

March 3, 1936.

L. K. SWART

2,032,514

GAS FILLED TUBE AND CIRCUIT THEREFOR

Filed June 1, 1935

2 Sheets-Sheet 1

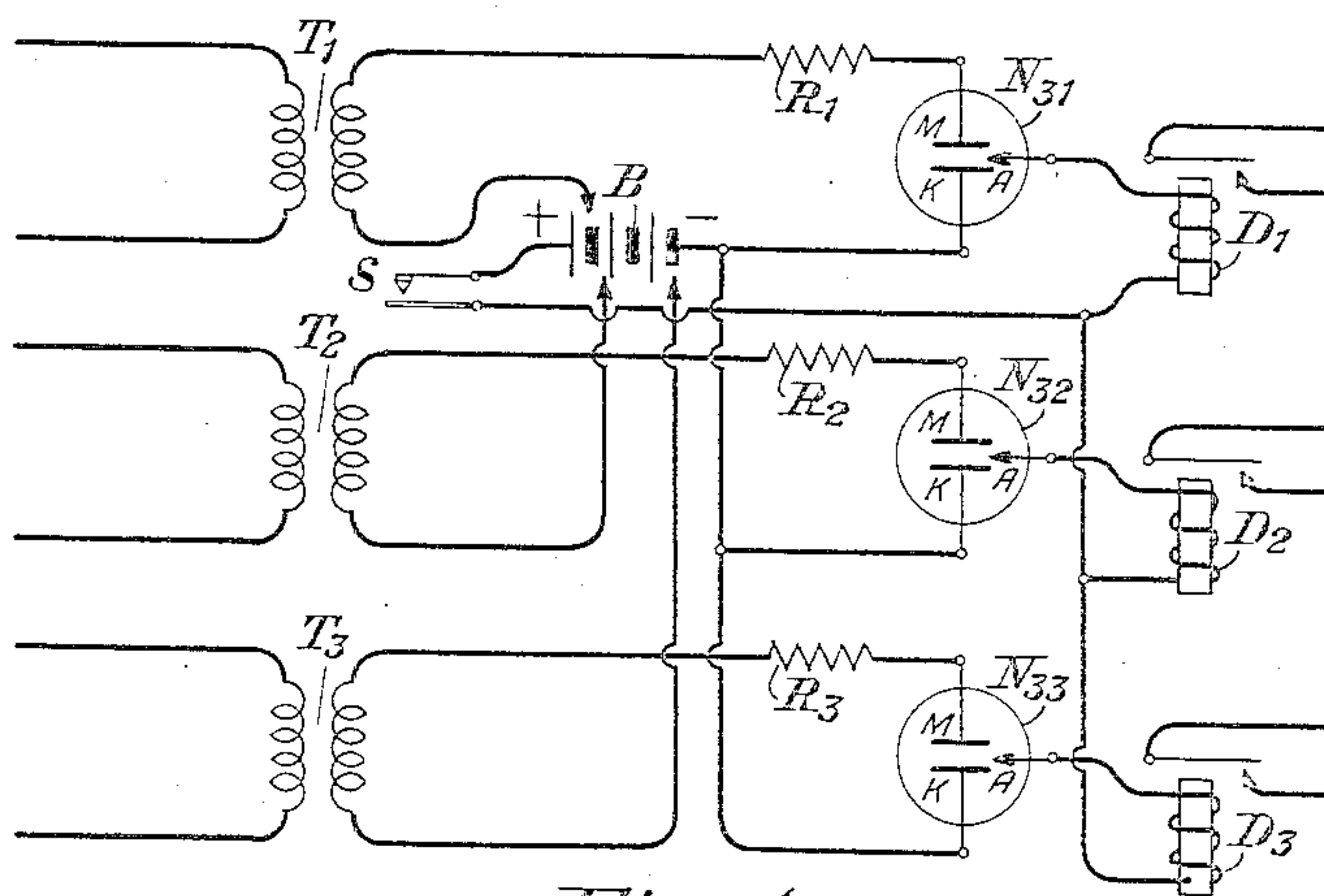


Fig. 1

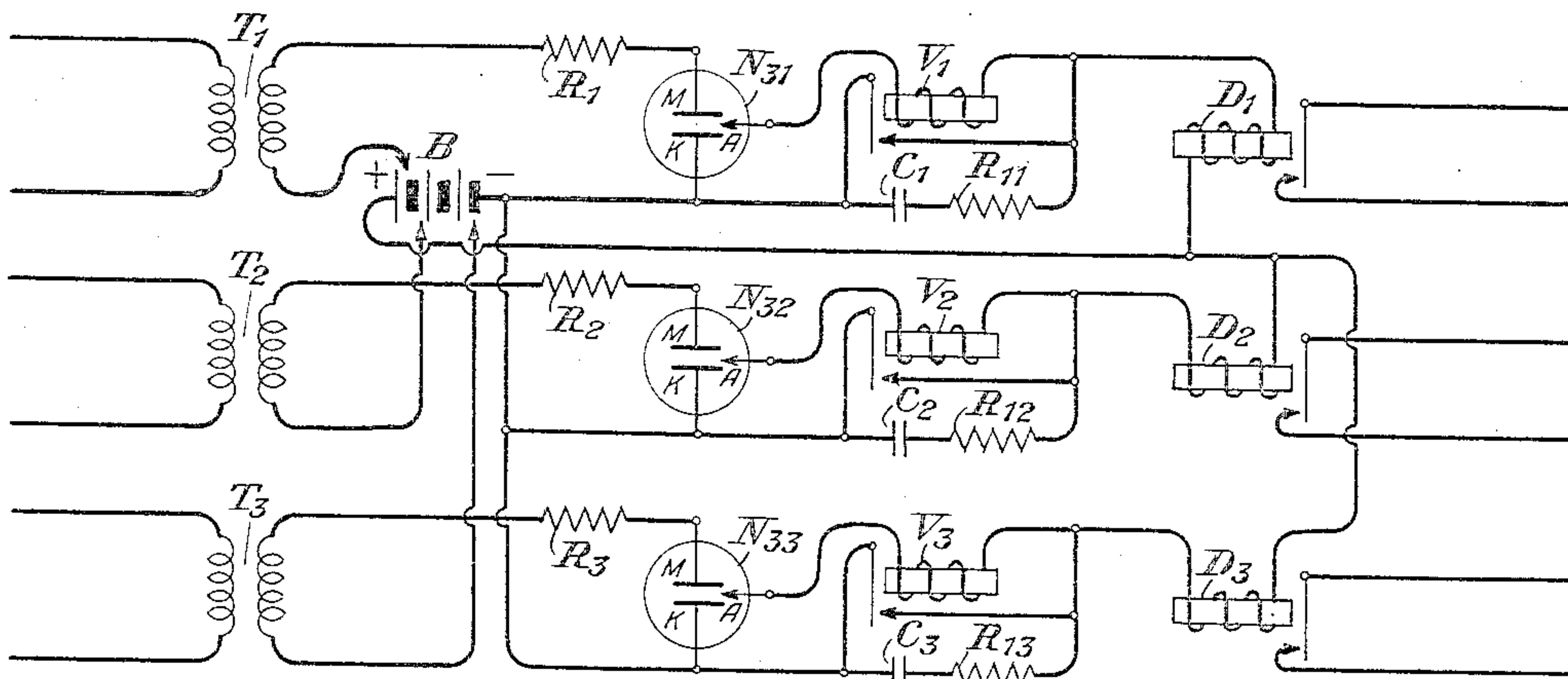


Fig. 2

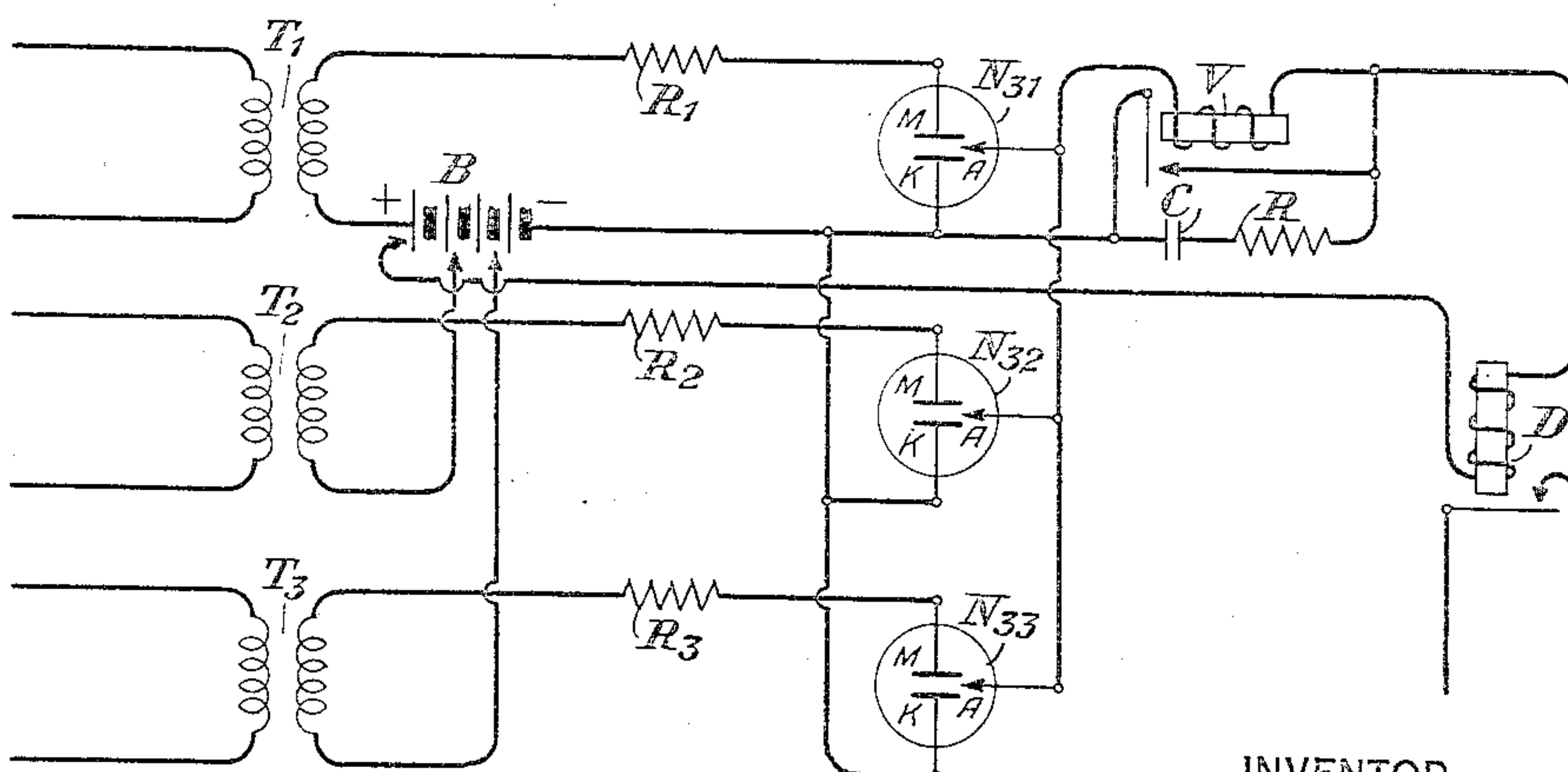


Fig. 3

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2 Sheets-Sheet 2

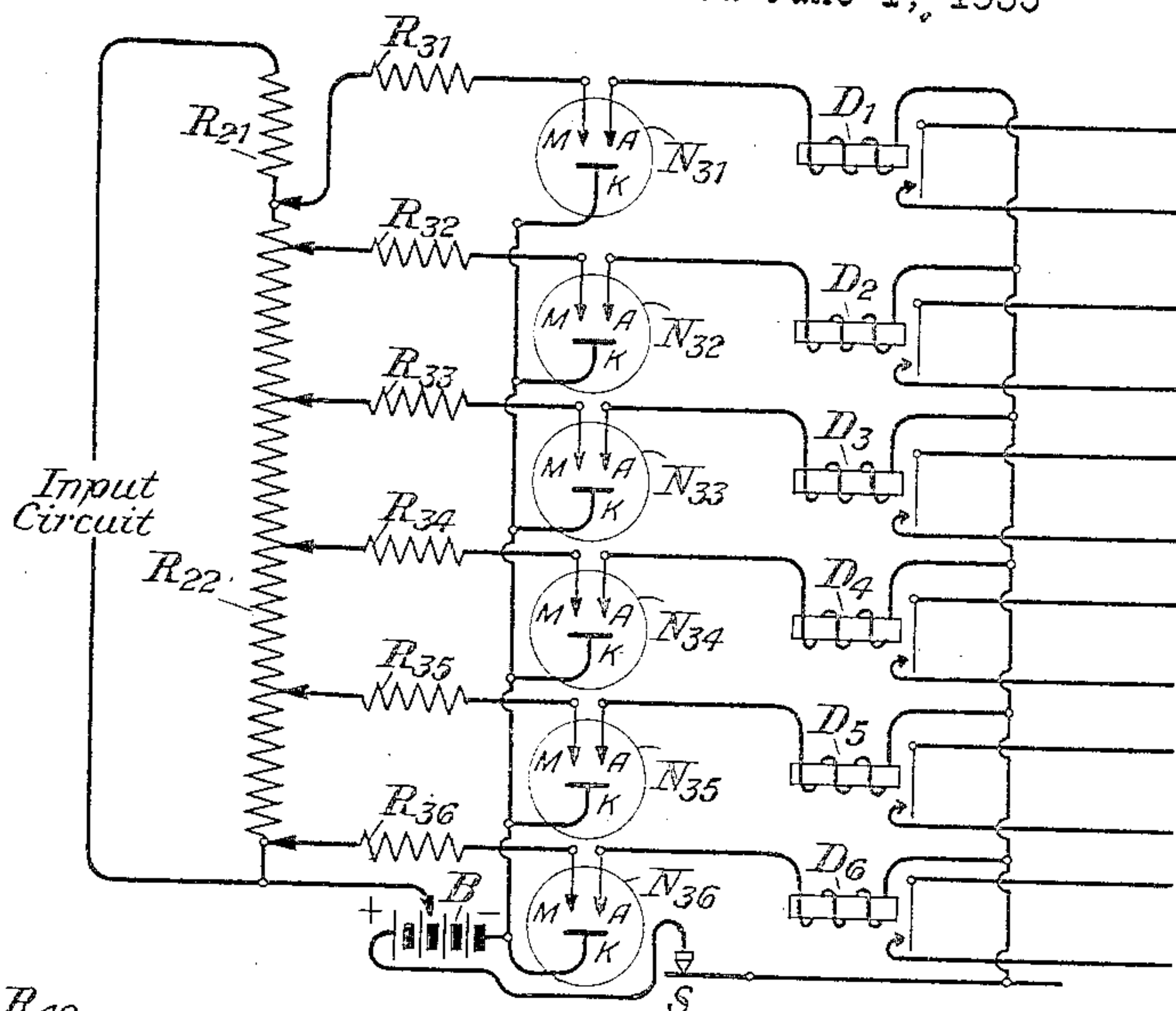


Fig. 4

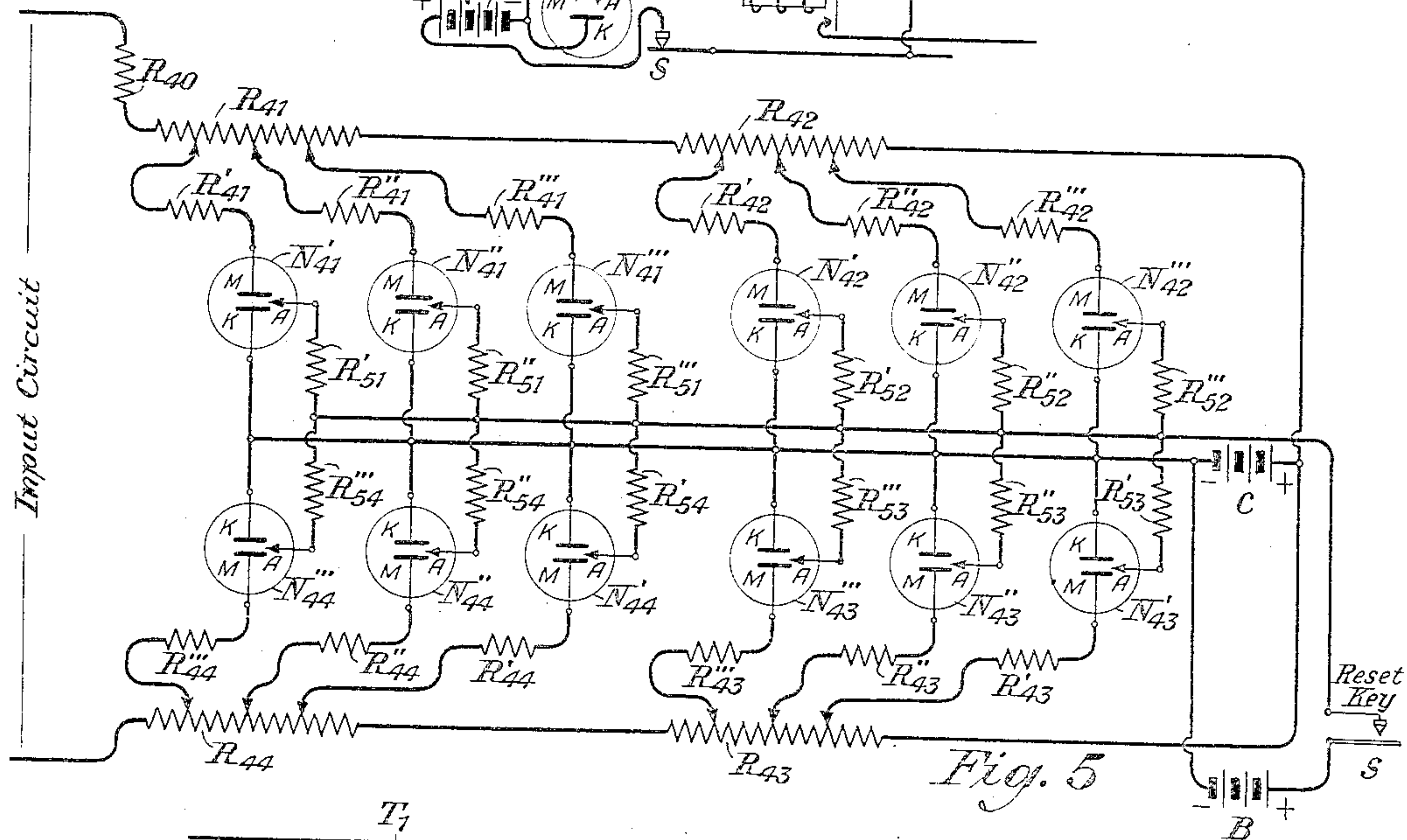


Fig. 5

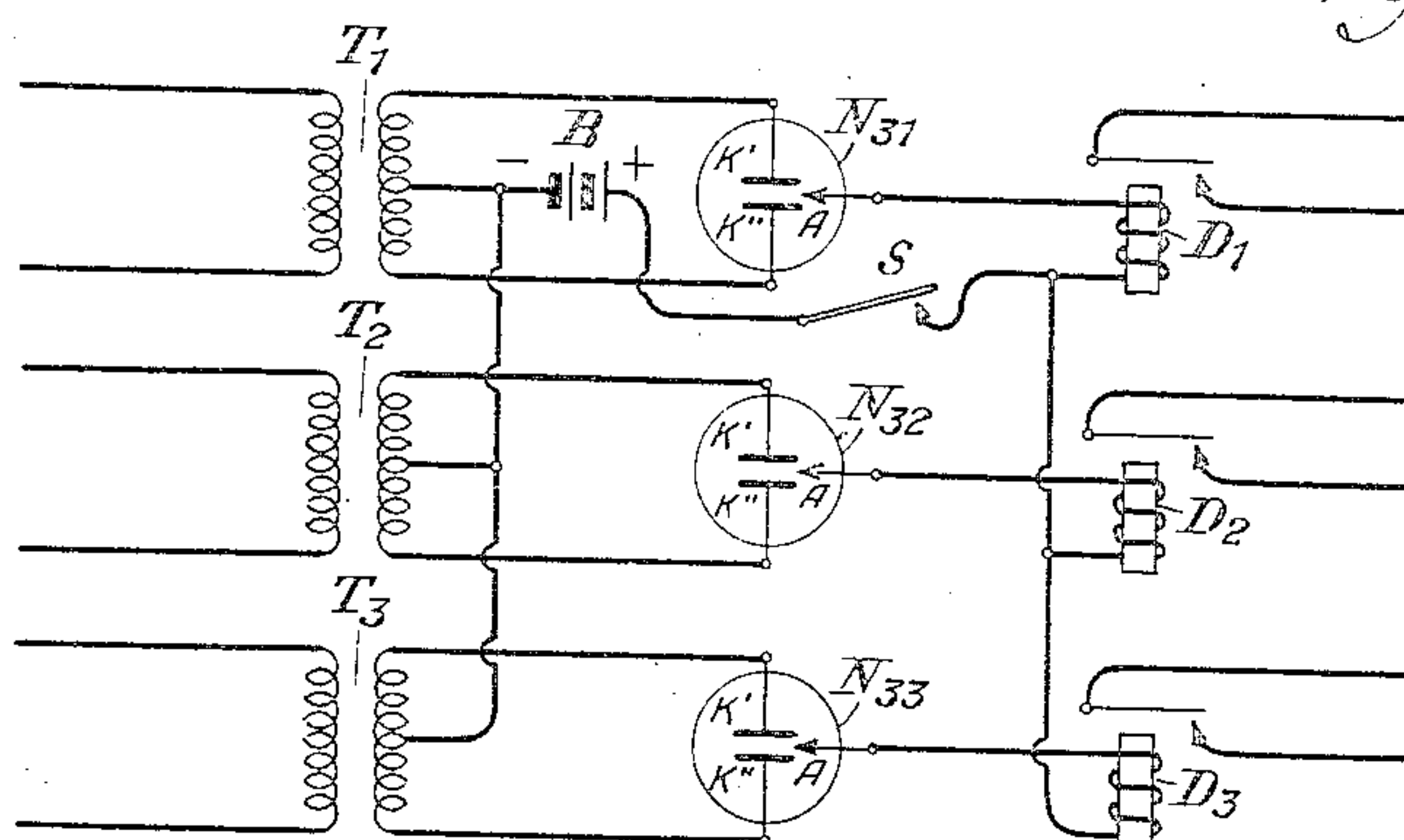


Fig. 6

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2,032,514

GAS-FILLED TUBE AND CIRCUIT
THEREFOR

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Application June 1, 1935, Serial No. 24,550

6 Claims. (Cl. 250—27)

This invention relates to electrical translating devices and circuits. This invention also relates to gas-filled tubes of the hot cathode type and of the cold cathode type and to circuits therefor.

5 This invention further relates to such circuits as may employ a common source of potential, for example, for biasing any or all of the various tubes and a common source of potential, for example, in its work circuit for the purpose of op-
10 erating any or all of the translating devices associated with the gas-filled tubes. This invention further relates to circuits which employ a single source of potential which may be employed both for biasing the gas-filled tubes and for pro-
15 viding the potential in its work circuit required to actuate the translating device or devices associated with the various gas-filled tubes.

In gas-filled tubes of the hot cathode type, the biasing potential associated with each tube generally is poled so as to be positive with respect to the cathode and negative with respect to the auxiliary electrode. In accordance with this invention, this formal arrangement will be modified so that the applied potential may always be positive with respect to the anode and negative with respect to the cathode in the work circuit and a single source of potential will be provided which will produce the biasing means, i. e. for biasing the auxiliary electrode with respect to the cathode
25 and for producing the current required to operate the work circuit which at the same time will maintain the anode positive with respect to the cathode. The biasing potential for such an arrangement may, for example, be poled so as to be negative with respect to the cathode and positive with respect to the auxiliary electrode, contrary to the general and usual practice.

By biasing a tube as just outlined, the bulk of the current may be made to pass from the anode to the cathode and little, if any, current will pass from the anode to the auxiliary electrode. In many systems involving high impedance input circuits, where a plurality of auxiliary electrodes are connected to the same input
35 circuit, it becomes desirable that virtually all of the current be confined to the circuit extending between the anode and the cathode and that little, if any, pass from the anode to the auxiliary electrode or electrodes.

50 In accordance with this invention, a plurality of gas-filled tubes are employed, all of which use the same biasing potential and a common potential in their work circuit. And furthermore, means are provided for resetting a plurality of translating devices such as relays connected to the various gas tubes but in certain arrangements of this invention a common source of potential is employed both for the work circuit and for the biasing means of the input circuit. And
60 still furthermore, a single translating device may

be used and it may be coupled to a single resetting circuit arranged with respect to a plurality of gas-filled tubes operated from a plurality of input circuits or sources of energy and employing but a single source of potential both
5 for biasing purposes and for the work circuit.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawings in which Figure 1 represents one embodiment of the invention in which three input
10 circuits are coupled to a corresponding number of translating devices through various gas-filled tubes; Figure 2 shows a modification of this arrangement in which each gas tube is provided with an individual resetting circuit; Figure 3
15 shows another modification in which a single automatic resetting circuit is provided in connection with a plurality of tubes and Figures 4, 5 and 6 represent still further embodiments of
20 the invention.

Referring to Figure 1, the transformers T₁, T₂ and T₃ are associated with individual input circuits or sources of energy and the secondaries of these transformers are each connected with
25 two of the electrodes M and K of the corresponding gas-filled tubes N₃₁, N₃₂ and N₃₃, the upper terminals of these windings being connected to the corresponding electrodes M through individual resistors R₁, R₂ and R₃, the lower terminals of these secondaries extending to the
30 cathodes K through individual adjustable taps of a local source of potential such as the battery B, as shown. The negative terminal of the battery B is connected to the cathodes K of all of
35 the tubes N₃₁, N₃₂ and N₃₃ and the various taps are used to apply any desired positive potential to the auxiliary electrodes M.

The positive terminal of the battery B is connected through an interruptor or switch S to the
40 lower terminals of a plurality of translating devices which are shown in the form of relays designated D₁, D₂ and D₃, the upper terminal of the windings of these relays being connected to the corresponding anodes A of the tubes N₃₁, N₃₂
45 and N₃₃. Although the translating devices are shown in the form of relays, it will be readily understood that these devices may take any other desirable form. It will be further understood that the armature and contact of each of the
50 devices D₁, D₂ and D₃ control individual output circuits.

It will be noted that the potential applied by the battery B to the various auxiliary electrodes M of the tubes N₃₁, N₃₂ and N₃₃ is adjustable but
55 this applied potential is so poled as always to be positive with respect to the corresponding cathodes. Voltages obtained from the various input circuits or sources of energy and transmitted through the transformers T₁, T₂ and T₃, if of
60

proper polarity, boost the potential derived from the tap of the battery B to such a value as to cause ionization of the gas between the auxiliary electrode M and the cathode K of any one or all of these tubes. When ionization of the gas is thus produced, it will permit current to pass from the battery B through the circuit or circuits which include the windings of the various relays D₁, D₂ and D₃ and the corresponding anodes A of the various tubes. Thus, those relays operate which are connected to tubes in which ionization has taken place and the corresponding output circuits of such devices also become operated.

In order to deionize the gas between electrodes A and K within any or all of the tubes so previously ionized, it is merely necessary to open the circuit at the switch S. To deionize the gas between electrodes M and K within any or all of the tubes so previously ionized, the potential impressed between these electrodes M and K must fall to a value below the sustaining value of glow between said electrodes. Subsequent closure of the switch S will bring about operation of only such of the translating devices D₁, D₂ and D₃ as are connected to input circuits or sources of energy which continue to provide sufficiently high and properly poled potential to the electrodes M and K.

In Fig. 2, three input circuits are connected through the transformers T₁, T₂ and T₃ and through resistors R₁, R₂ and R₃, respectively, to the electrodes M and K of the tubes N₃₁, N₃₂ and N₃₃ as in Fig. 1 and here, also, the source of potential or battery B may be tapped as desired to bias the various auxiliary electrodes M to suitable positive potentials with respect to the corresponding cathodes K. The positive terminal of the battery B is connected to one terminal of each of the windings of the translating devices or relays D₁, D₂ and D₃ and the other terminals of these devices are connected through the windings of vibrating relays V₁, V₂ and V₃, respectively, to the anodes A of the corresponding tubes N₃₁, N₃₂ and N₃₃. The armature and contact of each vibrating relay are connected, respectively, to the cathode K of the corresponding tube and to the contact common to the windings of the associated translating device and vibrating relay, as shown. Moreover, a condenser and resistor are bridged across the armature and contact of each vibrating relay. Thus, the condensers C₁, C₂ and C₃ and the resistors R₁₁, R₁₂ and R₁₃ are connected, respectively, in series with each other between the armature and contact of the associated vibrating relay.

The common source of potential B supplies the energy required to operate all of the translating devices or relays D₁, D₂ and D₃ as well as all of the vibrating relays V₁, V₂ and V₃. This same source of potential also serves as a biasing means for the auxiliary electrodes M of all of the tubes N₃₁, N₃₂ and N₃₃ and at the same time it aids in producing gaseous ionization in any one or all of these tubes.

The potential applied to the primary windings of any one or all of the various transformers T₁, T₂ and T₃, if of sufficient amplitude and of proper polarity, will produce ionization of the gas within the associated tube or tubes N₃₁, N₃₂ and N₃₃. Ionization of the gas within any one or several of the tubes will cause current to flow through the translating devices or relays D₁, D₂ and D₃ and the vibrating relays V₁, V₂ and V₃ associated with the tubes so ionized and this

current will pass between the electrodes A and K of such tubes. The devices D₁, D₂ and D₃ will then be operated as long as the associated tubes remain ionized and the corresponding vibrating relays will be intermittently operated, as will be now described.

When a particular vibrating relay such as V₁ operates, it will cause the corresponding condenser C₁ to discharge through the circuit which includes the resistor R₁₁ and the armature and contact of the vibrating relay. At the same time, the closure of the contact of the vibrating relay by its armature will provide a circuit between the electrodes A and K of the tube N₃₁ and this circuit will include the winding of the vibrating relay itself. This circuit, in effect, removes all potential from the anode A of the tube N₃₁ and when this occurs the vibrating relay V₁ will release. As soon as the armature of this relay leaves its contact, the corresponding condenser C₁ will again become charged, charging current being provided by battery B₁, the charging circuit including the winding of the relay D₁. This charging current will tend to hold the relay D₁ operated for a period in excess of the vibrating time of the armature of the relay V₁. The relay D₁, therefore, is held in the operated condition by virtue of the current either supplied through the path of the winding of the vibrating relay V₁, the anode A and cathode K and potential B, or by virtue of the current through the path of the armature and contact of the relay V₁ and the battery S, or through the above described path of the condenser C₁ and resistance R₁₁ and the battery B. Thus the relay D₁ will be maintained operated while the vibrating relay continues to make and break its contact at regular intervals thereafter, or as long as sufficient potential of the proper polarity persists at the input circuit of the transformer T₁.

It will be observed that as long as a sufficient and properly poled potential becomes applied through any one of the transformers as, for example, T₁, the relay D₁ will be continuously operated during this interval while the vibrating relay will be intermittently operated. Both relays will be returned to their unoperated conditions and will remain unoperated if the amplitude of the applied potential becomes sufficiently reduced. In the arrangement shown in Fig. 2, no manual device is employed for producing deionization within any one of the various tubes, that is, for resetting the circuits of any one of the tubes, since this function is performed automatically by the operation of the various vibrating relays and their associated circuits.

In Fig. 3, the circuits connected to the auxiliary electrodes M and the cathodes K of the various tubes N₃₁, N₃₂ and N₃₃ are the same as those illustrated in Figs. 1 and 2. But the positive terminal of the battery B is connected to the anodes of all of the tubes through a circuit which includes a single translating device or relay D and a single vibrating relay designated V, as shown. The armature and contact of the vibrating relay V are connected, respectively, to the cathodes K of all of the tubes and to the terminal common to the windings of the relays V and D. The armature and contact of the vibrating relay V are also shunted by a condenser C and a resistor R arranged in series relationship.

The operation of the arrangement shown in Fig. 3 is substantially the same as that described in connection with Fig. 2, except that the single translating device D becomes operated and re-

mains operated as long as gaseous ionization takes place within any one of the various tubes. At the same time, the vibrating relay V vibrates its armature against its contact as long as the gas within any one of the various tubes remains ionized. The translating device D can become released only when there is an absence of sufficient potential in all of the circuits connected to the primary windings of the transformers T₁, T₂ and T₃. The vibrating relay V will cease its vibration only when the relay D has released.

In Fig. 4, the resistor R₂₁ is connected in series with a large resistor R₂₂, the series circuit shunting the input circuit. The lower terminal of the resistor R₂₂ is connected to the variable tap of the battery B. A plurality of resistors R₃₁—R₃₆ are connected between selected points along the resistor R₂₂ and the auxiliary electrodes M of the corresponding tubes N₃₁—N₃₆ as shown. The negative terminal of the battery B is connected to the cathodes K of all of the various tubes while the positive terminal of this battery is connected to the anodes A of all of the tubes through a circuit which includes the common switch S and the windings of all of the relays D₁—D₆ which are connected in parallel with respect to the battery B, each relay, of course, controlling an individual output circuit. It will be clear also that the various taps along resistors R₂₁ and R₂₂ may be adjustable, if so desired.

It will be observed that the auxiliary electrodes M of the various tubes, by virtue of their connection to different points along the resistor R₂₂, derive different potentials from any voltage applied to the resistor R₂₂ by the input circuit. Assuming that a voltage of proper polarity is applied across the resistor R₂₂, then this entire voltage, as well as that produced between the tapped contact and the negative terminal of the battery B, will be applied through the resistor R₃₁ to the electrodes M and K of the tube N₃₁. A smaller portion of the voltage applied across the resistor R₂₂ will be supplied, along with that produced between the tap connection of battery B and its negative terminal, through the resistor R₃₂ and this composite voltage will be applied between the electrodes M and K of the tube N₃₂. It will be clear also that still smaller voltages are in turn applied between the electrodes M and K of the tubes N₃₃, N₃₄, N₃₅ and N₃₆, the smallest voltage being applied to the electrodes M and K of the last mentioned tube. It will be understood that the resistors R₃₁—R₃₆ are employed primarily as ballasting resistors and that they tend to reduce the flow of current between the electrodes M and K of the corresponding gas filled tubes to very low values in order not to disturb appreciably the impedance at the input, namely, resistance R₂₂.

The relays D₁ to D₆ will all be operated if gaseous ionization is produced within all of the tubes. If only some of the tubes, however, become subjected to gaseous ionization, then the relays corresponding to those tubes alone will become operated. In order to simultaneously deionize the gas within all of the tubes, it is necessary only to open the switch S which will remove the potential of the battery B from the anodes A of all of these tubes. Upon the subsequent closure of this switch, however, these relays will again be in condition to become operated.

It should be furthermore understood that the tubes may be restored to their deionized state by other means than by opening of the switch S; such means may be the employment of deionizing arrangements shown, for example, in Figs. 2

and 3 of this application and in my United States Letters Patent No. 1,977,256.

Fig. 5 shows still another arrangement embodying the principles of this invention. Here the resistors R₄₀, R₄₁, R₄₂, R₄₃ and R₄₄ are connected in series with each other across the input circuit. The resistor R₄₁ is tapped at three points and these taps are connected to the auxiliary electrodes M of the tubes N'₄₁, N''₄₁ and N'''₄₁ through corresponding resistors R'₄₁, R''₄₁ and R'''₄₁. The resistor R₄₂ is similarly tapped at three points which are connected to the auxiliary electrodes M of the tubes N'₄₂, N''₄₂ and N'''₄₂ through corresponding resistors R'₄₂, R''₄₂ and R'''₄₂. Similarly, the three taps of the resistors R₄₃ are connected to the auxiliary electrodes M of the tubes N'₄₃, N''₄₃ and N'''₄₃ through corresponding resistors R'₄₃, R''₄₃ and R'''₄₃. Also the three taps of the resistor R₄₄ are connected through resistors R'₄₄, R''₄₄ and R'''₄₄ to the auxiliary electrodes M of the corresponding tubes N'₄₄, N''₄₄ and N'''₄₄. It will be understood, of course, that the resistors R₄₁ and R₄₂ may in reality be but one resistor and moreover, that resistors R₄₃ and R₄₄ may also be but one resistor.

The cathodes K of all of the tubes are connected to each other and the common terminal is connected to the negative terminal of battery C. The positive terminal of battery C is connected to the junction of resistors R₄₂ and R₄₃. The battery C is therefore employed for the purpose of biasing all the auxiliary electrodes M to a suitable positive potential with respect to the corresponding cathodes K of the various tubes.

The battery B is so arranged that its negative terminals is connected to the terminal common to the cathodes K of all of the tubes and its positive terminal is connected through the reset key or switch S to the anodes A of all of the tubes through corresponding resistors which are designated R'₅₁—R'''₅₁, R'₅₂—R'''₅₂, R'₅₃—R'''₅₃ and R'₅₄—R'''₅₄, as shown. The latter resistors may, of course, be replaced by any forms of relays or translating devices and these resistors or the corresponding devices which are substituted therefor may have the same or different magnitudes of resistance.

It will be clear also that the reset key S may be opened whenever desired for the purpose of simultaneously producing deionization of the gas within the various tubes and at the same time for preventing the flow of current through all of the resistors R'₅₁—R'''₅₁, R'₅₂—R'''₅₂, R'₅₃—R'''₅₃ and R'₅₄—R'''₅₄. It will be clear also that the taps on the various resistors R₄₁, R₄₂, R₄₃ and R₄₄ are adjustable for the purpose of providing any desired potentials for application to the corresponding auxiliary electrodes M of the associated tubes.

The arrangement shown in Fig. 5 is one which is capable of causing the operation of the system upon both halves of each applied alternating current cycle. During the positive half of any one cycle, the gas within the tubes of the upper half of the diagram will become ionized and during the other half cycle ionization will take place within the tubes of the lower half of the diagram.

In Fig. 6, the transformers T₁, T₂ and T₃ connect the input circuits to the electrodes K' and K'' of the tubes N₃₁, N₃₂ and N₃₃, respectively. The battery B is connected between the mid-points of the secondary windings of these transformers and the anodes of the various tubes, each anode A being connected to the positive terminal of the battery B through an individual

relay winding such as D₁, D₂ and D₃ and a common switch S, as shown. The relay D will operate only in response to the ionization of the gas within the tube N₃₁. Similarly, tubes N₃₂ and N₃₃ will individually control the operation of the relays D₂ and D₃. But the current to operate all of these relays is derived from the common battery B.

It will again be understood that the switch S may be employed for the purpose of simultaneously causing the release of all of the relays D₁, D₂ and D₃ so as to allow the gas within all of the tubes to become deionized. It will be understood, however, that this switch S may be replaced by any of the resetting devices shown in the form of vibrating relays having individual armatures and contacts which are shunted by a series condenser and resistor, as shown in Fig. 2, if so desired. It will be further understood that this switch S may be eliminated if the battery is replaced by a source of alternating current of some predetermined frequency or by a source of direct current which is interrupted at some selected frequency.

In this arrangement, potential of either polarity, if of sufficient magnitude, will cause ionization to take place within any one of the tubes to which the applied potential is impressed through the corresponding transformer. Just as soon as ionization is started within any particular tube such as N₃₁, current will continuously flow from the battery B through the winding of the relay D₁ and this current will continue until the switch is opened. Upon the opening of the switch S, the associated relay D₁ will be released and the gas within the tube N₃₁ may become deionized if a sufficient potential no longer is applied through the transformer T₁. This same effect will be observed in the circuits associated with the tubes N₃₂ and N₃₃. It will be understood that the battery B will produce a voltage which will aid ionization to take place between the electrodes K' and K'' of all of the tubes N₃₁, N₃₂ and N₃₃. Thus, the battery B not only acts as a biasing means but also provides the energy to operate all of the relays D₁, D₂ and D₃.

It will be further understood that the arrangement of Fig. 6 will not only be adjusted so that it may respond to voltages of a particular polarity but it may be so adjusted also that it will become operated in response to voltages of both polarities. In other words, this arrangement may be made to be responsive to both cycles of an applied alternating voltage.

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. The combination of a plurality of three electrode gas-filled tubes, a plurality of translating devices, a source of potential for continuously biasing one of the electrodes of each tube with respect to a second electrode of each tube and for supplying current for operating each of said translating devices in a circuit which includes the third electrode and the second electrode, and a plurality of sources for applying in-

dividual potentials between the first two electrodes of each tube for separately ionizing the gas within said tubes.

2. The combination of a plurality of gas-filled tubes each having an anode, a cathode and an auxiliary electrode, a common source of direct potential for rendering the auxiliary electrode of each tube positive with respect to the corresponding cathode, a plurality of translating devices each connected between the anode and cathode of each of the tubes through the source of direct potential, and means for individually applying additional potential between the auxiliary electrode and cathode of each tube for ionizing the gas within said tube and for operating the translating device associated therewith.

3. The combination of a plurality of gas-filled tubes each having three electrodes, a translating device connected in common with two of the electrodes of each of the tubes, a source of direct potential for rendering the third electrode of each of the tubes positive with respect to one of its other electrodes and for supplying the current required to operate the translating device, and means for individually applying additional potential between the electrodes of each of the tubes to which the bias is applied for ionizing the gas within the tube and for operating the translating device.

4. The combination of a plurality of gas-filled tubes each having an anode, a cathode and a control electrode, a translating device connected in common with the anode and cathode of each of the tubes, a source of potential for biasing the control electrodes of all of the tubes to a positive potential with respect to their corresponding cathodes, means for applying additional potential between the auxiliary electrode and cathode of any one of the various tubes for ionizing the gas therein and for operating the translating device, and means for simultaneously interrupting the flow of current between the anodes and cathodes of all of the tubes.

5. The combination of a plurality of gas-filled tubes each having two control electrodes and an anode, a plurality of translating devices each associated with the anode of one of said tubes, a source of potential for biasing each control electrode with respect to the anode and for supplying current for operating each translating device, means for individually applying potentials between the control electrodes of all of the tubes for ionizing the gas therein and for simultaneously operating the associated translating devices, and means for periodically removing the potential of the source from all of the translating devices.

6. The combination of a plurality of gas-filled tubes each having an anode, a cathode and an auxiliary electrode, a source of potential for positively biasing all of the auxiliary electrodes with respect to their cathodes, a plurality of translating devices each associated with one of the tubes, all of the translating devices being connected between the anode of the corresponding tube and its cathode through the common source of biasing potential, a resistor, means for applying additional potential to said resistor, and means for applying different portions of potential across the resistor between the auxiliary electrodes and the corresponding cathodes of the various tubes.

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