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GAS FILLED DISCHARGE TUBE

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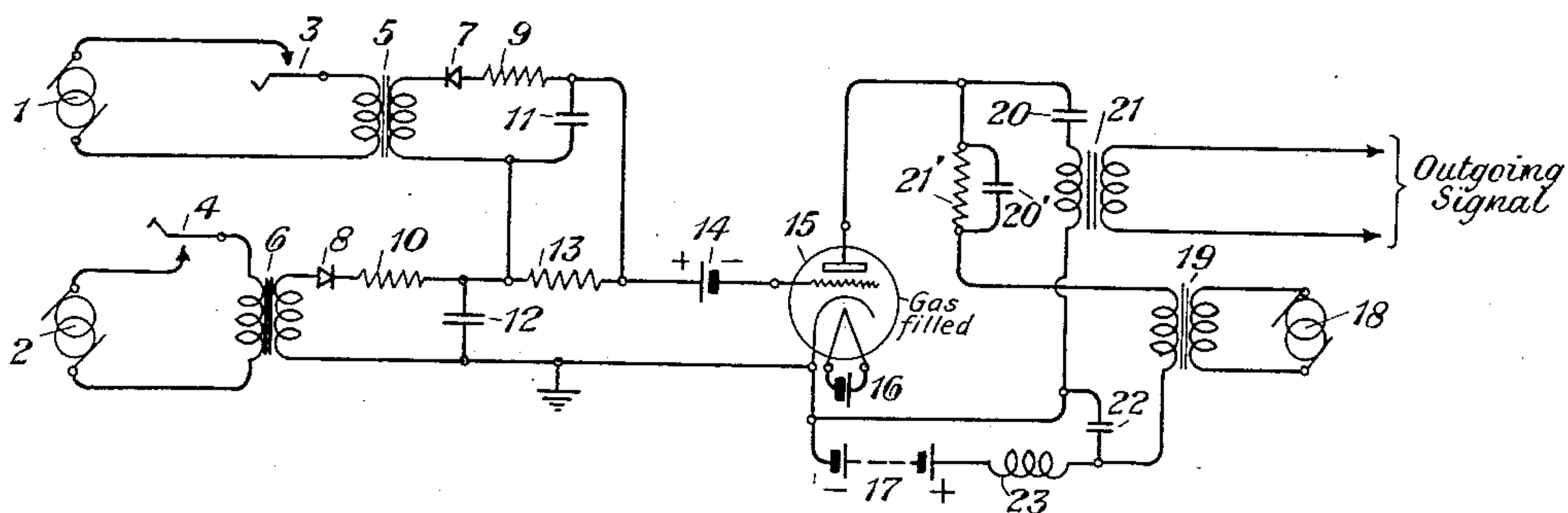


Fig. 1

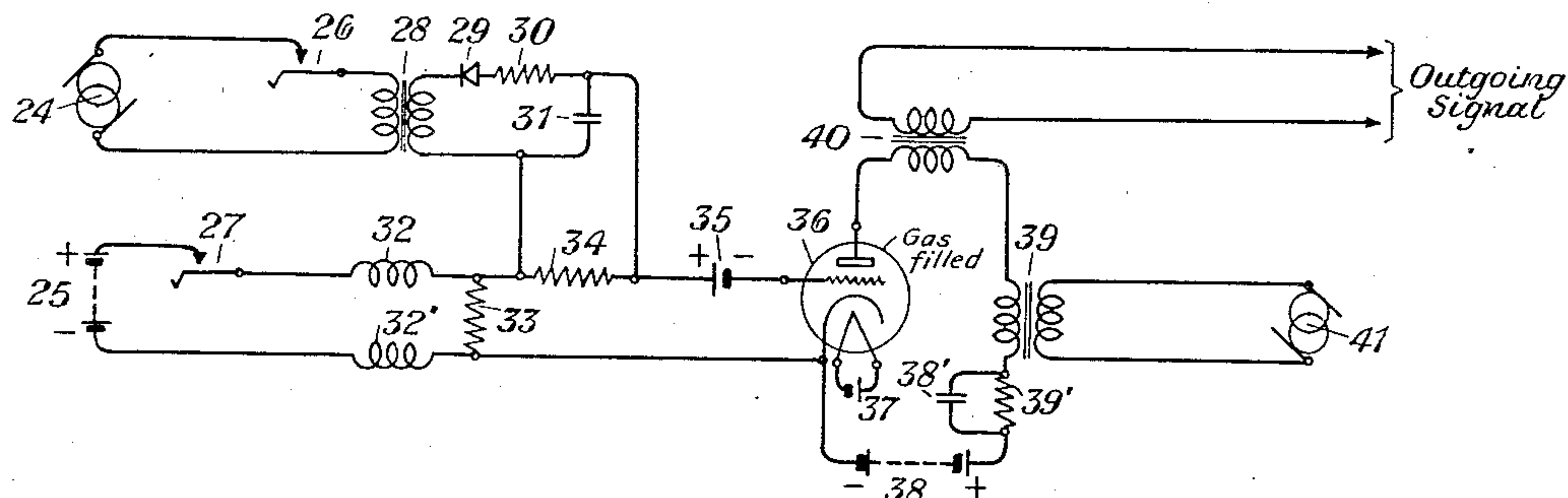


Fig. 2

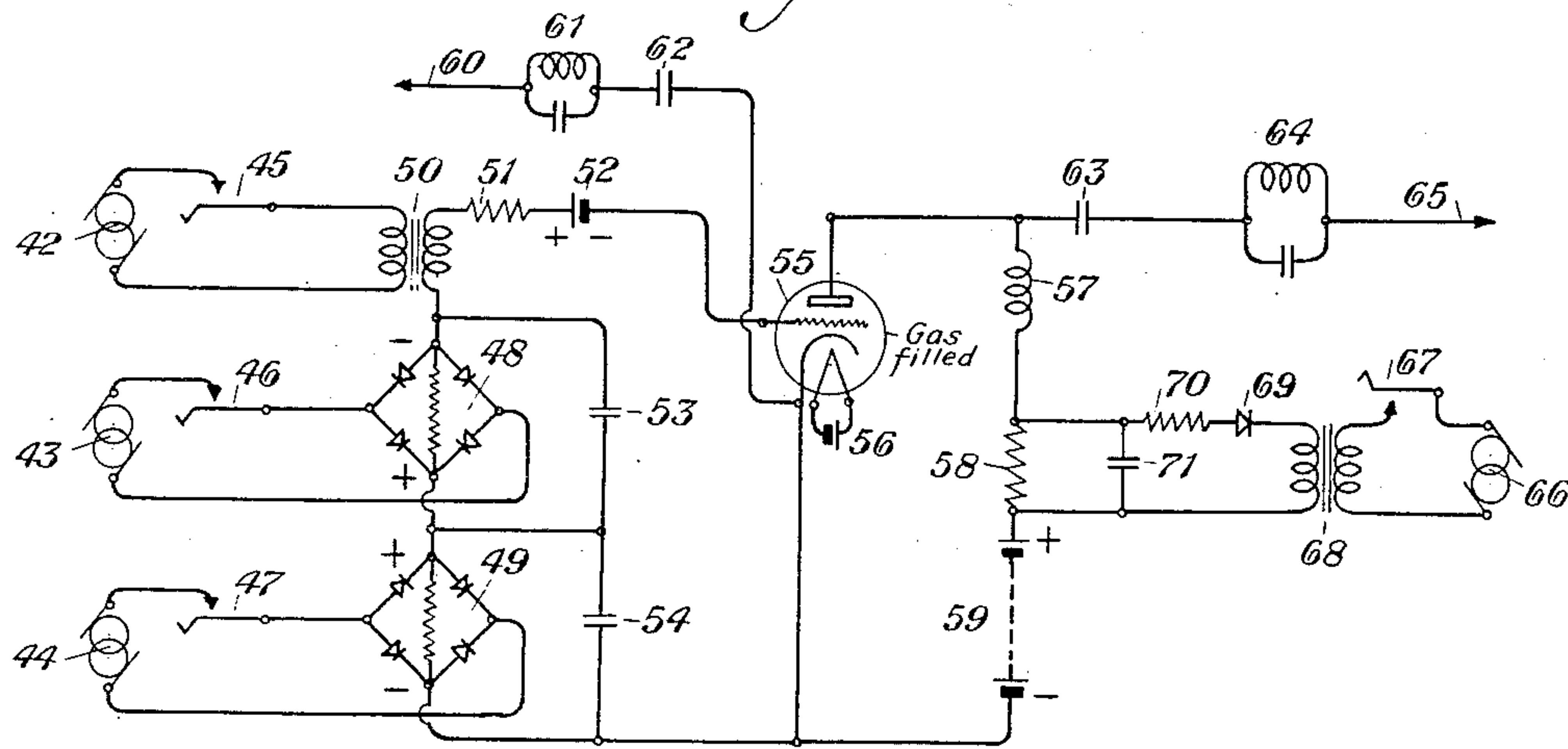


Fig. 3

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GAS-FILLED DISCHARGE TUBE

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Application November 16, 1932
Serial No. 642,956

4 Claims. (Cl. 250—27)

This invention relates to electrical circuits and more particularly to that class of electrical circuits intended to control the operation of gas-filled discharge tubes of the hot or cold cathode type.

In many applications of such discharge tubes it becomes necessary to provide interlocking arrangements so that a given tube will become conducting only when two separate conditions are fulfilled. Or it may be desired to hold a tube in the non-operated condition when an input which might normally lead to the passage of current is applied. This has ordinarily been accomplished either by means of electromagnetically operated relays, or by so arranging the circuits that a flow of direct current in one circuit introduces an aiding or opposing bias, as may be required, in the grid circuit of the tube whose operation is to be controlled. But the use of electromagnetic relays is at times objectionable, owing to the necessity for mechanical adjustment and to the possibility of contact troubles, as well as their effect upon speed of operation, while the second method is likely to lead to circuit difficulties and prove impracticable in many cases. Another method well known in the art utilizes the shift in phase of an alternating voltage applied to the grid, relative to the phase of an alternating voltage of the same frequency applied to the anode. This again is not always a convenient nor even a possible method. In the present invention alternating current may be used on the control circuits, but this is rectified before application to the grid so that phase difficulties do not arise. Other objects and principles of this invention may be more clearly understood from the following detailed description thereof.

The invention may be more fully understood from the following description together with the accompanying drawing in the Figures 1, 2, 3 of which the invention is illustrated. Figure 1 is a circuit diagram embodying one form of the invention. Figures 2 and 3 are circuit diagrams embodying modifications of the arrangements.

Fig. 1 represents an arrangement in which two input circuits are applied to a gas-filled thermionic discharge tube, in such a manner that an output circuit leading to a work circuit, which latter is not shown, will receive alternating current from a source connected into the anode circuit of the tube, but whereby the amplitude of this output will be substantially reduced if one of the two input circuits be energized, with alternating current but will rise to its normal

value again if a second input circuit be energized, also with alternating current. The gas-filled tubes may be of the type of tube filled with a monatomic gas, such as neon.

Fig. 2 represents a similar arrangement, but which differs from Fig. 1 in that output is delivered to the work circuit only if the tube be in a conducting condition, while one of the input circuits is arranged for direct current operation, the other remaining adapted for alternating current operation.

Fig. 3 represents an arrangement whereby a gas-filled thermionic discharge tube is arranged to complete a line circuit, carrying alternating currents at amplitudes small in comparison with the arc drop of the tube, and provided with four control circuits, the first of which is adapted to impress alternating voltage on the grid of the tube while the second and third such circuits apply alternating current to rectifiers in the grid circuit, one of which is so poled as to aid the signal in operating the tube, while the other is in opposition thereto. The fourth circuit is arranged to apply alternating current to a rectifier in the anode circuit arranged to oppose the anode potential supply so as to extinguish the arc in the tube.

While the invention has been illustrated in connection with the use of thermionic gas-filled discharge tubes, it is not intended to be so limited, but will also be applicable to cases in which cold cathode tubes are used.

Referring to Fig. 1, reference characters 1 and 2 designate sources of alternating current which may be connected to input transformers 5 and 6, respectively, by means of keys 3 and 4. These keys have been shown merely for illustrative purposes as other means of applying current from the sources 1 and 2 would be used in many cases. The secondary of transformer 6 is connected to a rectifier 8, resistance 10 and condenser 12, the latter being shunted about the other three elements in series. One side of condenser 12 is connected to one side of the secondary of transformer 6, and also to the cathode of the thermionic gas-filled discharge tube 15, and to ground. Rectifier 8 is so poled that when alternating current is applied to the primary of transformer 6, by closure of key 4, the ungrounded side of condenser 12 will receive a positive charge. This side of condenser 12 is connected to the grid of tube 15 through resistance 13 and grid biasing battery 14, which is poled as indicated so that a negative bias normally is applied to the grid. But if key 4 is

closed, a positive charge is built up in condenser 12, at a rate determined by the amplitude of the input, and the values of resistance 10 and condenser 12, which will after a certain predeterminable delay override the bias of battery 14 and thus change the grid bias of tube 15 to a value permitting an arc to strike therein. But if key 3 be closed, alternating current from source 1 will be applied to transformer 5, and the secondary circuit of this transformer is connected to rectifier 7, resistance 9 and condenser 11 in such a manner that condenser 11 will be charged. Condenser 11 is connected in shunt with resistance 13, which preferably has a value so high that it does not appreciably reduce the voltage applied to condenser 11 through rectifier 7. The poling of this rectifier is such that the charge on the terminal of condenser 11 nearest the grid of tube 15 will be negative, thus opposing the action of rectifier 8, and tending to or actually preventing the firing of an arc in tube 15, or causing the discharge to be interrupted if one already exists.

The anode circuit of tube 15 is connected through current limiting resistance 21' to the secondary of transformer 19 and thence through inductance 23 to the positive pole of anode battery 17, the negative pole of which is connected to the cathode of tube 15. The primary of transformer 19 is connected to alternating current source 18. The amplitude of the alternating voltage applied to the anode circuit of tube 15 by transformer 19 is so chosen that its maximum value is slightly greater than that of anode battery 17. Thus the arc in tube 15, if established will be interrupted for a brief period in every negative half cycle of the alternating voltage introduced into this anode circuit from generator 18, and the grid of the tube 15 can regain control during this period. If the grid bias be shifted as hereinbefore described, by either closing key 3 or opening key 4, which latter must be closed if an arc is to strike, upon the next negative half cycle of the superimposed alternating plate voltage, the arc will go out and the grid will thus regain control. Inductance 23 and capacity 22 prevent alternating current flow through battery 17.

The work circuit, not otherwise shown, receives the outgoing signal from the secondary of transformer 21. The primary of this transformer is connected in series with condenser 20, between anode and cathode of tube 15. When this tube is in a non-conducting state, therefore, condenser 20 will be charged to a direct current potential equal to that of battery 17, and an alternating current path may be traced from the secondary of transformer 19, through condenser 20' to condenser 20, to the primary of transformer 21, to condenser 22 and back to the secondary of transformer 19. The output to the work circuit will thus be obtained from generator 18 without substantial attenuation. If, however, tube 15 be in an arcing condition the alternating current resistance of the anode-cathode arc path is substantially zero except during that brief portion of the negative half cycle when the anode circuit is open. Therefore, the output supplied to the work circuit will be greatly reduced when an arc exists in tube 15.

Fig. 2 represents another embodiment of this invention. Reference character 25 indicates a direct current source of signaling current, con-

trolled by key 27, although it is to be understood that a key is shown merely for illustrative purposes. When key 27 is closed, direct current will flow from the positive pole of source 25 through key 27, inductance 32, resistance 33, inductance 32' and back to the negative pole of source 25. The terminal of resistance 33 which is connected to the negative side of source 25 is also connected to the cathode of the thermionic gas-filled discharge tube 36, while the other terminal of resistance 33 is connected to the grid of the aforesaid tube through resistance 34 and biasing battery 35. When key 27 is open, the biasing battery 35 will maintain tube 36 in a non-arcing condition, while when this key is closed the drop in resistance 33 will override the voltage from battery 35 and permit an arc to strike in tube 36.

A second input is provided, from generator 24, through key 26 to transformer 28. The secondary of transformer 28 is connected to condenser 31 through rectifier 29 and resistance 30. Condenser 31 is in parallel with resistance 34, and the rectifier 29 is so poled that if key 26 is closed, a voltage is built up across resistance 34 so as to aid biasing battery 35, thus preventing an arc from striking in tube 36 even though input be applied by closing key 27.

The anode circuit of tube 36 contains the secondary of transformer 39 and the primary of transformer 40, in series, and in series with this anode battery 38 and current limiting resistance 39' shunted by condenser 38'. The primary of transformer 39 is connected to generator 41. The maximum amplitude of voltage induced thereby in the secondary of transformer 39 is adjusted to be slightly greater than that of anode battery 38, so that there will be an interval in each negative half cycle during which no anode current flows and the grid of tube 36 can regain control, so that if this grid be shifted to a voltage not permitting an arc to strike, the arc will go out on the next negative half cycle and will not be reestablished until the grid bias is again such as to permit an arc to strike. The secondary of transformer 40 is connected to a work circuit, not specifically shown in the drawing. When an arc exists in tube 36, alternating current flows around the path from the secondary of transformer 39, through the primary of transformer 40, the arc path of tube 36, anode battery 38, condenser 38' and back to the secondary of transformer 39. Alternating current is thus delivered from the secondary of transformer 40 to the work circuit. But if the arc be stopped as described in tube 36, no current will flow in the anode path and no alternating current will be delivered to the work circuit.

Referring now to Fig. 3, reference characters 42, 43 and 44 indicate sources of alternating current which may be connected to the grid circuit of tube 55 by closing keys 45, 46, or 47, respectively. The output of generator 42 passes, when key 45 is closed, to the primary of transformer 50. One terminal of this transformer is connected to the grid of tube 55 through resistance 51 and grid biasing battery 52, while the other terminal is connected to the cathode of tube 55 through the resistances associated with the resistance and rectifier units designated 48 and 49, which are by-passed by condensers 53 and 54. Tube 55 is arranged to connect lines 60 and 65 when in the arcing condition, and to disconnect them when non-conducting. The

currents passing over these lines and through the arc of tube 55 from one to the other may be signaling currents in a frequency range which does not include that of the generators 42, 43, 44 and 66, and whose amplitude is small compared to the arc voltage or current in tube 55. Blocking condensers 62 and 63 are provided to keep the direct currents of the anode circuit of tube 55 out of the signaling circuit, while reference characters 61 and 64 indicate anti-resonant circuits, or if required a plurality thereof, to keep the alternating currents, such as that from generator 66, used for control of the tube, out of the signaling lines.

15 The anode circuit of tube 55 contains, in series anode battery 59, resistance 58 and choke coil 57, connected between anode and cathode of this tube. Choke coil 57 is provided to keep signaling currents from being by-passed around the tube by the anode supply circuit, while resistance 58 serves both as a current limiting resistance and as a means for quenching the arc in tube 55 as explained in connection with my copending application, Serial No. 642,955, filed 20 November 16, 1932 operating for this purpose in conjunction with condenser 71, resistance 70, rectifier 69 and transformer 68. When key 67 is closed, completing the circuit from generator 66 to the primary of transformer 68, the output 25 of the secondary of this transformer, rectified by rectifier 69 builds up a charge in condenser 71 and after a predetermined interval this is of sufficient magnitude to quench the arc in tube 55 by lowering the anode potential below the 30 minimum required to sustain an arc.

In addition to the input circuit from generator 42 there are two other inputs from generators 43 and 44 through keys 46 and 47 respectively to rectifier and resistance units 48 and 49. 35 When inputs are applied the action of these rectifiers produces direct potentials of the polarity indicated on the drawing across the resistance members of these elements 48 and 49. Rectifier 48 produces a potential passing the 40 grid of tube 55 more negatively and assisting grid battery 52 in preventing the formation of an arc, while rectifier 49 tends to bias the grid more positively. Precisely what will happen depends on the relative amplitudes of the three 45 inputs and of the grid battery biasing voltage. It is possible to adjust these so that (a) input from generator 42 alone will not cause the arc to strike, unless assisted by input from generator 44, with no input from generator 43, which can 50 inhibit the striking of the arc if also applied; (b) input from generator 42 will cause the arc to strike, unless generator 43 is also connected, in which case if generator 44 be turned on also the arc will strike (c) input from generator 43 55 will prevent the striking of an arc at any time; (d) input from generator 44 will cause an arc to strike at any time. The particular adjustment chosen will depend on the requirements of the application of this invention. In any 60 case, the arc can only be quenched by the operation of key 67.

While this invention has been described with reference to certain embodiments thereof, it is not so limited, but includes any and all organization falling within the scope and spirit of the 65 appended claims.

What is claimed is:

75 1. A gas-filled discharge tube comprising grid, plate and cathode electrode, a work circuit connected to said cathode and plate electrodes and

adapted to be closed when said tube discharges, means for applying an operating voltage to said plate, means for applying a negative biasing voltage to said grid whereby said tube will normally be in a non-discharging condition, means 80 for so applying an alternating voltage to the grid circuit of said tube as to reduce said negative biasing voltage so that said tube will discharge, and means for so applying another alternating voltage to the grid circuit of said tube as 85 to increase said reduced negative biasing voltage to a value such that said tube will again cease to discharge.

2. A gas-filled discharge tube comprising grid, plate and cathode electrodes, a circuit connected 90 to said cathode and plate electrodes and adapted to be closed when said tube discharges, means for applying an operating voltage to said plate, a grid-cathode circuit for said tube, means in 95 said grid-cathode circuit for applying a negative biasing voltage to said grid to prevent the discharge of said tube, a rectifier and a resistance and a condenser included in said grid-cathode circuit, means for applying an alternating 100 current to said rectifier, said rectifier being so poled that the alternating current applied thereto will build up a potential on the side of said condenser connected to said grid which will oppose said biasing voltage, a second rec- 105 tifier and a second resistance and a second condenser associated with said grid-cathode circuit, and means for applying an alternating current to said second rectifier, said second rectifier being 110 so poled that the alternating current applied thereto will build up a potential on the side of the said second condenser connected to said grid which will aid said biasing voltage.

3. A gas-filled discharge tube comprising grid, cathode and plate electrodes, means for applying 115 an operating voltage to said plate, means for applying a biasing voltage to said grid, means for varying said biasing voltage so that the condition of operation of said tube may be controlled, a transformer having its secondary wind- 120 ing in the plate circuit of said tube and having its primary winding connected to a source of current, and a second transformer having its primary winding in the plate circuit of said tube and its secondary winding connected to a work circuit.

4. A gas-filled discharge tube comprising grid, 125 plate and cathode electrodes, a transmission circuit connected to said cathode and plate electrodes and adapted to be closed when said tube discharges, means for applying an operating voltage to said plate, a grid-cathode circuit for 130 said tube, means in said grid-cathode circuit for applying a negative biasing voltage to said grid to prevent the discharge of said tube, means for applying an alternating current to said grid-cathode circuit to vary said negative biasing 135 voltage, a rectifier and resistance connected in said grid-cathode circuit, means for applying an alternating current across said resistance through said rectifier, said rectifier being so 140 poled that the voltage drop across said resistance will oppose said biasing voltage, a second rectifier and resistance connected in said grid-cathode circuit in series with said first rectifier and resistance unit, and means for applying an alternating current across said last mentioned re- 145 sistance through said last mentioned rectifier, said last mentioned rectifier being so poled that the voltage drop across said last mentioned resistance will aid said biasing voltage.

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