June 11, 1935. W. H. T. HOLDEN 2,004,244

SELECTIVE SIGNALING SYSTEM

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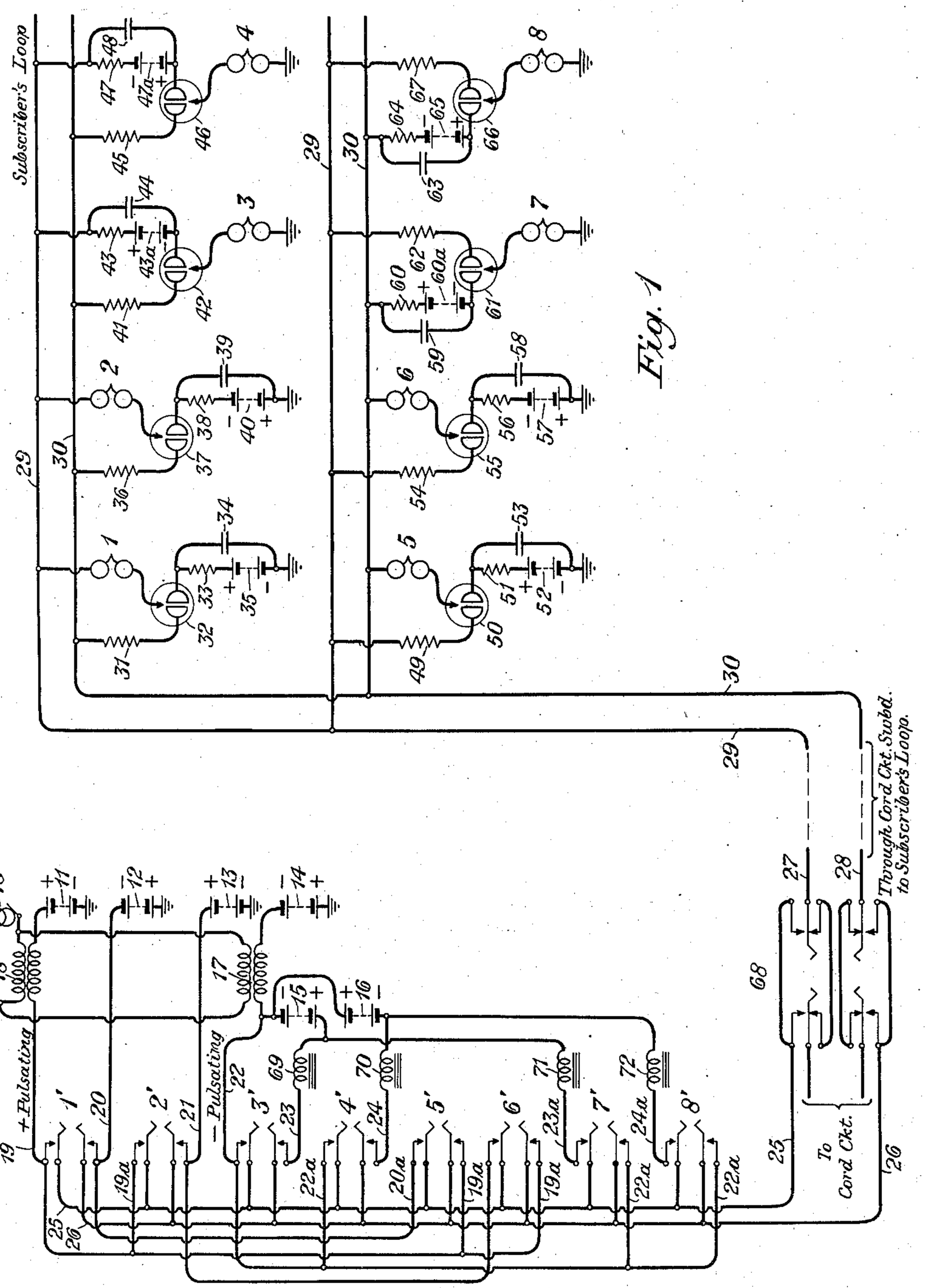


Fig. 1

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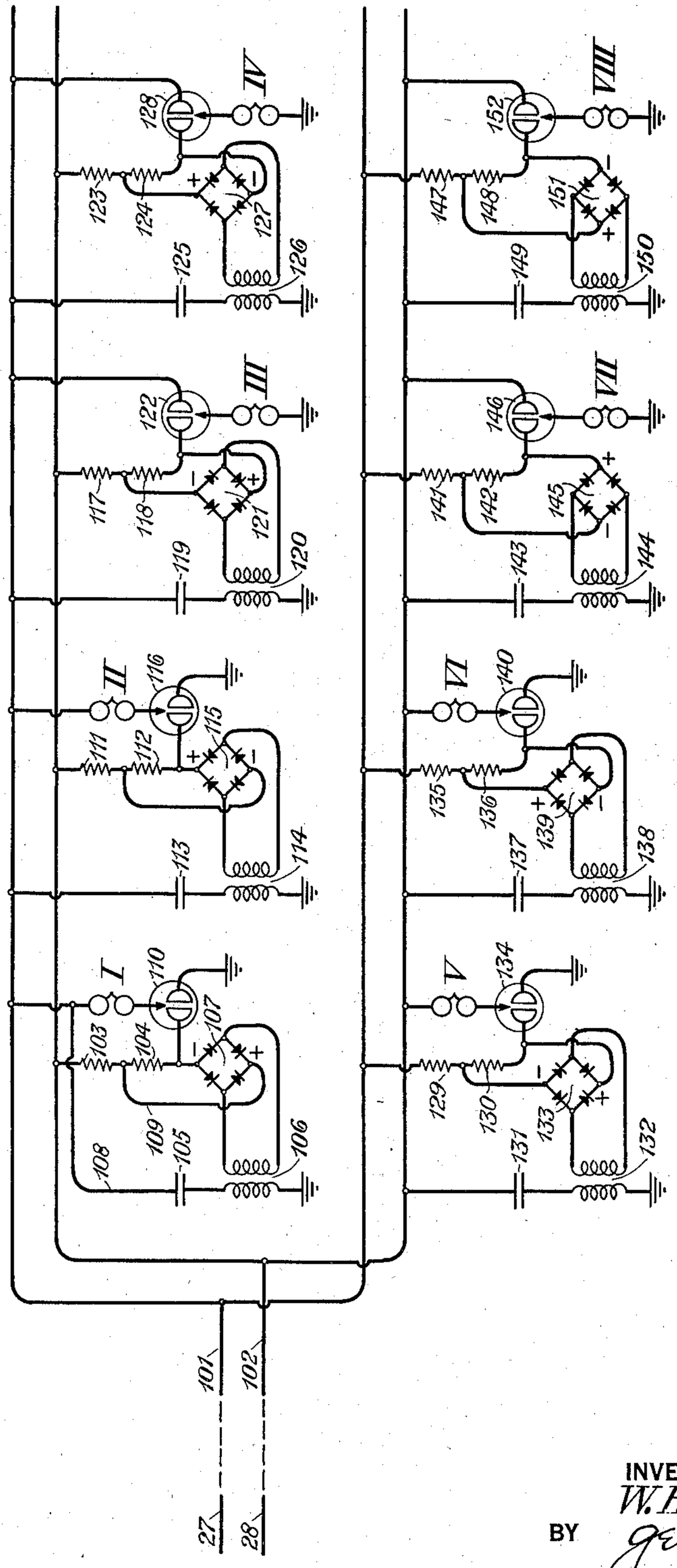


Fig. 2

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## SELECTIVE SIGNALING SYSTEM

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4 Claims. (Cl. 179—86)

This invention relates to electrical circuits, and more particularly to that class of circuits used for selective ringing or signaling, whereby a signal may be operated at one of a plurality of stations connected to the same line.

In the past it has been usual to obtain selective ringing by suitable connections between line and ground, together with the use of bias arrangements, as in the well known four-party selective ringing system. The arrangements there used are inherently limited to not more than four stations. Where greater numbers of stations are required it has been necessary to resort to harmonic ringing, selectors at stations, or other expedients.

It is one of the objects of this invention to provide a selective ringing system which will permit full selective operation up to eight stations, without requiring multi-frequency generators to be used.

Another object is to provide a fully selective system which will be distinguished from semi-selective systems. In other words, one of the objects of this invention is to signal any one of a plurality of different stations independently of all of the remaining stations. Thus, in an eight-party system, for example, one of the parties would be exclusively signaled while all of the remaining parties would be absolutely unaware that the single party was so signaled. Other objects of this invention will be apparent from the following description when read in connection with the accompanying drawings in which certain embodiments of the invention are illustrated.

Referring to the drawings, Figure 1 is a diagrammatic illustration of one modification of the invention, showing biasing batteries at the several stations connected with the line circuit, and Fig. 2 is a modification thereof wherein rectifiers are substituted for said batteries.

The means utilized at the stations for producing the selective operation include a cold electrode gas filled discharge tube, of the type commonly referred to in the art as a cold cathode ionic tube of the double gap type. Such tubes possess a cathode, coated preferably with some material to reduce the cathode fall, or activated, as this is termed, an auxiliary electrode, also activated, and so spaced from the cathode that the breakdown voltage between this electrode and the cathode is relatively low, of the order of 60 volts. This discharge path, auxiliary electrode to cathode, is spoken of as the control discharge path or control gap. These tubes are also provided with an anode, so spaced from the cathode that the breakdown voltage therebetween is much greater than that from cathode to auxiliary electrode, and voltages of 200 to 300 are typical. The minimum voltage to sustain a discharge, once started, will be nearly the same for the two discharge paths, the main gap, or anode to cathode path being possibly 10 volts higher. It is found that if a voltage less than the breakdown, but above the sustaining voltage is applied to the main gap, and a discharge is caused to pass through the control gap, a breakdown of the main gap will take place, being triggered off by the control gap. The main gap, that is, the gap between the anode and one of the cathodes, can be broken down only when positively poled superposed ringing current,—hereinabove called a positive ringing current—is applied between the anode and cathode. This main gap cannot be broken down when negative ringing current is applied to the anode. When positive ringing current is thus applied to the anode and this current passes between said anode and the cathode, current is discharged through this path only during one-half cycle. During the remaining half of the cycle there is no discharge whatever between the anode and cathode. In other words, the tube acts as a half-wave rectifier in that part of the tube which includes the anode and cathode. Before a particular station can be effectively signaled, however, it is necessary that the control gap and the main gap be both broken down at the station to be signaled.

Referring to Fig. 1 of the drawings, reference characters **1**, **2**, **3**, **4**, **5**, **6**, **7** and **8** indicate subscribers stations, while **1'**, **2'**, **3'**, **4'**, **5'**, **6'**, **7'**, and **8'** indicate respective ringing keys at the central office. When key **68** is operated so as to connect conductors **25** and **26** to conductors **27** and **28**, respectively, and when key **1'** is depressed, station **1** will be signaled; and if key **2'** be depressed, station **2** will be signaled, and so for the remaining six keys and stations. The method by which this is accomplished is as follows:

Let it be assumed that key **68** is operated in such a manner as to connect conductor **25** to conductor **27**, and conductor **26** to conductor **28**. When a cord circuit is in use, conductor **27** will be connected to conductor **29** through the plugs and jacks of the switchboard in a manner well known in the art, and similarly conductor **28** will be connected to conductor **30**. Conductors **29** and **30** are the conductors constituting the metallic subscriber's loop, across which the subscribers' stations **1** to **8** are bridged. It may be remarked that only the ringing equipment has

been shown in the drawings, as this invention is not concerned with the features of the talking circuit and the telephone instruments have therefore not been shown, in order to simplify the drawings.

When key 1' is depressed, conductor 25 is connected to conductor 19, through the upper contacts of key 1', while conductor 26 is connected to conductor 20, through the lower contacts of the same key. Conductor 19 is connected to the secondary of transformer 18, the other end of which is connected to ground through battery 11. The primary transformer 18 is connected to ringing generator 10, which supplies ringing current at a frequency of approximately 20 cycles per second. The voltages are so adjusted that the battery 11 will be approximately equal to the peak value of the 20-cycle voltage in the secondary of transformer 18. This pulsating or superposed ringing current is therefore transmitted over conductor 25 through key 68, conductor 27, conductor 29 to all subscribers' stations. At all stations the voltage thereby applied is too low to break down the main discharge path from anode to cathode in any of the cold cathode ionic tubes 32, 37, 42, 46, 50, 55, 61 or 66, if no current is flowing in the control discharge paths thereof or from electrode to cathode. But the voltage of the negative battery 12, whose positive terminal is grounded, will be applied to conductor 30, over conductor 20 and the lower contacts of key 1', conductor 26, key 68, conductor 28 and conductor 30. Conductor 30 is connected to the control discharge gaps of tubes 32, 37, 42, 46, 61 and 66. No discharge will take place in tube 37 because the polarity of battery 40, connected between cathode and ground, is such as to make the voltage across the control gap of tube 37 too low to cause a discharge. The control gaps in tubes 42 and 46 are connected across the loop, and will therefore pass discharges, due to the total voltage difference between conductors 19 and 20, but the ringers at these stations are connected between the anode of the discharge tube and ground, and owing to the polarity of battery 11, and rectifying property of the anode to cathode circuit of these tubes, insufficient current will flow to operate the ringers at stations 3 and 4. The same situation exists at stations 7 and 8. At station 1, however, the polarity of battery 35 is such that it aids battery 12 to produce a discharge in the control gap of the ionic tube 32, the current flow being limited by resistances 31 and 33. Whenever the anode of tube 32 is more than 65 to 70 volts positive, current will flow in the anode and cathode path, charging condenser 34. Whenever the anode is less than 65 to 70 volts positive, condenser 34 will discharge through resistance 33 and battery 35. As a result pulses of current, corresponding to one-half wave rectified 20-cycle ringing current, will flow through the ringer at station 1 and give a signal at that station. Ringers at stations 5 and 6 cannot operate as they are not connected to the line conductor 29.

If it is desired to signal station 2, key 2' is operated, instead of key 1'. As before, alternating ringing voltage superposed on the positive battery 11 is connected to conductor 25 and thence through key 68 to conductors 27 and 29, the circuit being completed over conductor 19, conductor 19a and the upper contacts of key 2'. As before, positive superposed ringing current applied to conductor 29 cannot cause ringer operation at stations 3, 4, 7 or 8 even if the control gaps of the tubes 42, 46, 61, 66 at these stations break down, owing to the unilateral conductivity of the anode-cathode discharge paths of the ionic tubes employed. Ringers at stations 5 and 6 cannot operate as these ringers are not connected to the line conductor 29. The control gap in tube 32 at station 1 will not break down, as the operation of key 2' connected positive battery 13 over conductor 21 through the lower contacts of key 2' and conductor 26, through key 68 to conductors 28 and 30. The negative terminal of battery 13 is grounded. This battery will oppose battery 35 at station 1, but will aid battery 40 at station 2. The control gap of tube 37 will pass a discharge and ringing current will as before flow through ringer at station 2, tube 37 and condenser 39 to ground, operating the ringing signal at station 2.

In a similar manner selective ringing of stations 5 or 6 may be obtained by depressing keys 5' or 6', the circuits being identical with those already described, except that ringing current is sent out over conductor 30 and negative battery over conductor 29 for station 5 from battery 12 and conductor 20, and positive battery for station 6 from battery 13 over conductor 21, there being no other difference beyond this interchange of functions of the conductors 29 and 30.

If it is desired to signal station 3, key 3' is depressed. This connects conductor 22 to conductor 25 and thence through key 68 to conductors 27 and 29. Conductor 22 is connected to one end of the secondary of transformer 17, the other terminal of which is connected to ground through battery 14, whose positive terminal is grounded. The primary of transformer 17 is connected in parallel with that of transformer 18 to the source of ringing current 10. The voltages in this circuit are also so adjusted that battery 14 is substantially equal to the peak voltage in the secondary of transformer 17, but as this battery is poled oppositely to battery 11, negative superposed ringing current is applied to conductor 29. This cannot operate ringers 1 or 2 even though the control gaps in these tubes break down, owing to the unilateral conductivity of the anode circuits. Nor can it operate ringers 7 and 8 as the resistances 62 and 67 are too high to permit sufficient current to pass; while flow of ringing current through condensers 59 or 63 over conductor 30 back to key 3', conductor 32, and battery 15 is prevented by the large inductive reactance presented by inductance 69. Ringing current can only flow in sufficient quantity to operate a ringer through the ringers at stations 3, or 4, depending upon which of the tubes 42 or 46 is caused to pass current by a discharge across the control gap thereof. The operation of key 3' connects battery 15 between conductors 25 and 26, the negative terminal thereof being connected to conductor 22 and thence to conductor 25 through the upper contacts of key 3', while the positive terminal of battery 15 is connected to conductor 23 through inductance 69, and conductor 23 is connected to conductor 26 through the lower contacts of key 3'. The control gaps of tubes 42 and 46 are connected across conductors 29 and 30, which are connected respectively to conductors 25 and 26, via conductors 27 and 28 and key 68. Battery 43a is so poled as to aid battery 15 in producing a discharge in the control gap of tube 42, while battery 47a is poled in the reverse direction. Tube 42 will therefore pass a discharge in the control gap and ringing

current will flow through condenser 44, main discharge path of tube 42, and ringer to ground, operating the ringer at station 3. Had key 4' instead of 3' been operated, battery 16 would have been substituted for battery 15, and as this battery is poled oppositely, a discharge would have occurred in tube 46 instead of tube 42, and ringer at station 4 would have operated instead of the ringer at station 3. In a similar manner stations 7 or 8 could be signaled instead of 3 or 4, by operating the keys 7' or 8'. In this case negative superposed ringing current would be applied to conductor 30 instead of conductor 29 and control battery 15 or 16 would be applied between conductors 29 and 30 as before. The operation of the ringers at stations 3 or 4 will be prevented, although the control gaps in tubes 42 or 46 will break down, because there is no ringing current path of sufficiently low impedance to permit operation of ringers at stations 3 or 4, owing to the high value of resistances 41 or 45 and the high inductive reactance of choke coils 71 or 72. It will thus be seen that this system provides full selective eight-party ringing over a metallic loop.

Fig. 2 shows a modification of the invention disclosed in Fig. 1 whereby the biasing batteries 35, 40, 43*a*, 47*a*, 52, 57, 60*a* or 65 shown in Fig. 1 may be eliminated, the necessary direct voltages being obtained from the alternating ringing current by means of rectifiers, preferably of the copper-cuprous oxide or similar types.

Referring to Fig. 2 reference characters 27 and 28 refer to the same conductors as shown in Fig. 1, connected through the key 68 to the ringing keys 1' to 8', inclusive.

Conductors 27 and 28 are connected to the conductors 101 and 102, respectively, of the subscriber's loop through the switchboard in the well known manner. The details of this circuit are not shown, as not being essential to an understanding of this invention. As explained previously, when ringing key 1' is operated, positive superposed ringing current is sent out over conductor 27 to conductor 101, and negative battery is connected to conductor 28 and thence to conductor 102. At station I, positive superposed ringing current is applied to the anode of cold cathode ionic tube 110 through ringer at station I. At the same time the alternating component of the ringing current passes over conductor 108, from conductor 101 to and through condenser 105 and to ground through the primary of transformer 106. The secondary of this transformer is connected to rectifier 107 which produces a direct or pulsating direct potential across resistance 104, in such a manner that the end of resistance 104 connected to resistance 103 is positive while the end of resistance 104 connected to the control electrode of tube 110 is negative. The battery connected to conductor 102 over conductor 28 as previously described is positive grounded, the negative side being connected to the circuit. The voltage across the control gap of tube 110 will thus be the sum of the two voltages, and this will be adjusted so as to be sufficient to cause a discharge to pass in the control gap. As a result ringing current will flow in the main gap and ringer at station I will be operated.

The ringer at station II will not be operated under this condition because the rectifier 115, supplied with alternating ringing current from the secondary of transformer 114, is poled oppositely and thus the voltage on the control gap, being the difference of potential between battery 12 and the output of rectifier 115 working resistance 112 will be too low to cause a discharge to pass in the control gap. No ringing current sufficient to cause a signal will flow through tubes at stations III and IV, or VII and VIII because of the unilateral conductivity of the anode cathode discharge path of the ionic tubes. No signals will occur at stations V or VI because, while, the ringing current may cause discharges in the control gap, the battery voltage on conductor 102 is too low to cause a discharge in the main gap under any conditions. Thus station I will be signaled in a selective manner.

If, now key 2' be operated, instead of key 1', the potential applied to conductor 102 is reversed and will aid the rectifier output to produce a discharge in tube 116 instead of tube 110, thus signaling station II.

When negative superposed ringing current is applied to conductor 101 by the operation of key 31, and a direct potential produced by battery 15 is applied between conductors 101 and 102, the stations I, II, V and VI will not be signaled because of the high impedance of tubes 110, 116, 134 and 140 when the anodes are negative. Tubes 122, 123, 146 or 152 would be able to pass a ringing signal, but no sufficient current to operate the ringers can flow through the resistances 141 and 142 at station VII or 147 and 148 at station VIII, nor through the reactance 69 interposed in conductor 23 between key 3' and battery 15. This will prevent operation of tubes 146 or 152. In addition, of the rectifiers 145, 151, only 145 is so poled that the output thereof will aid battery 15 to produce a discharge in the control gap circuit. The presence of reactance 69 however prevents a false signal on the ringer at station VII when station III is desired. In the case of station III, the A. C. component of ringing current flows from the conductor 101 through condenser 119 to and through the primary of transformer 120 to ground. The secondary of this transformer is connected to rectifier 121, which applies a potential to resistance 118 of such polarity as to assist battery 15 in causing a discharge of the control gap of tube 122, which results then in a flow of negative superposed ringing current from conductor 101 through tube 122 and ringer at station III to ground, causing a signal at station III. In the case of station IV, the opposite poling of rectifier 127 opposes battery 15 so that the control gap of this tube does not break down and no signal takes place at station IV. But if key 4' be operated instead of 3', battery 16, of opposite poling, is substituted for battery 15, and now the output of rectifier 121 opposes the battery voltage, while that of rectifier 127 aids it. Accordingly, a discharge passes in the control gap of tube 128, resulting in a flow of ringing current from conductor 101 through tube 128 and the ringer at station IV to ground. As a result, the ringer at station IV operates but not the ringer at station III. A discharge also occurs in the control gap of tube 152 at station VIII, but reactance 70 limits the current to a value too small to operate the ringer at station VIII and hence only station IV is signaled.

Stations V, VI, VII and VIII are connected in a manner similar to I, II, III, and IV, except that for the operation of the stations V, VI, VII and VIII, the ringing current must be applied to conductor 102 and the control battery to conductor 101, instead of vice versa, as for the first four stations I, II, III and IV. It thus appears that full selective signaling can be accomplished by the system shown in Fig. 2, which has the ad-

vantage of eliminating the station batteries shown in Fig. 1.

While this invention has been described with regard to certain specific embodiments thereof, it is to be understood that it is not so limited, but includes any and all arrangements falling within the scope and spirit of the appended claims.

What is claimed is:

1. In a signaling system, the combination of a plurality of subscribers' stations, a ringer at each subscriber's station, a three-electrode gas-filled tube at each subscriber's station, each gas-filled tube having two electrodes which form a control gap and an anode which together with one of the electrodes forms a main gap in series with which the corresponding ringer is connected, a loop across which all of the subscribers' stations are connected, and means responsive to current received over said loop for simultaneously discharging the control gap and the main gap of the gas-filled tube at a selected subscriber's station to the exclusion of all other subscribers' stations so as to operate the ringer at said selected subscriber's station.

2. In a multi-party ringing system, the combination of a plurality of subscribers' stations, a two-wire line across which all of the subscribers' stations are connected, a source of alternating current, two sources of direct current, means for connecting said source of alternating current and one of said sources of direct current to one of the wires of said line and the other source of direct current to the other wire of said line, a three-electrode gas-filled tube at each subscriber's station, each of which tubes has a control gap, and a main gap, and means including said sources of current for simultaneously discharging both gaps of the tube at a selected station, said sources of direct current being so poled that only one of said subscribers' stations will be effectively signaled to the complete exclusion of all other subscribers' stations.

3. In a multi-party signaling system, the combination of a plurality of subscribers' stations, a two-wire line across which all of the subscribers' stations are connected, a source of alternating current, two sources of direct current, means for connecting said source of alternating current and one of said sources of direct current to one of the wires of said line and the other source of direct current to the other wire of said line, switching means for selectively controlling the polarity of both sources of direct current connected to the two wires of said line and for selectively controlling the connection of said source of alternating current to either of said wires of said line, a plurality of cold cathode three-element gas-filled tubes each of which has two electrodes which form a control gap and an anode which, together with one of said electrodes, forms a main gap, one of said tubes being located at each of said subscribers' stations, and means at each of said stations responsive to the currents transmitted over the said two-wire line, said means including means for simultaneously discharging the control gap and the main gap of only one of said gas-filled tubes to the exclusion of all other of said tubes whereby the subscriber's station at which both of the gaps of the said tubes have become discharged will be signaled to the exclusion of all other subscribers' stations.

4. In a multi-party signaling system, the combination of a plurality of subscribers' stations, a plurality of indicating devices, a plurality of three-element tubes each having two electrodes forming a control gap and an anode which, together with one of the electrodes, forms the main gap, a plurality of full wave rectifiers at each subscriber's station including means for interconnecting one of said indicating devices, one of said devices and one of said rectifiers so that the corresponding rectifier will be in circuit with the control gap of said tube and the indicating device will be in circuit with the main gap of said tube, a two-wire line to which all of said subscribers' stations are connected, a source of alternating current, two sources of direct current, means for selectively connecting the source of alternating current and one of said sources of direct current to one of the wires and the other source of direct current to the other of the wires and for controlling the polarity of the sources of direct current so connected, the rectifiers and the main gaps of the tubes at the various subscribers' stations being so poled that only one of the indicating devices will be operated to the exclusion of all of the other indicating devices.

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