Feb. 13, 1934. C. S. DEMAREST 1,946,615

SIGNALING SYSTEM

Filed Oct. 1, 1932 3 Sheets-Sheet 1

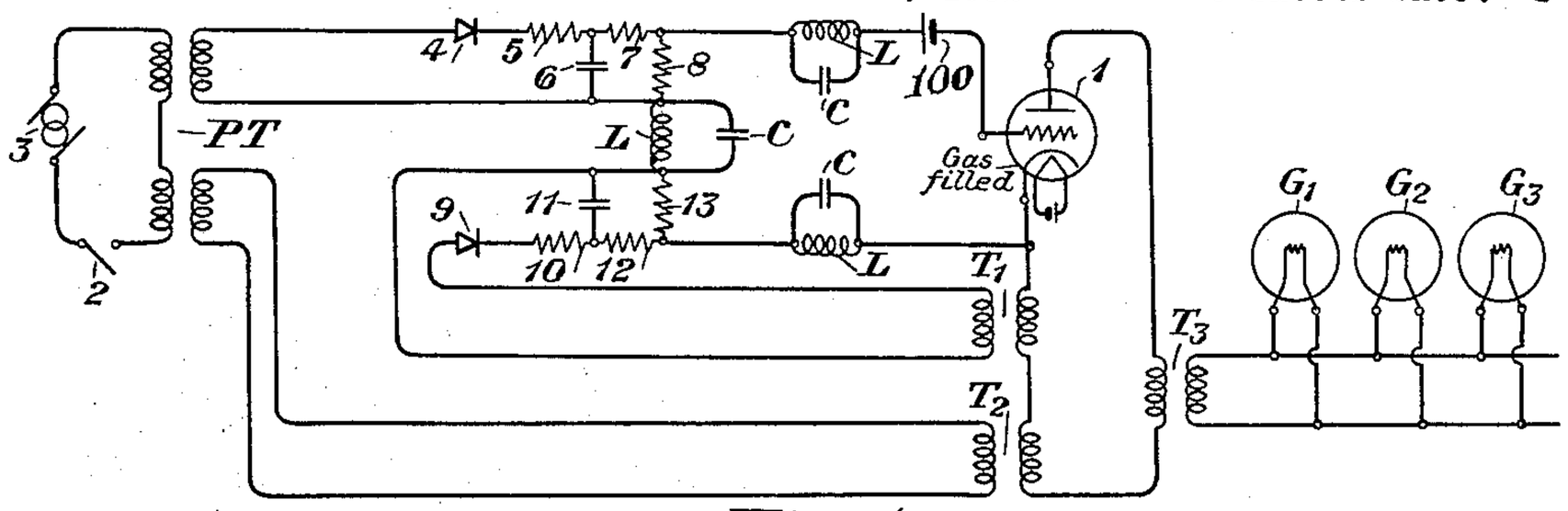

Fig. 1

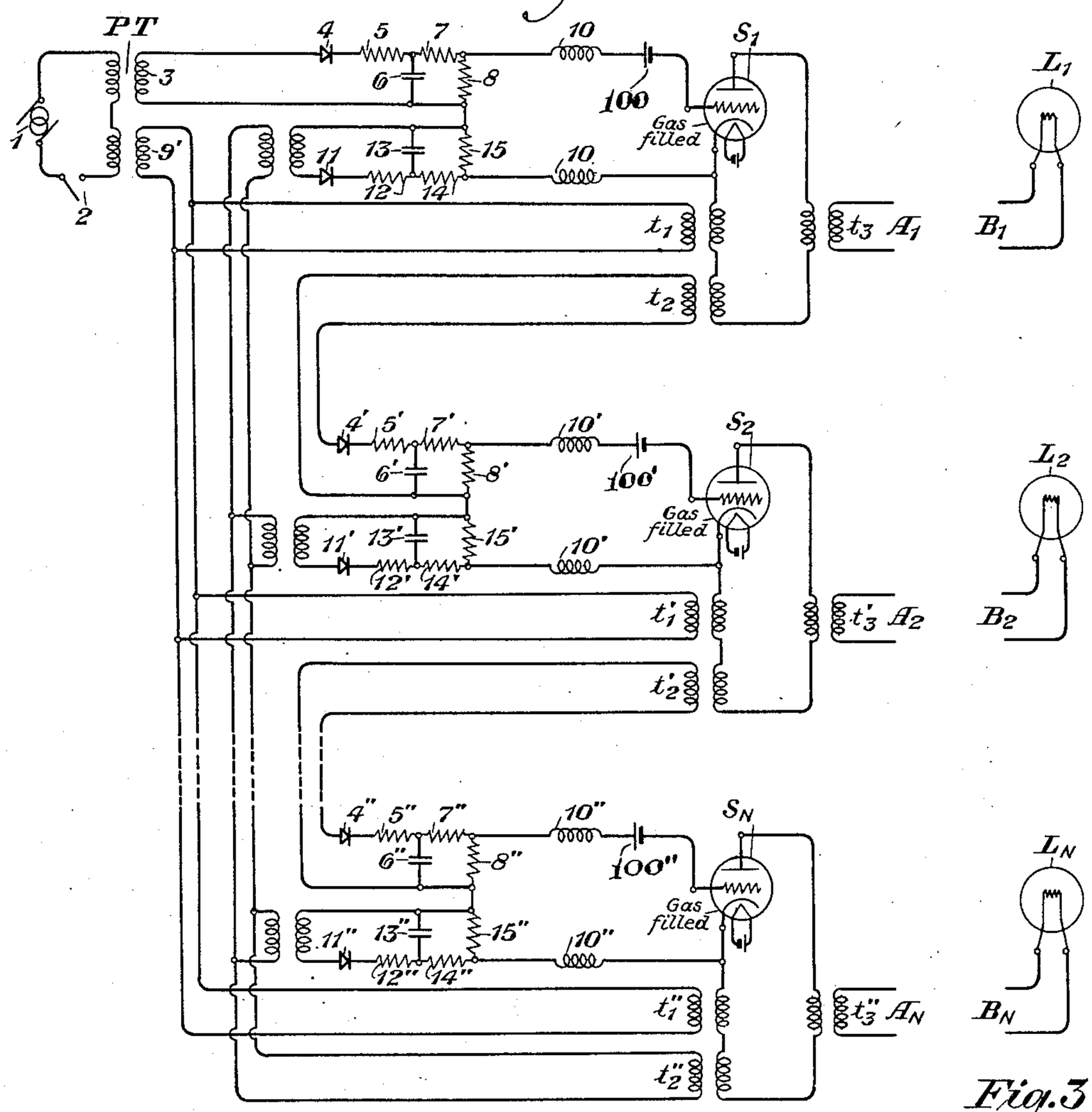

Fig. 2

Fig. 3

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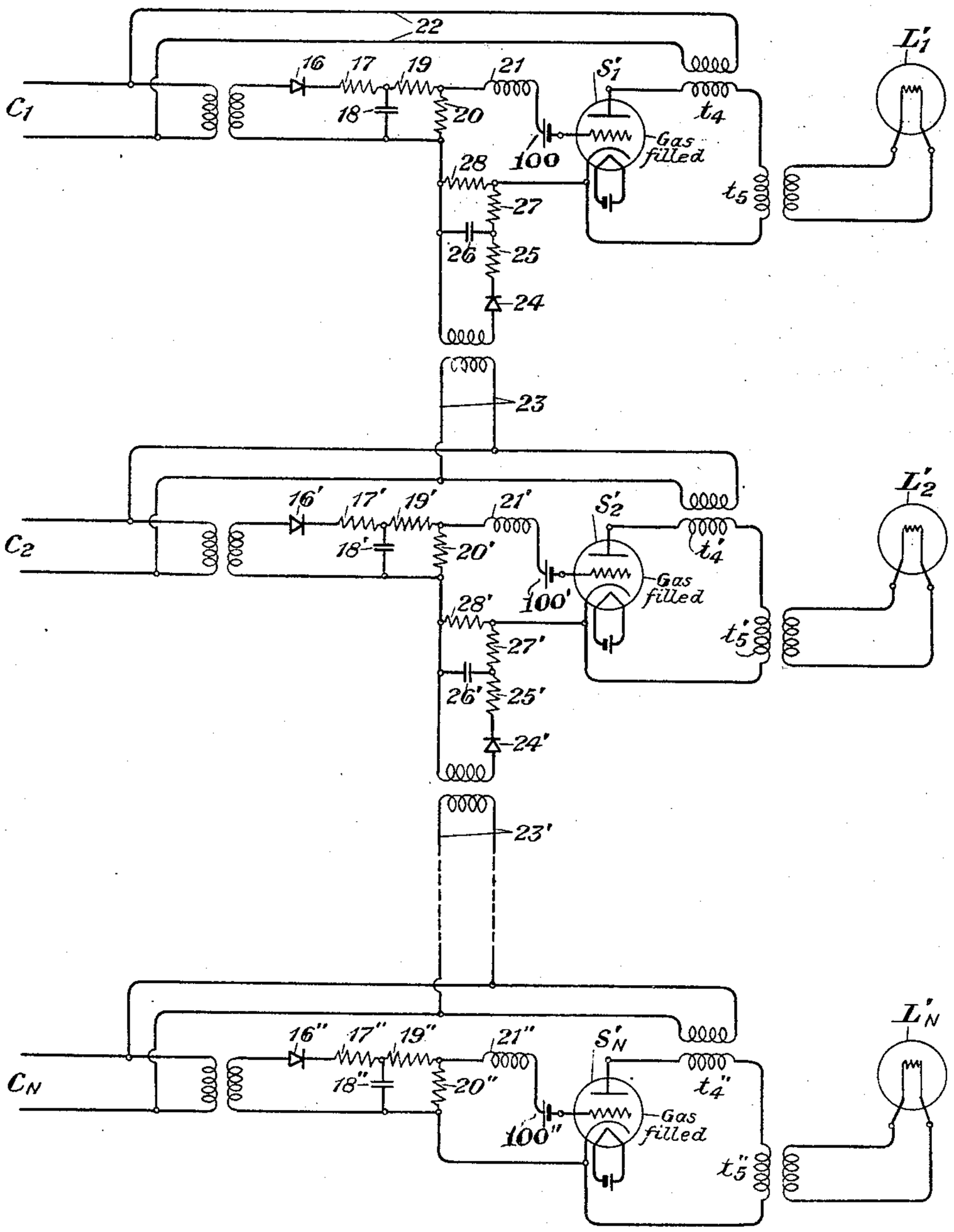

Fig. 4

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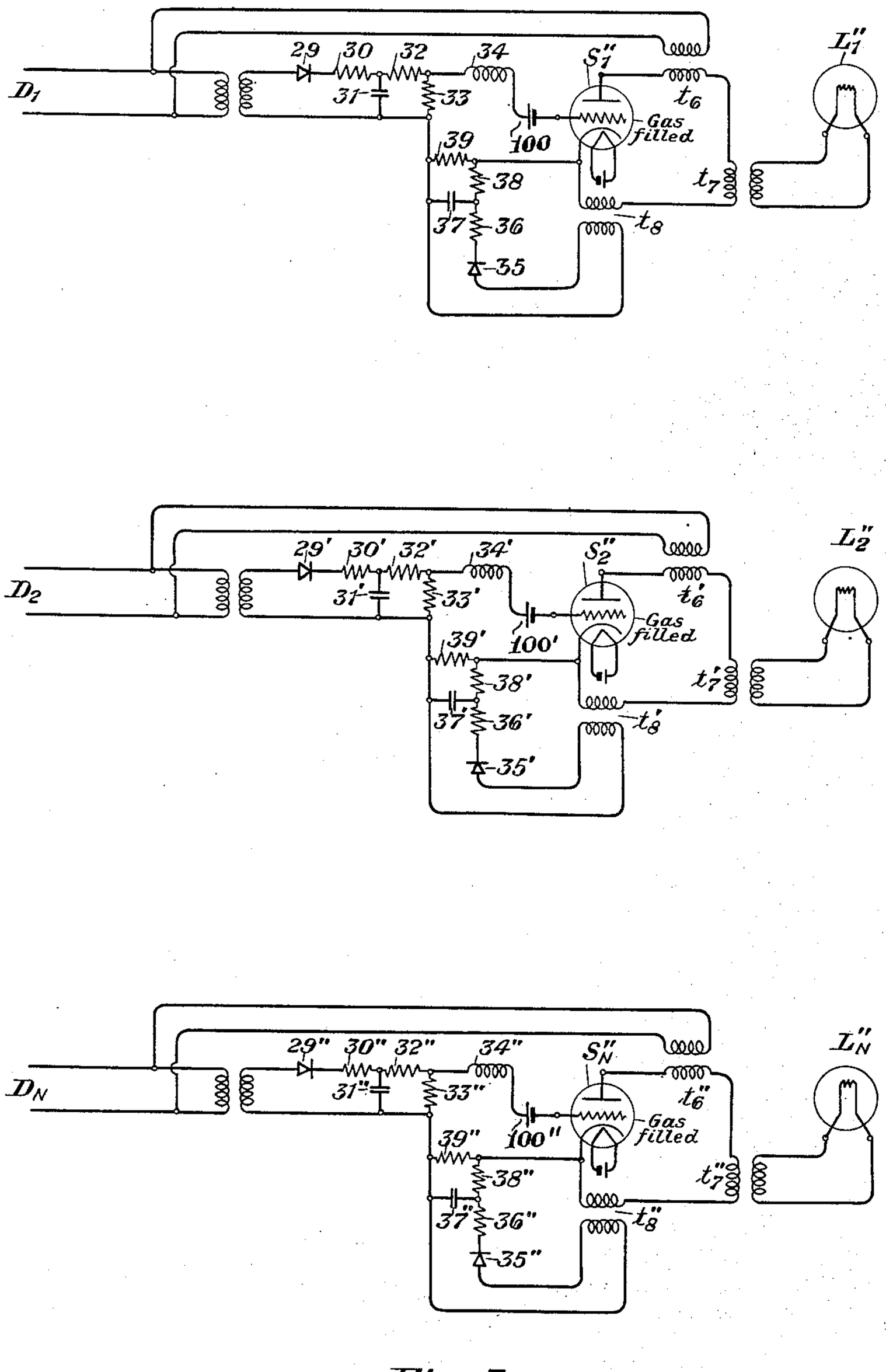

Fig. 5

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UNITED STATES PATENT OFFICE

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SIGNALING SYSTEM

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Application October 1, 1932. Serial No. 635,835

8 Claims. (Cl. 177—346)

This invention relates to signaling systems and more particularly to visual signaling systems such as used for intermittent operation or operation in sequence of lamps or other indicating devices.

Various applications of the arrangements described herein would be to provide intermittent or sequence flashing signals for certain indications at telephone or power switchboards, for warning signals at road crossings, advertising sign displays, etc. An object of the invention would be to eliminate mechanically moving parts and sparking contacts for such purposes by the use of gas-filled tubes. Another object would be to provide simple means for the control of the speed of operation of the various signals individually and in relation to each other. Another object would be to provide a signal array wherein the individual duration and sequence of operation and release could easily be changed by rearrangement of the tube and rectifier elements without changes in the general arrangement of the display elements.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2, 3, 4 and 5 of which are shown various embodiments of the invention. Fig. 1 shows an arrangement for interrupting a power supply of one frequency at any other desired frequency as might be required for operation of signals such as ringers, lamps or glow tubes. Fig. 2, in connection with Figs. 3, 4 and 5 shows arrangements to provide consecutive operation of lamps, each remaining lighted thereafter until the end of the cycle, consecutive single operation of signals or consecutive intermittent operation of signals. Various combinations of these types of operation may be obtained by combinations of Figs. 3, 4 and 5 with Fig. 2. Similar reference characters have been used to denote like parts in all of the figures.

In Fig. 1 is shown a gas-filled discharge tube 1, controlling the flashing of lamps G_1, G_2, G_3, etc. The tube 1 might, for example, be filled with a gas such as neon or argon. In the grid circuit of the tube 1 would be the battery 100 so poled as to apply a negative charge to the grid and thus keep the tube normally in a quenched condition. In the grid to cathode circuit of this tube are two rectifier circuits controlling the ionization and quenching of tube 1. When switch 2 is closed energy is supplied by the A. C. source 3, through transformer PT to the "start" rectifier circuit comprising rectifier 4, resistance 5, condenser 6 and resistances 7 and 8. The A. C. voltage applied to this circuit causes condenser 6 to charge through resistance 5 and current to flow through resistances 7 and 8 such that the drop across resistance 8 applied between the grid and cathode of tube 1 makes the grid more positive with respect to the cathode until a value is reached at which the gas in the tube ionizes and an arc is established between the anode and cathode. Anode potential is supplied through transformers T_2 and PT from source 1. When the arc is established the circuit through the windings of transformers T_1, T_2, and T_3 is closed and voltage is applied through T_3 to the lamps G_1, G_2, G_3, etc. causing them to operate. Voltage is also applied through transformer T_1 to the "stop" rectifier circuit comprising rectifier 9, resistance 10, condenser 11 and resistances 12 and 13 causing condenser 11 to charge through resistance 10 and current to flow through resistances 12 and 13 such that the drop across resistance 13 is opposed to the drop across resistance 8. When the resultant voltage between grid and cathode is more negative than the value at which ionization occurs the tube will quench at the next negative half cycle of anode potential. During the time that the arc is established the impedance between the grid and cathode of tube 1 is reduced to a low value thus creating a low resistance shunt across resistance 8, through the tuned circuits LC and resistance 13 such that the charge on condenser 6 leaks off faster than it is built up by the action of rectifier 4. As soon as the arc is quenched the impedance of the grid-cathode path rises to a high value and the charge on condenser 6 begins to increase until the grid potential is again reached at which ionization occurs, causing a repetition of the cycle just described. The charge on condenser 11 leaks off through resistances 12 and 13 during the period when the arc is quenched. Lamps G_1, G_2, G_3, etc. are lighted during each period of ionization of tube 1, energy being supplied from source 3 through transformers PT, T_2 and T_3, and are extinguished each time the arc is quenched. The frequency of operation of such an intermittent cycle and the length of light and dark intervals may be controlled by adjustment of the values of resistances 5, 7, 8, 10, 12 and 13 of condensers 6 and 11. When the arc is established an increase in the value of resistance 10, for instance, or the capacity of condenser 11 will cause an increase of the interval during which the lamps are lighted and vice versa. A decrease in the value of resistance 7 or an in-

crease in the value of resistance 12 will increase the period during which the lamps are out and vice versa. The tuned circuits LC are tuned to the frequency of the A. C. supply and are provided to keep alternating currents out of the grid-cathode circuit.

In Fig. 2 are shown a series of gas-filled tubes S_1, S_2, . . . S_N arranged to operate in sequence, each tube remaining operated until the last tube of the series, S_N, quenches all tubes. In the grid circuits of the tubes S_1, S_2, . . . S_N there would be provided the batteries 100, 100′ and 100″ so poled as to apply negative charges to the grids of the respective tubes and thus keep the tubes normally in a quenched condition. Upon the operation of each tube, energy is supplied from the A. C. source 1, through transformer PT, transformer t_1 associated with the anode circuit and transformer t_3 to leads A_1, A_2, . . . A_N which may be connected to various signal devices, lamps or circuits as hereinafter described. The detailed operation of the circuit is as follows:

When switch 2 is closed, energy is supplied from source 1 through winding 3 of transformer PT to the "start" rectifier circuit of tube S_1 which consists of rectifier 4, resistance 5, condenser 6 and resistances 7 and 8. Voltage is also applied at the same time through winding 9′ of transformer PT to the primary windings of all transformers t_1, t_1', etc., associated with the anode circuits of all the tubes S_1, S_2, . . . S_N. The voltage applied to the rectifier circuit causes condenser 6 to charge thus causing a current to flow through resistances 7 and 8, the voltage drop across resistance 8 being applied between the grid and cathode of tube S_1 through inductance 10 and resistance 15. When this voltage reaches the value at which ionization occurs an arc is established between the anode and cathode of tube S_1 closing the series circuit through the windings of transformers t_1, t_2 and t_3. The voltage from winding 9′ of transformer PT is then transmitted through transformers t_1 and t_3 to leads A_1 which may be connected to leads B_1 of Fig. 3, C_1 of Fig. 4, D_1 of Fig. 5 or to various combinations of these. Voltage is also applied through transformers t_1 and t_2 to the "start" rectifier circuit of tube S_2, where the action is the same as described above in connection with tube S_1. The time delay between the operation of tube S_1 and tube S_2 is regulated by the values of resistances 5, 7 and 8 and condenser 6. The operation of tube S_2 causes voltage to be applied to leads A_2 in a manner similar to that in which voltage was applied to leads A_1. Leads A_2 may, in a like manner, be connected to leads B_2 of Fig. 3, C_2 of Fig. 4, D_2 of Fig. 5, or any combination of these. The operation of tube S_2 causes voltage to be applied to the "start" rectifier circuit of the next succeeding tube in the series, and so on until tube S_N is operated, applying voltage to leads A_N and thence to leads B_N of Fig. 3, C_N of Fig. 4, D_N of Fig. 5, etc. Upon the operation of tube S_N voltage is applied through transformer t_2'' associated with this tube to the "stop" rectifier circuits associated with each tube of the series consisting of rectifier 11, resistance 12, condenser 13 and resistances 14 and 15 for tube S_1 and for the other tubes consisting of similar elements with similar reference characters with the added designation prime, etc. Voltage drops opposing those across resistance 8 are built up across resistance 15 and in a time determined by the values resistance 12 and condensers 13 will reduce the grid potentials of each tube to the point where ionization ceases, this occurring simultaneously in all the tubes of the series, and removing voltage from all the leads A_1, A_2, . . . A_N. The charges on condensers 6 of all the tubes will have leaked off during the time that the tubes are ionized and on condensers 13 after they have been quenched as described in connection with the "start" and "stop" rectifiers of Fig. 1. If switch 2 remains closed the voltage from winding 3 of transformer PT will again begin to charge condenser 6 of tube S_1 and the cycle will be restarted.

Fig. 3 shows lamps, or groups of lamps, L_1, L_2, . . . L_N associated with leads B_1, B_2, . . . B_N which may be connected respectively to leads A_1, A_2, . . . A_N as described above. Each lamp or group of lamps may, for instance, correspond to a letter, number, word, etc., of a display which will thus be spelt out letter by letter or word by word, be extinguished after the display has been completely illuminated and repeat the cycle as long as power is applied to transformer PT.

Fig. 4 shows a series of gas-filled tubes S_1', S_2', . . . S_N' corresponding to tubes S_1, S_2, . . . S_N of Fig. 2 and corresponding lamps or groups of lamps L_1', L_2', . . . L_N' which are arranged to operate in sequence as tubes S_1, S_2, . . . S_N are operated and to be extinguished in sequence after a predetermined interval for each. Leads C_1, C_2, . . . C_N are connected respectively to leads A_1, A_2, . . . A_N of Fig. 2. The detailed operation of the circuit is as follows:

In the grid circuits of tubes S_1', S_2' and S_3', respectively, would be provided the batteries 100, 100′ and 100″ so poled as to apply negative charges to the grids of the respective tubes and thus keep the tubes normally in a quenched condition.

When tube S_1 of Fig. 2 operates and voltage is applied to leads C_1 from leads A_1 condenser 18 is charged through resistance 17 by the action of the "start" rectifier 16 causing current to flow through resistances 19 and 20. The voltage drop across resistance 20 is applied between grid and cathode of the S_1' through inductance 21 and resistance 28. When this voltage reaches the value at which tube S_1' ionizes an arc is established in this tube closing the circuit including windings of transformers t_4 and t_5. Anode potential is provided, when tube S_1 is operated, through transformer t_4, over leads 22 connected to leads C_1. Lamp L_1' is then lighted through transformer t_5. When tube S_2 operates the same action takes place for tube S_2' as described here for tube S_1' lighting lamp L_2'. In addition, however, the voltage on leads C_2 is also applied, through leads 23, to the "stop" rectifier circuit of tube S_1' consisting of rectifier 24, resistances 25, 27 and 28 and condenser 26, charging condenser 26 and producing a voltage drop across resistance 28 opposing the drop across resistance 20. When the resultant voltage between grid and cathode of tube S_1' is reduced below the ionization value, tube S_1' is quenched at the next negative half cycle of anode potential and remains quenched until the end of the cycle of operations described in connection with tubes S_1, S_2, . . . S_N in Fig. 2. Upon the operation of the tube next is succession to S_2 the same cycle of operations occurs for the tube succeeding S_2' and S_2' is quenched in a similar manner. When tube S_N of Fig. 2 is operated and quenches all tubes of this series voltage is removed from leads C_N quenching this tube and extinguishing lamp L_N'. At the same time, since voltage is removed from

all the leads C_1, C_2, etc., tubes S_1', S_2', . . . S_N' are restored to normal condition, ready to be operated again when the cycle of operations of tubes S_1, S_2, . . . S_N is repeated. In this way lamps L_1', L_2', . . . L_N' are lighted once each cycle for an interval determined by the values of the resistances and condensers in the rectifier circuits and extinguished a predetermined time thereafter.

In Fig. 5 is shown an arrangement of gas-filled tubes S_1'', S_2'', . . . S_N'' and corresponding lamps L_1'', L_2'', . . . L_N'' which, in connection with the arrangement shown in Fig. 2, provides a series of flashing lamps which are started in sequence, following the operation of tubes S_1, S_2, . . . S_N, and flash intermittently thereafter until the end of the cycle of operations described in connection with Fig. 2 at which time all are quenched and restored to the normal condition to repeat as the cycle of S_1, S_2, . . . S_N is repeated. The intervals of flashing are determined by the adjustment of the resistance and condenser values in the "start" and "stop" rectifier circuits associated with each of the tubes S_1'', S_2'', . . . S_N''. The detailed operation of each tube is described in connection with Fig. 1. Lamp L_1'' will flash intermittently as long as voltage is applied to leads D_1. When tube S_2 is operated, following the operation of S_1, tube S_2'' will also begin to ionize and quench in a manner similar to tube S_1'' and lamp L_2'' will flash intermittently. In a similar manner, as voltage is applied in sequence to leads D_1, D_2, . . . D_N. the lamps succeeding will begin to flash intermittently and all will cease flashing when tubes S_1, S_2, . . . S_N are all quenched by S_N at the end of the cycle of operations. By combination with Fig. 2 of the various circuits described in Figs. 3, 4 and 5 any desired sequential arrangement of continuous, single flash or intermittent flashing signals or lamps may be provided. The arrangement of Fig. 1 may also be included to provide intermittent operation not in sequence.

While the invention as herein described is shown in certain specific arrangements it is understood that many other arrangements and modifications may be employed without departing from the scope of the appended claims.

What is claimed is:

1. A gas-filled discharge tube having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, a starting circuit connected across said first resistance, a stopping circuit connected across said second resistance, said starting circuit including a condenser connected in parallel with said first resistance and a rectifier poled so that the application of an alternating current to said starting circuit wil cause a charge to build up on said condenser of a polarity to apply across said first resistance a voltage opposing that of said biasing means, said stopping circuit including a condenser connected in parallel with said second resistance and a rectifier so poled that the application of an alternating current to said stopping circuit will cause a charge to build up on the condenser therein of a polarity to apply across said second resistance a voltage aiding that of said biasing means, means for applying an alternating current to said starting circuit, and means controlled by the discharging of said tube for applying an alternating current to said stopping circuit.

2. A gas-filled discharge tube having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, a starting circuit for said tube connected across the first resistance, a stopping circuit for said tube connected across the second resistance, said starting circuit including means so that the application of alternating current thereto will build up a voltage across said first resistance opposing that of said biasing means, said stopping circuit including means so that the application of an alternating current thereto will build up a voltage across said second resistance aiding that of said biasing means, means for applying an alternating current to said starting circuit, and means controlled by the discharging of said tube for applying an alternating current to said stopping circuit.

3. A gas-filled discharge tube having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, a starting circuit for said tube connected across the first resistance, a stopping circuit for said tube connected across the second resistance, said starting circuit including means so that the application of alternating current thereto will build up a voltage across said first resistance opposing that of said biasing means, said stopping circuit including means so that the application of an alternating current thereto will build up a voltage across said second resistance aiding that of said biasing means, means for applying an alternating current to said starting circuit, additional gas-filled discharge tubes similar to said first tube, each of said tubes having starting and stopping circuits similar to those of said first tube, means controlled by the operation of said first tube for applying an alternating current to the starting circuit of the succeeding tube, means controlled by the operation of said last mentioned tube for applying an alternating current to the starting circuit of the next succeeding tube, and means controlled by the operation of the last tube of the series for applying an alternating current to the stopping circuits of all of said tubes.

4. A series of gas-filled discharge tubes, each of said tubes having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, each of said tubes having a starting circuit connected across the first resistance and a stopping circuit connected across the second resistance, each of said starting circuits including means so that the application of an alternating current thereto will build up a voltage across its first resistance opposing that of the biasing means, each of said stopping circuits including means so that the application of an alternating current thereto will build up across its second resistance a voltage aiding that of the biasing means, means for applying an alternating current to the starting circuit of the first tube of said series, means controlled by the operation of each tube in said series for applying an alternating current to the starting circuit of the next succeeding tube in the series, means controlled by the operation of the last tube of the series for applying an alternating current to the stopping circuits of all of said tubes, a second series of gas-filled discharge tubes corresponding to those of said first series and each having starting and stopping circuits similar to those of said first series of tubes, means controlled by the discharging of each of the tubes of said first series for ap-

plying alternating current to the starting circuits of corresponding tubes of said second series, and means controlled by the application of alternating current to the starting circuits of each of the tubes of said second series for applying alternating current to the stopping circuit of the next preceding tube in said second series.

5. A series of gas-filled discharge tubes, each of said tubes having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, each of said tubes having a starting circuit connected across the first resistance and a stopping circuit connected across the second resistance, each of said starting circuits including means so that the application of an alternating current thereto will build up a voltage across its first resistance opposing that of the biasing means, each of said stopping circuits including means so that the application of an alternating current thereto will build up across its second resistance a voltage aiding that of the biasing means, means for applying an alternating current to the starting circuit of the first tube of said series, means controlled by the operation of each tube in said series for applying an alternating current to the starting circuit of the next succeeding tube in the series, means controlled by the operation of the last tube of the series for applying an alternating current to the stopping circuits of all of said tubes, a second series of gas-filled discharge tubes corresponding to those of said first series and each having starting and stopping circuits similar to those of said first series of tubes, means controlled by the discharging of each of the tubes of said first series for applying alternating current to the starting circuits of corresponding tubes of said second series, and means controlled by the discharging of each of the tubes of said second series for applying alternating current to its stopping circuit.

6. A gas-filled discharge tube having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, a starting circuit for said tube connected across the first resistance, a stopping circuit for said tube connected across the second resistance, said starting circuit including means so that the application of alternating current thereto will build up a voltage across said first resistance opposing that of said biasing means, said stopping circuit including means so that the application of an alternating current thereto will build up a voltage across said second resistance aiding that of said biasing means, means for applying an alternating current to said starting circuit, means for applying an alternating current to the cathode-anode circuit of said tube, means controlled by the discharging of said tube for applying an alternating current to said stopping circuit, and signaling means controlled by the cathode-anode circuit of said tube.

7. A series of gas-filled discharge tubes, each of said tubes having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, each of said tubes having a starting circuit connected across the first resistance and a stopping circuit connected across the second resistance, each of said starting circuits including means so that the application of an alternating current thereto will build up a voltage across its first resistance opposing that of the biasing means, each of said stopping circuits including means so that the application of an alternating current thereto will build up across its second resistance a voltage aiding that of said biasing means, means for applying an alternating current to the starting circuit of the first tube of said series, means controlled by the operation of each tube of said series for applying an alternating current to the starting circuit of the next succeeding tube of said series, means controlled by the last tube of said series for applying an alternating current to the stopping circuits of all of said tubes, means for applying an alternating current to the cathode-anode circuits of all of said tubes, and signaling means controlled by each of said cathode-anode circuits.

8. A gas-filled discharge tube having a grid-cathode circuit including a biasing means for applying a negative charge to the grid and a first and second resistance connected in series, a starting circuit for said tube connected across the first resistance, a stopping circuit for said tube connected across the second resistance, said starting circuit including means so that the application of alternating current thereto will build up a voltage across said first resistance opposing that of said biasing means, said stopping circuit including means so that the application of an alternating current thereto will build up a voltage across said second resistance aiding that of said biasing means, means for applying an alternating current to said starting circuit, means controlled by the discharging of said tube for applying an alternating current to said stopping circuit, and means for controlling the rate at which the voltage across said first and second resistances is built up.

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