Jan. 8, 1935. C. S. DEMAREST 1,986,921

SELECTIVE SIGNALING SYSTEM

Filed Oct. 20, 1932 3 Sheets-Sheet 1

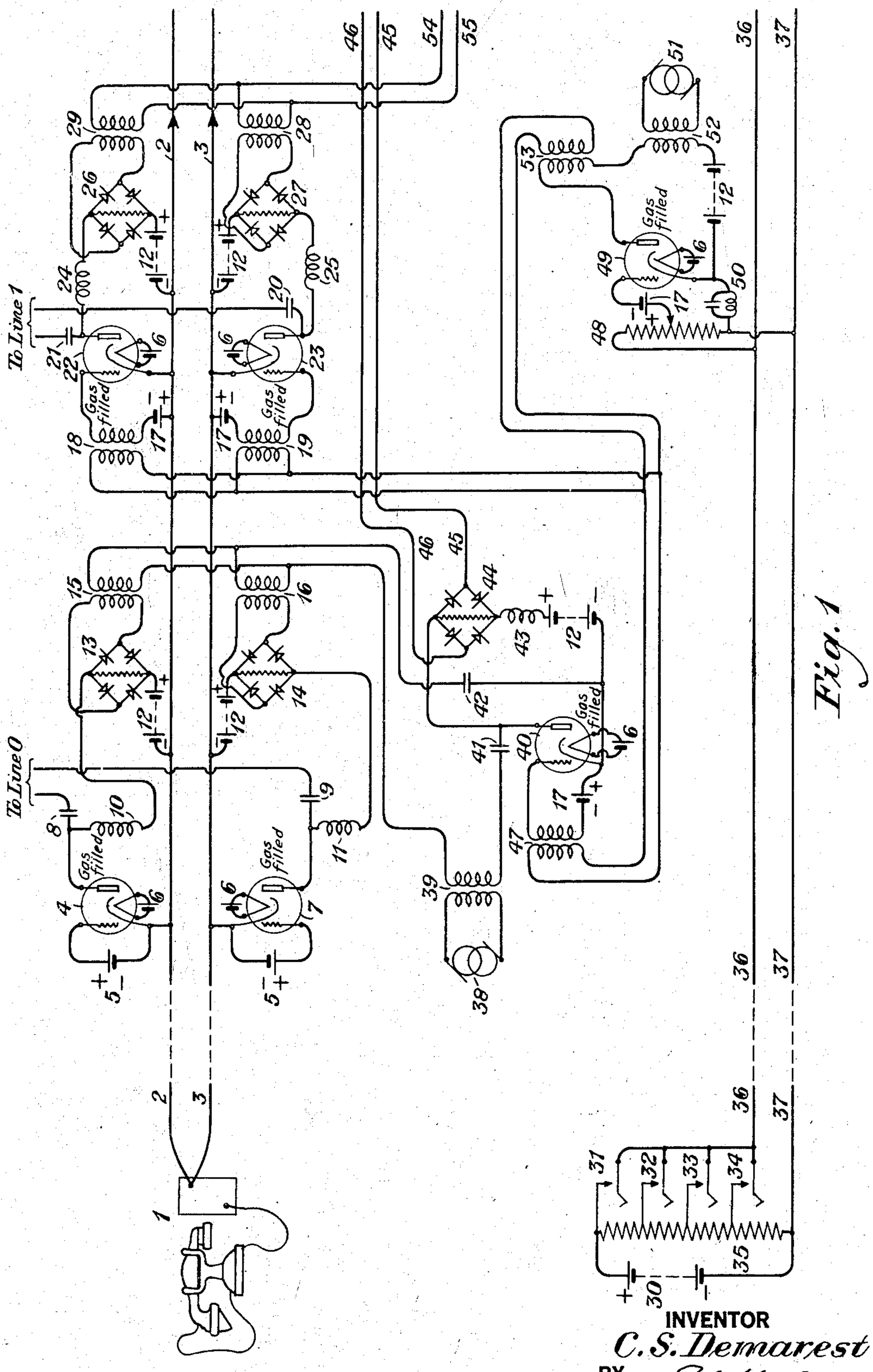

Fig. 1

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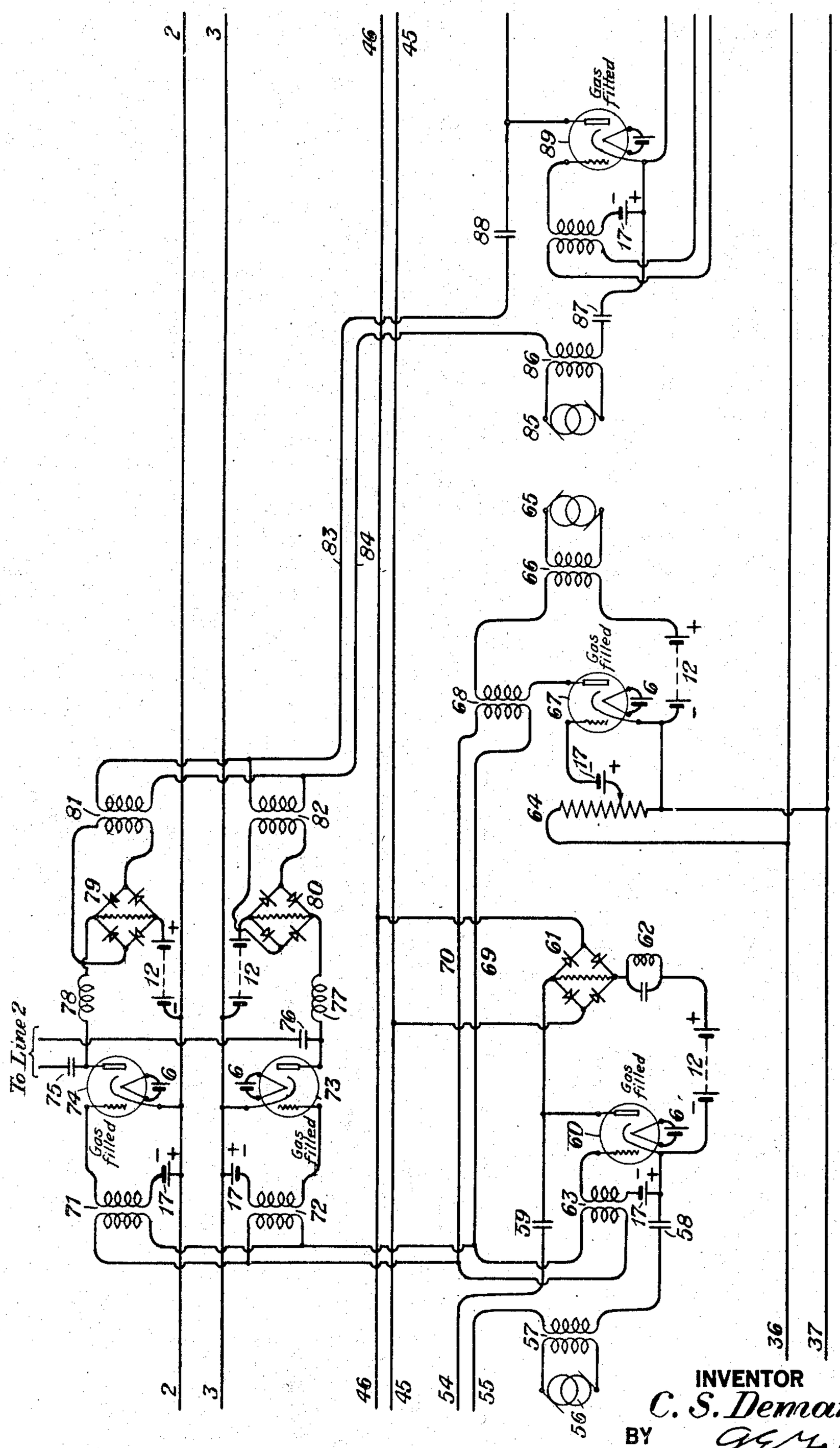

Fig. 2

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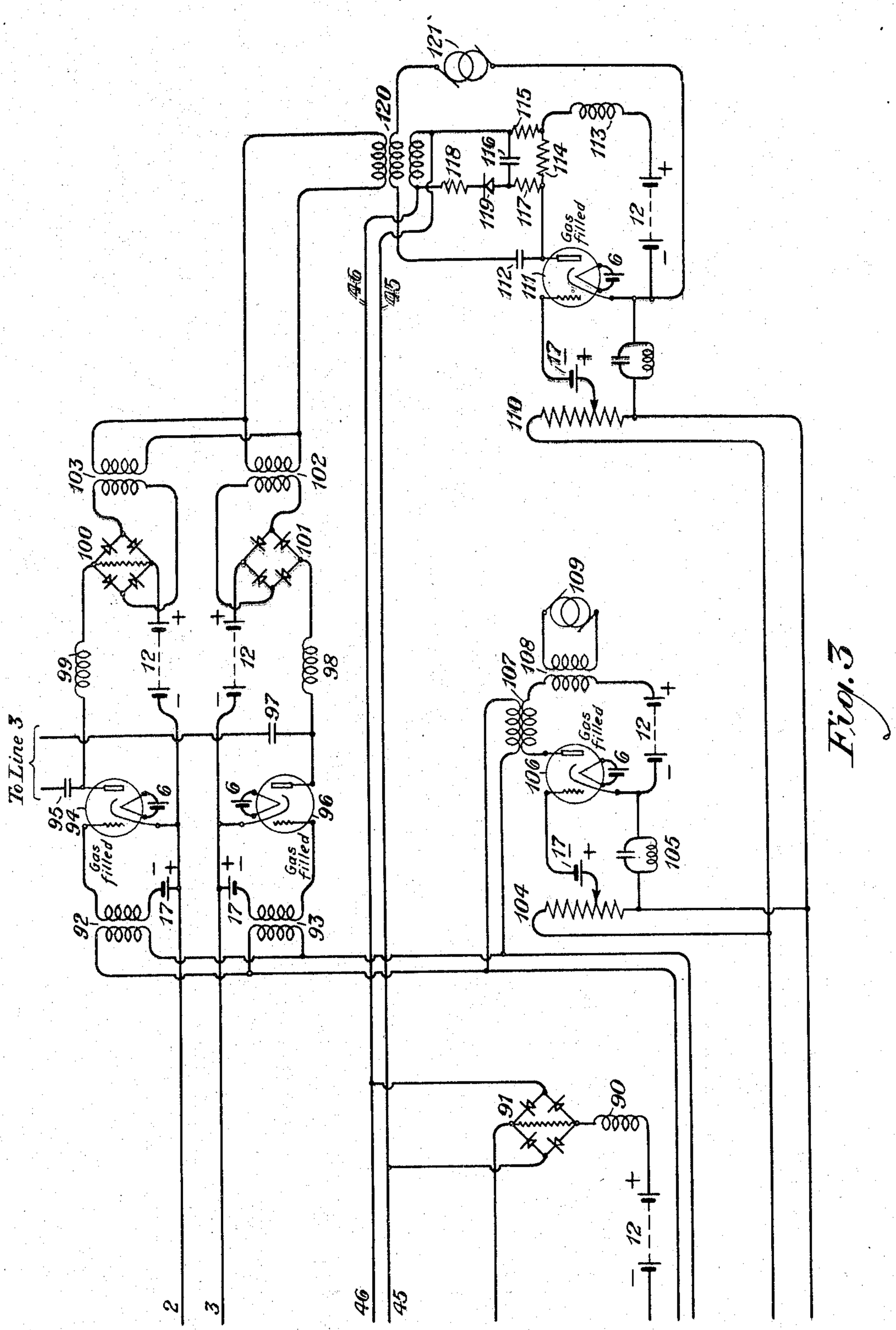

Fig. 3

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UNITED STATES PATENT OFFICE

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SELECTIVE SIGNALING SYSTEM

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Application October 20, 1932, Serial No. 638,786

3 Claims. (Cl. 177—353)

This invention relates to electrical circuits, and more particularly to circuits for selective signaling of switching, in which a signal may be transmitted selectively to one of a plurality of circuits or a circuit may be connected selectively to one of a plurality of circuits.

Circuits for selective switching and signaling have in the past employed electromagnetically operated relays and selectors, having mechanically moving parts, and which require careful adjustment and maintenance of mechanical motions, such as armature travel, clearance between moving members, spring tensions and contact pressures. Furthermore, it has been found impracticable to secure any considerable number of selections on a voltage basis owing to the difficulty of securing accurate marginal operation with conventional types of relays and selectors. It is an object of this invention to provide means for selective signaling or switching operations which do not require mechanically moving parts operated directly or indirectly by electromagnets, but which employ instead electrical discharge devices of the thermionic gas-filled type, operating on a voltage marginal basis. The thermionic gas-filled discharge tube is especially adapted to this use on account of the close and accurate setting for marginal operation possible by adjustment of grid bias or anode potential or both.

Other objects of this invention will appear from the following description of an embodiment thereof, when read in connection with the appended drawings, in the Figures 1, 2 and 3 of which the invention is illustrated. Figs. 1, 2 and 3 when taken together constitute a circuit diagram illustrating a preferred form of the invention.

Referring to Fig. 1, reference character 1 indicates a telephone subscriber's station, connected to a central office over wires 2 and 3. Also at the subscriber's station is a source of direct current 30 connected to a potentiometer resistance 35 from which taps are brought out to keys 31, 32, 33 and 34, so that when any one of these keys, which are preferably mechanically interlocked so that only one can be depressed at a time, is operated a predetermined voltage will be applied to signaling conductors 36 and 37. It would of course be possible and generally desirable to combine pairs 2, 3 and 36, 37, utilizing filtering means to separate the signaling and speech currents, but these circuits have here been shown separate for illustrative purposes only and to clarify the description.

At the central office the conductors 2 and 3 are connected to a plurality of gas-filled thermionic tubes, grouped in pairs, these being tubes 4, 7, tubes 22, 23, tubes 73, 74 and tubes 94, 96. When arcs are struck in any one pair of these tubes an alternating current path for speech currents can be traced through the arc paths of the given pair, the cathodes thereof being connected to conductors 2 and 3 respectively, and through the blocking condensers, such as 8, 9, or 20, 21 or 75, 76 or 95, and 97, to conductors leading to lines 0, 1, 2, or 3.

Grid biasing batteries 5 have the grids of tubes 4 and 7 positive so that normally arcs will be established therein and conductors 2 and 3 thus connected for speech currents to line 0. Under such conditions it would be possible for the subscriber's set 1 to be connected to an operator when none of the keys 31 to 34, inclusive, are operated. If now a given key, for example 34, be depressed this will cause a voltage impulse of predetermined magnitude to be sent over wires 36 and 37 and applied to the potentiometers 48, 64, 104 and 110. Wire 36 is raised to a postive potential above wire 37, but as key 34 applies the lowest voltage tube 49 alone will operate, as the settings of the other potentiometers are so adjusted that the fraction of the voltage difference between wires 36 and 37 by them applied to the grid circuits of the corresponding tubes is insufficient to override the grid biasing batteries 17 which normally bias the grids negatively to such an extent that no arc will strike.

In the anode circuit of tube 49 there are transformers 52 and 53. The primary winding of transformer 52 is connected to the source of alternating current 51. The alternating voltage induced in the secondary is greater in peak value than the voltage of anode battery 12, and therefore upon removal of the positive voltage applied to the grid through potentiometer 48 the arc in the anode circuit will be extinguished in the next negative half cycle. As long as key 34 remains closed, however, alternating and direct currents both will flow in the anode circuit of tube 49 and through the primary of transformer 53. The alternating current induced thereby in the secondary of transformer 53 will be applied to the input transformers 47, 18 and 19, associated with tubes 40, 22 and 23 respectively. Arcs will accordingly strike in these tubes. The arcs in tubes 22 and 23 will connect conductors 2 and 3 to line 1, as hereinbefore explained. Striking of the arc in the anode circuit of tube 40 will complete an alternating current circuit from the secondary of transformer 39, the primary of which is connected to alternating current

source 38. Alternating current will flow from the secondary of transformer 39, through condenser 41, the arc path in tube 40, and condenser 42 to the primaries of transformers 15 and 16. The secondaries of these transformers are connected to rectifier-resistance units 13 and 14, and the application of alternating current thereto builds up a potential in the resistances of these units 13 and 14 in opposition to the anode batteries 12, thus extinguishing the arcs in tubes 4 and 7 and disconnecting conductors 2 and 3 from line 0. Inductances 10 and 11 prevent any alternating current ripple voltage from rectifiers 13 and 14 from passing into conductors 2 and 3 or into line 0. Tube 49 ceases to conduct on opening key 34, but tube 40 retains an arc and holds tubes 4 and 7 inoperative. Tubes 22 and 23 remain operated due to the voltage of anode batteries 12.

Application of a higher voltage by closing key 33 will cause tube 67 to pass current, but not tubes 106 or 111. The plate circuits of this tube are identical with those of tube 49, resulting in the striking of arcs in tubes 73 and 74 and also in tube 60. Tube 60 will now remain in a conducting condition and alternating current from its anode circuit will be carried over conductors 54 and 55 to transformers 28 and 29. The secondaries of these are connected to rectifier resistance units 26 and 27 which, as in the case of tube 40, build up a voltage in opposition to the anode battery and extinguish their arcs, and so disconnect conductors 2 and 3 from line 1, while the striking of arcs in tubes 73 and 75 connects conductors 2 and 3 to line 2. Similarly, closing key 32 will apply a still higher voltage, operating tube 106, in consequence of which as explained previously in the case of tube 49, arcs will strike in tubes 94 and 96, connecting conductors 2 and 3 to line 3, an arc will also be caused to strike in tube 89, which will extinguish tubes 73 and 74, in the same way as the striking of an arc in tube 40 extinguished tubes 4 and 7.

It should be noted that the keys 34, 33, 32 need not be closed sequentially as stated to secure the stepwise progression from line 0 to line 3. False or double connections will not result, for instance, if key 34 is closed after key 32, an arc will strike momentarily in tube 49, but as tubes 40, 60 and 89 are already passing anode currents, tubes 73 and 74 and also tubes 4, 6 and 21, 23 are disabled by the action of the rectifier resistance elements 79 and 80, 13 and 14, and 26 and 27 in their respective anode circuits, these rectifier resistance units receiving power from tubes 40, 60 and 89 as hereinbefore explained.

Closure of key 31 will apply the maximum voltage difference between conductors 2 and 3 and will result in the arc striking in tube 111, the potentiometer 110 and grid biasing battery 17 of which are so adjusted that only the maximum voltage will enable this tube 111 to pass an arc. When this occurs, alternating current will flow from alternating current source 121 through the primary winding of transformer 120, condenser 112, arc path of tube 111 and so back to alternating current source 121. The secondary winding of transformer 120 will then apply alternating current to conductors 45 and 46, to which are connected rectifier and resistance elements 91, in the anode circuit of tube 89, 61, in the anode circuit of tube 60, and 44, in the anode circuit of tube 40. The direct potential, developed across the resistance elements of these units in opposition to the anode batteries 12, will result in lowering the anode potentials of these tubes to such an extent that arcs will no longer be maintained therein. This will permit arcs to restrike in tubes 4 and 7, reconnecting conductors 2 and 3 to line 0. At the same time, the tertiary winding of transformer 120 applies alternating voltage, through transformers 102 and 103 to the rectifier resistance units 100 and 101 in the anode circuits of tubes 94 and 96, extinguishing the arcs in these tubes as hereinbefore explained, and thus disconnecting conductors 2 and 3 from line 3.

At the same time, alternating current from the secondary of transformer 120 is applied to the network consisting of resistances 118, 117, 114 and 115, condenser 116 and rectifier 119 in the anode circuit of tube 111. The rectifier 119 will charge up condenser 116 slowly through the resistance 118, and current from condenser 116 will also pass through resistances 114, 115 and 117, developing sufficient electromotive force in resistance 114 to oppose anode battery 12 and extinguish the arc in tube 111, but only after a delay predetermined by value of the resistances 114, 115, 117 and 118 and capacity 116. This will not occur until after the quenching of the arcs in all other tubes operating before the arc struck in tube 111, and after tubes 4 and 7 have again begun to pass current. The conditions are thus restored to normal, conductors 2 and 3 being connected to line 0.

While this invention has been described with respect to a particular embodiment thereof, it is not limited by the arrangements described, but includes any and all organizations falling within the scope and spirit of the appended claims. In particular, it might be found desirable in certain applications of this invention to utilize cold cathode gas-filled tubes rather than the thermionic type, thus eliminating the cathode heating batteries 6, or other quenching methods, not involving the use of rectifier and resistance elements might be employed. Such modifications are, however, within the scope of my invention.

In my copending application, Serial No. 629,382, filed August 18, 1932, Patent No. 1,908,326 I have disclosed a system whereby a line may be selectively connected to any of a plurality of other lines. In the above referred to arrangements selection is made by the use of a train of coded impulses. It is pointed out that the system in the above copending application might readily be combined or associated with any of the lines, such as 0, 1, 2 or 3 of this invention. After such a line was selected and connected to circuit 2, 3, trains of coded impulses could be sent out thereover to operate arrangements, such as shown in the above copending application, connected to such a line.

Accordingly while the invention has been disclosed as embodied in certain specific arrangements which have been deemed desirable, it is pointed out that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. In a signaling system, selectively operated switching means comprising a first set of gas filled tube devices each having input and output circuits, each of said devices having plate voltages sufficient to maintain the devices in discharging condition after they are initially broken down and started in discharging condition, extinguishing means associated with the output circuits of each of said tube devices for changing said plate voltages so that they will be insuffi-

cient to maintain the devices in discharging condition, a second set of gas filled tube devices corresponding to said first set, each of the gas filled tube devices of said second set having different fixed voltages applied to their input circuits, a source of currents of different voltages, switching means for selectively applying voltages of different values from said source to the input circuits of the tubes of said second set to cause different ones of said tubes to break down and operate, and means controlled by each tube device of said second set for operating its corresponding tube device in said first set and for operating the extinguishing means associated with the preceding tube device in said first set.

2. In a signaling system, selectively operated switching means comprising a first set of gas filled tube devices each having input and output circuits, each of said devices having plate voltages sufficient to maintain the devices in discharging condition after they are initially broken down and started in discharging condition, extinguishing means associated with the output circuits of each of said tube devices for changing said plate voltages so that they will be insufficient to maintain the devices in discharging condition, a second set of gas filled tube devices corresponding to said first set, each of the gas filled tube devices of said second set having different fixed voltages applied to their input circuits, a source of currents of different voltages, switching means for selectively applying voltages of different values from said source to the input circuits of the tubes of said second set to cause different ones of said tubes to break down and operate, means for adjusting the output circuits of the tubes of said second set so that when the voltages applied from said source to the input circuits of said tubes are removed said tubes will become extinguished, and means controlled by each tube device of said second set for operating its corresponding tube device in said first set and for operating the extinguishing means associated with the preceding tube device in said first set.

3. In a signaling system, selectively operated switching means comprising a first set of gas filled tube devices each having input and output circuits, each of said devices having plate voltages sufficient to maintain the devices in discharging condition after they are initially broken down and started in discharging condition, extinguishing means associated with the output circuits of each of said tube devices for changing said plate voltages so that they will be insufficient to maintain the devices in discharging condition, a second set of gas filled tube devices corresponding to said first set, each of the gas filled tube devices of said second set having different fixed voltages applied to their input circuits, a source of currents of different voltages, switching means for selectively applying voltages of different values from said source to the input circuits of the tubes of said second set to cause different ones of said tubes to break down and operate, means for adjusting the output circuits of the tubes of said second set so that when the voltages applied from said source to the input circuits of said tubes are removed said tubes will become extinguished, an auxiliary gas filled tube associated with each of the tube devices of said second set, each of said auxiliary gas filled tubes controlling the operation of the corresponding tube device of said first set and controlling the extinguishing means associated with the preceding tube device of said first set, and means controlled by the last tube device of said second set for extinguishing all of said auxiliary gas filled tubes.

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