodically deionizing the gas between all of the electrodes of said tube.

4. The combination of a gas-filled discharge tube having at least three electrodes to which input and output circuits are connected, individual sources of potential in said input and output circuits, and means responsive to the energization of the output circuit for continuously

and periodically reducing the effective voltage of both of said sources of potential.

5 5. The combination of a three-electrode gas-filled tube, a source of potential, an impedance connected in series with said source between two of the tube's electrodes, a second source of potential, a work circuit including said impedance and said second source of potential and connected between the third electrode and one
10 of the other electrodes, means for continuously transmitting pulsating current through said work circuit, and means for periodically deionizing the gas between all of the electrodes of the tube, said means being connected to said work
15 circuit.

6. The combination of a gas-filled tube having electrodes, a source of potential for biasing one of the electrodes with respect to another electrode to a potential exceeding the sustaining voltage between said electrodes, a second source
20 of potential, a load circuit connected to the third electrode and one of the other electrodes and including said second source of potential, said load circuit including means for periodically deionizing the gas between the electrodes to
25 which said load circuit is connected and for simultaneously neutralizing the voltage of said source.

7. The combination of a three-electrode gas-filled tube, voltage biasing means connected between two of the electrodes and of a value exceeding the sustaining voltage therebetween, a source of potential, a work circuit connected between the third electrode and one of the other
35 electrodes and including said source of potential, and means for periodically deionizing the gas between the two electrodes to which the work circuit is connected, said means including means connected to said work circuit for periodically deionizing the gas between the first two
40 electrodes.

8. Voltage recording apparatus comprising a three-electrode gas-filled tube, an impedance to which incoming voltages are applied, a source
45 of potential connected to said impedance and to two of the tube's electrodes, a vibrating relay, a load device, a recording relay, a second source of potential supplying current through the wind-

ing of the vibrating relay and the third electrode and one of the other electrodes of the tube to said load device, means responsive to flow of current to said load device to operate the recording relay, and means connected to the armature and contact of said vibrating relay to periodically nullify the effect of both sources of potential.

9. The combination of a three-electrode gas-filled discharge tube, a source of potential exceeding the sustaining voltage value but below the breakdown voltage value connected to two of the tube's electrodes, a similar source connected to the third electrode and one of the other electrodes, means responsive to the ionization of the gas within the tube to periodically reduce the effective potential of both sources below the sustaining voltage value, said means being connected to the aforementioned circuit extending to said third electrode and said other
20 electrode.

10. The combination of a three-electrode gas-filled tube, input and output circuits each connected to two of the tube's electrodes one of which is common to both circuits, two sources of potential connected respectively to said input and output circuits the magnitudes of which exceed the sustaining voltage value between the electrodes to which each circuit is connected, and means responsive to the application of additional voltage to the input circuit to simultaneously, synchronously and periodically deionize the gas between the two pairs of electrodes, said means including means for feeding voltage from the output circuit to the input circuit to reduce the effective voltage of the input circuit..

11. In a circuit having a three-electrode gas-filled tube providing two discharge gaps, two sources of potential one for each gap, the magnitude of each of said sources exceeding the voltage required to sustain glow in its corresponding gaps, and means for periodically extinguishing the glow of each gap, said means including means for returning potential across one gap to the circuit of the other gap to reduce the effective potential across the latter gap.

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