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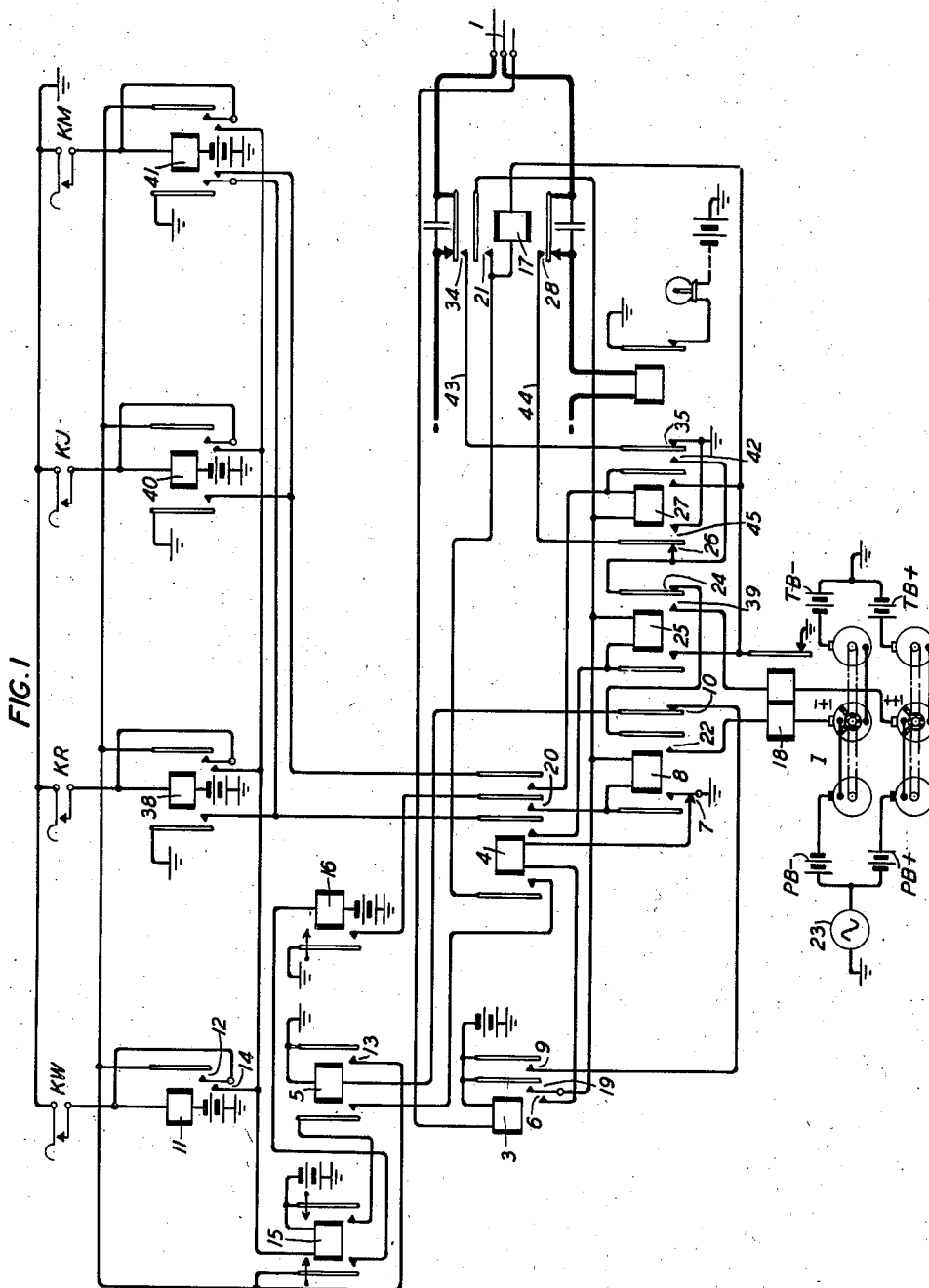
L. J. STACY

2,088,311

TELEPHONE RINGING SYSTEM

Filed April 17, 1936

2 Sheets-Sheet 1



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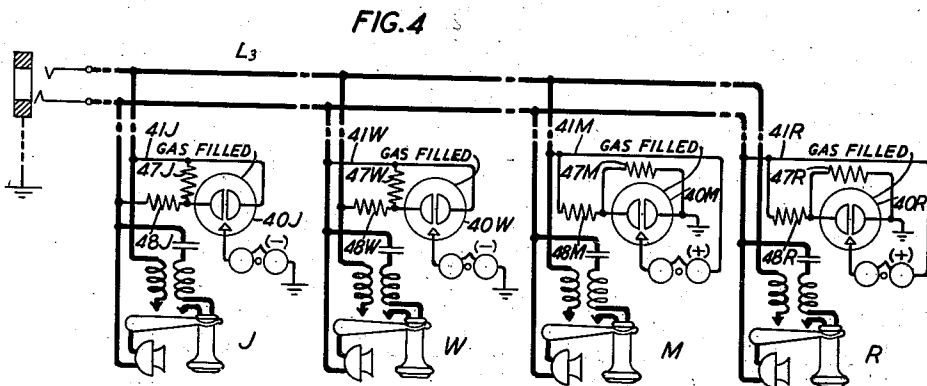
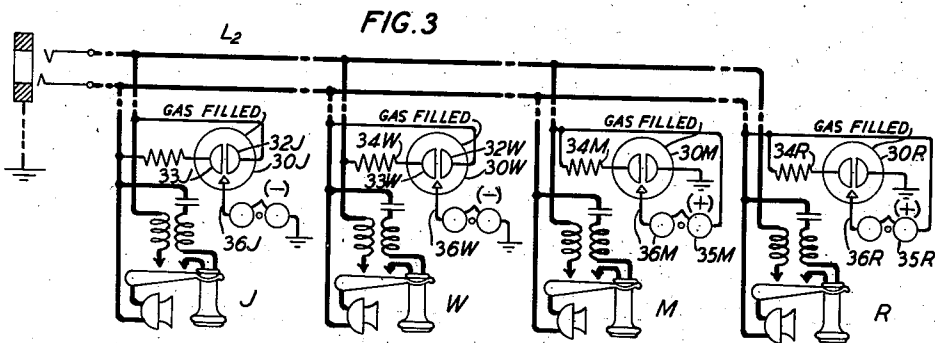
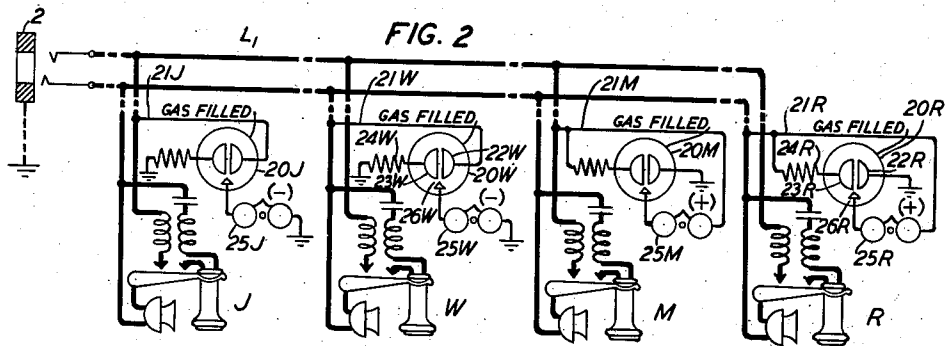
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TELEPHONE RINGING SYSTEM

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2 Sheets-Sheet 2



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TELEPHONE RINGING SYSTEM

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Application April 17, 1936, Serial No. 74,836

4 Claims. (Cl. 179—86)

This invention relates to selective signaling systems and more particularly to selective ringing systems for telephone lines. The object is to improve and simplify systems of this character.

5 Systems now generally employed for selectively operating any one of four telephone ringers connected to a single line employ what is known as "superimposed pulsating" currents the source of which comprises a conventional twenty-cycle
10 ringing generator in series with a source of direct current, such as a battery, which results in a current which may be considered as an alternating current wave with its neutral axis displaced from the central line of the wave by the
15 amount of the battery voltage. Such an arrangement is disclosed in the patent to Drake 763,970 of July 5, 1904.

At each station a relay is bridged across the line in series with a condenser and a ringer is
20 connected from one side of the line or the other to ground over a normally opened contact of its associated relay as shown in the Thompson et al. Patent No. 644,647 of March 6, 1900. When the superimposed current source is connected to
25 the line, all the bridged relays operate but current only flows through the two ringers which are connected to the live or ungrounded side of the line as the other side of the line is grounded at the central office thereby shunting the ringers
30 connected thereto.

Each ringer employed in this system must be of the usual polarized type and further must be biased, i. e. the armature must be held by a spring to one side or the other depending on
35 the direction of the current pulsations to which it is desired that it shall respond.

Systems of this character are so well known that a more complete description is deemed unnecessary.

40 A more recent suggestion relating to the connection of such polarized and biased ringers to a line to selectively respond to superimposed pulsating currents, as before described, is contained in the patent to Norton and May 1,517,857, dated
45 December 2, 1924 which proposed to replace the bridged relay and condenser combination, shown in the Thompson et al. patent with a gas discharge device containing two relatively closely spaced electrodes which device is serially con-
50 nected between the respective ringer and the line, such devices having the characteristic of preventing the start of any current flow in the ringer at voltages below the peak ringing voltage, i. e. of the order of 117 to 126 volts, but
55 when the ringing source is connected, those de-

vices connected to the line side of the line allow the ringing current to flow through the associated ringers.

As such two-element devices break down on, and conduct, current flowing in either direction, substantially equally, therefore, it is necessary to retain the polarized and biased types of ringers in order to insure that only one ringer responds to a particular direction of the ringing current. In the patent to Norton, 1,778,768 issued October 21, 1930 this problem was attacked by including in the discharge tube ringer circuit of Patent 1,517,857, a rectifying device.

A feature of the present invention resides in the substitution, for the two-element device of Norton et al., of a new type of gas discharge device employing three electrodes one of which is designated as the control electrode, which device is so constructed and connected that an applied ringing voltage of the proper value first causes a discharge to take place between the control electrode and the cathode thereby causing ionization of the gas within the device whereupon current therein, and only then, flows freely in the direction of the anode to the cathode and not at all, or at greatly reduced volume, from the cathode to the anode.

By employing such a discharge device and connecting the anode-cathode path thereof, in series with any type of electromagnetic ringer, which need not be polarized or biased, selective operation of the proper ringer can be obtained due to the rectifying characteristic of the discharge device without relying on a polarized biased characteristic of the ringing devices per se. In practice, it is further necessary to connect a high impedance in series with the connection to the control electrode to limit the breakdown discharge.

40 In certain instances where selective party line ringing, of the foregoing character, is employed it is desired to install coin boxes at the subscriber's station which are controlled, for the purpose of collecting coins, by negative polarity direct current of the order of 110 volts transmitted over the tip conductor of the line to ground through the coin box magnet. In this case if discharge devices, of the character described above, are substituted for the present relay and condenser arrangement, the two devices poled with their anodes to ground and cathodes to the line, which may be referred to as the "negative" devices, may break down when the negative 110-volts coin collect current is connected to the tip of the line. The negative de-

vice connected to the tip breaks down directly therefrom and the negative device connected to the ring conductor breaks down due to the coin voltage on the tip which passes through the subscriber's telephone set to the ring conductor.

To overcome this situation it is proposed to connect the two "negative" station discharge devices, not to ground as in non-coin box lines but, to the opposite side of the line from which the cathode of the device is connected. In this case the device gets its ground over the side of the line which is grounded at the central office when the ringing current is connected and only then.

A subordinate feature therefore resides in substituting, at the "negative" stations, a connection from the control electrode to the opposite side of the line from the side the cathode is connected, in place of local ground at the station.

In systems, where ringing current is intermittently and automatically connected to the subscriber's line at regular intervals until the subscriber answers (known as machine ringing), a source of direct tripping current is connected across the line during the silent interval, i. e. the interval between rings, for the purpose of operating a tripping relay at the central office to disconnect the ringing current when the called subscriber answers. The voltage of this source of direct current may vary in different exchanges and in certain instances it may be as high or higher than the breakdown voltage of the discharge devices which it is desired to employ.

In this case it may be desirable to prevent breakdown of the discharge devices during the silent interval which is accomplished by shunting the control electrode cathode gap with another high impedance.

The invention will be understood from the following description and drawings in which:

Fig. 1 represents the calling end of a machine ringing cord circuit arranged for four-party full selective signaling employing superimposed pulsating currents;

Fig. 2 represents a four-party subscriber's line arranged for full selective ringing in which a three-element gas-filled tube of the cold cathode type, having a rectifying characteristic, is employed in series with the associated ringer to ground;

Fig. 3 is identical with Fig. 2 except that in the case of the negative stations the control cathode of the gas-filled tube is connected in each case to the side of the line opposite to that over which ringing current is transmitted, instead of to local ground; and

Fig. 4 is identical with Fig. 3 except that a high impedance is connected between the two cathodes of each of the four tubes of the four-party full selective line.

Referring to Fig. 1 of the drawings, which shows only such essential details as are necessary for an understanding of the method of applying selective ringing current to lines arranged in accordance with the present invention, 23 is a source of alternating ringing current of any desired frequency, for example, 20 cycles, which is selectively supplied to contacts of the ringing relay 17 through either the polarizing battery PB- or PB+, corresponding brushes of the interrupter I, windings of relay 18 and contacts of relays 8, 25 and 27 as determined by the setting of the individual party ringing keys KW, KR, KJ and KM. Fig. 2 represents, as before mentioned, a subscriber's line equipped with four four-party selective ringing subscriber's sets arranged to

operate on polarized ringing current, which sets have been modified from the standard arrangement to the extent that three-element gas-filled tubes of the cold cathode type 29W, 29R, 29J and 20M have been connected, in accordance with this invention, in such a manner that the respective ringers of the W, R, J and M sets respond only in accordance with the setting of the ringing at the central office. Fig. 3 also represents a four-party selective line with similar gas-filled tubes 30W, 30R, 30J and 30M connected so that the respective ringers function as in Fig. 2, but also connected, in accordance with a subordinate feature of the invention hereinbefore mentioned, so that, when negative coin current is connected to the tip of the line, the tubes 30W and 30J at negative stations W and J do not break down. Fig. 4 also represents a four-party full selective line, similar to the line of Fig. 3 and, provided with gas-filled tubes 40W, 40J, 40R and 40M connected, in accordance with another subordinate feature of the invention, before mentioned, with a high impedance 47W, 47J, 47R and 47M shunting the cathode elements of the respective tubes, said impedance being provided to prevent the breakdown of the tubes when machine ringing is used and the tripping battery voltage of the so-called silent interval exceeds the normal breakdown voltage of the tube.

The circuit details and method of operation of these selective ringing sets, except as changed by the gas-filled tubes, are well known and described in the patent to Thompson et al. 644,647, patented March 6, 1900.

The invention will probably be best understood from a description of the operation of the circuit shown in the drawings and it will therefore be first assumed that the operator having control of the automatic or machine ringing cord circuit of Fig. 1 desires to ring the bell of the subscriber W on line L1 of Fig. 2. To accomplish this the operator will insert the plug 1 in the jack 2 of the subscriber's line and press the key KW associated with the cord circuit.

Insertion of the plug 1 in the jack 2 completes an obvious circuit for operating the sleeve relay 3, which in operating completes circuits for operating start relay 4 and relay 5 which can be traced from battery, contacts 19 and 6 of relay 3, winding of relay 4 and contacts 7 of cut-off relay 8 to ground, and from battery, contacts 3 of relay 3, contacts 10 of relay 8 and winding of relay 5 to ground.

When key KW is actuated an obvious circuit is closed for operating relay 11 which thereupon locks up to ground under control of relay 5 in the following circuit, battery, winding and contacts 12 of relay 11 and contacts 13 of relay 5 to ground. Relay 11 also completes, at its contacts 14, a circuit for operating relay 15 which can be traced from battery, winding of relay 15, contacts 14 and 12 of relay 11 and contacts 13 of relay 5 to ground.

Relay 15 in operating completes a circuit at its left-hand contacts, for operating relay 16 which can be traced from battery, winding of relay 16, left-hand contacts of relay 15 and contacts 13 of relay 5 to ground.

The operation of relay 15 also completes a circuit to operate ringing relay 17 which can be traced from battery, right-hand contacts of relay 15, left-hand contacts of relay 5, left-hand contacts of relay 4, winding of relay 17 and right-hand normal contacts of tripping relay 18 to ground.

When relay 17 operates it connects the ringing leads 43 and 44 to the tip and ring of the cord and locks itself operated, at its contacts 21, under control of relay 3.

The operation of relay 16 completes a circuit for operating relay 3 which can be traced from battery, contacts 19 of relay 3, winding of relay 8, contacts 20 of relay 4 and contacts of relay 16 to ground. Relay 8 in operating locks up at its left-hand contacts to ground under control of the sleeve relay 3, by opening its contacts, 7, it releases relay 4, and by opening its contacts 10 releases relay 5.

Relay 5 in releasing opens the holding path for relays 11, 15 and 16 which relays in turn release.

It will be noted that relays 8 and 17 are now held operated under control of sleeve relay 3.

When relay 8 operated it also closed its right-hand contacts 22 thereby connecting negative pulsating current, generated by superimposed alternating ringing current supplied by the grounded source 23 on the battery PB—, to the ring conductors of the cord and line in a circuit including contacts of the ringing interrupter I, left-hand winding of tripping relay 18, contacts 22 of relay 8, contacts 24 of relay 25, contacts 26 of relay 27 and contacts 28 of relay 17 to the ring conductor of the cord and thence over the ring contacts of the plug 1 and jack 2 and ring conductor of the line L1 to the W station and over conductor 21W to the cathode element 22W of the gas-filled tube 20W. A potential difference is accordingly established between the cathode element 22W and the control cathode element 23W which is connected through high control resistance 24W to ground. In similar manner the potential on the said ring conductor of line L1 also establishes a potential between the cathode elements of the tube 20R, at the positive station R, also on the ring conductor.

Battery PB— is connected in the circuit with its negative pole toward the line and its positive pole toward the grounded alternating current source 23 and consequently the negative halves of the alternating current waves will be increased and the positive half waves decreased, thus supplying what is termed a negative pulsating current to the ring conductors of the line. This method of generating a so-called pulsating current for selective ringing purposes by superposing alternating current on a direct current source was described in Patent 763,970 to T. C. Drake dated July 5, 1904.

This so-called pulsating current is in fact alternating current with its neutral axis displaced from the center line of the wave by the amount of the battery voltage. On the basis of the before given description, assuming that ringing current has been connected to the ring conductor of line L1, when a certain point on the wave of the said pulsating current potential is reached, ionization of tubes 20W and 20R is effected. This point of ionization is controlled by the impedances 24W and 24R connected to cathode elements 23W and 23R of tubes 20W and 20R, respectively. In practice it has been found convenient to have the tubes designed to break down on an ionization potential of approximately 70 volts, although any other feasible voltage that is suitable for the conditions encountered may be used. As soon as ionization takes place there is a flow of current at station W from positive ground through the winding of the ringer 25W to the anode element 26W of tube 20W, thence through tube 20W to cathode element 22W, con-

ductor 21W and back over the ring conductor path before traced. Prior to ionization the breakdown voltage between anode and cathode elements may be of the order of 150 volts; after ionization the voltage between cathode and anode may be reduced to approximately 80 volts before deionization takes place. It is to be understood, however, that any other feasible voltages required by a particular party line installation may be used.

The surface area of the anode element 26W of the tube 20W is small compared with that of the cathode element 22W. This anode element may be essentially a wire of small diameter. When the cathode element 22W is accordingly subjected to a breakdown negative potential, an appreciable quantity of electrons is emitted from its comparatively large surface and there is a corresponding flow of current through the tube from the anode element to the cathode element. This flow of current, due to its pulsating character, causes the ringer 25W to respond in unison with the negative waves of ringing current transmitted over the ring conductor of line L1. When the ringing current wave passes through zero, from negative to positive, tube 20W is deionized and the voltage of the positive half-wave, reduced as it is by the voltage of the opposing battery PB—, is insufficient to cause reionization and the current in the anode-cathode circuit remains at zero. Consequently, the ringer 25W responds only to current during the negative half of the ringing current wave.

As before stated, tube 20R of station R is also ionized simultaneously with tube 20W of station W. In this case, however, the cathode element 22R is connected to ground, and the anode element 26R to the conductor 21R through the winding of the ringer 25R. Consequently the anode element 26R is now at negative potential and due to its small surface and the consequently small electronic emission therefrom, the current flow from cathode element 22R to anode element 26R is so small that the ringer 25R does not respond on the negative half-cycle. It will be noted that the ringers 25J and 25M at the stations J and M, respectively, which stations are connected to the tip side of the line, also do not respond at this time, since the tip conductor is connected to ground through a circuit traced from ground through contacts 35 of relay 27, operated contacts 34 of relay 17 and over conductors of plug 1 and jack 2 to the tip conductor of line L1.

When the called subscriber of station W responds to the signal of the ringer 25W by lifting his receiver from the switch-hook, the impedance of the circuit is reduced and an increased current flow results, thereby causing the tripping relay 18 to operate over the tip and ring conductors of line L1. This removes the holding ground from ringing relay 17, which thereupon releases and disconnects ringing leads 43 and 44 from the line, silencing the ringer 25W.

In case the operator desires to ring the R subscriber the key KR is depressed, which causes consecutive operation of relays 38, 25 and 15, 16 and 17, and 8. The operation of relay 25 opens at its contacts 24, the negative ringing lead 44 previously described and closes, at its contact 39, the positive ringing lead which can be traced from battery PB+, through interrupter I and the right-hand winding of tripping relay 18, contacts 39 of relay 25, contacts 26 of relay 27, ringing lead 44, and contacts 28 of relay 17 to the

ring side of the cord and of line L1. This will apply a positive potential to conductor 21R of station R, and thence through the high resistance 24R to control cathode 23R. The other cathode element 22R is connected to ground. The potential difference between the two cathodes thus established causes tube 20R to ionize. The anode element 26R is connected through the winding of ringer 25R also to conductor 21R, and when tube 20R ionizes there is a flow of current from anode 26R to cathode 22R and the ringer 25R responds. Ringer 25W of station W, however, is not actuated, as the anode element 26W is now negative and accordingly passes only a small current, although tube 20W is ionized. When the subscriber of station R answers by removing the receiver from the switch-hook, a low impedance path is connected across the tip and ring conductors, thereby causing the operation of tripping relay 18 through its right-hand winding. This removes the ground from the winding of relay 17, which releases, disconnecting the ringing lead 44, which silences ringer 25R.

Similarly, operation of key KJ operates relays 40, 15 and 27, 16, and 17 and 8. Relay 27 reverses the leads 43 and 44 with respect to the contacts of ringing relay 17, thereby causing a negative pulsating potential to be connected to the tip of the cord and of the line, instead of to the ring as in the case of key KW. This negative potential is applied to conductor 21J, causing tube 20J with its associated ringer 25J to function in the same manner as did tube 20W and its ringer 25W when negative pulsating current was applied to the ring conductor of line L1.

Finally, operation of key KM operates relays 41, 15, 25 and 27, 16 and 17, and 8. Relays 25 and 27, which in this instance are both operated, connect a positive pulsating potential to the tip of the cord over a path which includes the right-hand winding of relay 18, contacts 39 of relay 25, contacts 42 of relay 27, ringing lead 43 and contacts 34 of relay 17. The aforesaid positive potential is connected to conductor 21M. Tube 20M and its associated ringer 25M now function in the same manner as did tube 25R when a positive pulsating potential was connected to the ring of the line.

The operation of the invention as disclosed by Fig. 3 will now be discussed. This is a subordinate arrangement provided to prevent the improper breakdown of the tubes 30J and 30W of the negative stations J and W when a grounded negative coin battery, the voltage of which exceeds the breakdown voltage of the tube, is connected at the central office to the tip of the line, for the purpose of operating a grounded coin box device, not shown, which is connected to the tip conductor at each of the stations W, J, M and R.

It will be observed that the connections at stations J and W of the line L2 of Fig. 3 are the same as the corresponding connections of stations J and W of line L1 of Fig. 2, excepting that the control cathodes 33J and 33W are not connected to ground but to the side of the line opposite to that over which ringing current for the stations is received. In the case of station J when negative coin potential is applied to the tip of the line at the central office, in the manner well known in the art and which, therefore, is not shown here, tube 30J will not ionize. This is because the ring conductor of line L2 is not grounded when the aforesaid coin potential is connected to the tip conductor and consequently

the potential drop across the cathode elements 32J and 33J will be insufficient to cause ionization. The potential drop from anode 36J to cathode 32J, which is the full potential due to the coin current, is, however, insufficient to ionize the tube, since the breakdown voltage from anode to cathode, as hereinbefore stated, is required to be approximately 150 volts, which is considerably in excess of the coin battery voltage that is ordinarily used.

Although negative station W is connected to the ring side of the line, it is necessary to make the connections shown in Fig. 3, because with the receiver off the switch-hook, negative coin battery would have access to tube 20W through the switch-hook contacts. Accordingly, in the case of negative station W, control cathode 33W is connected through its associated high resistance 34W to the tip conductor and cathode 32W to the ring conductor. In this case also the potentials across the cathode elements 33W and 32W, and across the anode element 36W and cathode element 32W, respectively, are insufficient to ionize the tube. In the case of positive stations M and R, if the negative coin potential should be sufficient to ionize tubes 30M and 30R, no appreciable current would flow through the ringers 35M and 25R, due to the negative potential applied to the anodes 36M and 36R, and no appreciable current through the cathode circuits due to the high impedances 34M and 34R.

The description of the functioning of line L1, when ringing current was applied by keys KW, KR, KJ and KM is applicable to line L2, except that in the case of stations J and W the breakdown potential across the cathode elements is obtained over the line conductors, the ground at contacts 35 of relay 27 being used instead of the local ground as in the case of the J and W stations of line L1.

A description of the operation of another subordinate feature of the invention as disclosed by Fig. 4 will now be given. In the case of machine ringing it is the usual practice to provide means for operating the tripping relay during the so-called "silent period", when ringing current is temporarily disconnected from the line, thereby making the line immediately available when the receiver at the called station is lifted. This is accomplished by the connection of a tripping battery in series with the ringing leads, as soon as the ringing current supply is disconnected. Referring to Fig. 1, the tripping batteries are TB- and TB+. When negative stations J or W are called, battery TB- is connected, in well-known manner, by the interrupter I, in series with the left-hand winding of tripping relay 18, when negative ringing current is disconnected therefrom. In like manner, when positive stations M and R are called, interrupter I connects tripping battery TB+. In some installations the voltage of the batteries TB- and TB+ may be sufficiently high to break down the tubes at the stations on the side of the line over which ringing current is being transmitted if an arrangement similar to that shown by Figs. 2 and 3 is used. To avoid this improper breakdown which might result in the false operation of tripping relay 18, the arrangement of Fig. 4 may be used wherein high impedances 47J, 47W, 47M and 47R are connected across the cathode elements of tubes 40J, 40W, 40M and 40R, respectively. When the tripping battery TB- is connected to the tip conductor of line L3 of Fig. 4, current flows through high impedances 47J and 48J in series over the

ring conductor back to the ground connected through the operated contacts 45 of relay 27. The potential across the cathodes of tube 40J is therefore equivalent to the voltage drop in impedance 47J. It has been found in practice that impedances 47J and 48J may be approximately 100,000 ohms and 80,000 ohms, respectively. It is to be understood, however, that these values are not fixed, but should be determined by the requirements of each installation. They should be selected so that the drop across the cathode elements is low enough to prevent breakdown of the tube on tripping battery voltage, but still high enough to assure breakdown on ringing current. Accordingly, since the values of impedances 47J and 48J are selected to obtain this result, tube 40J does not break down. When once the tube has broken down the shunting effect of the high impedance 47J has little effect on the operation of the tube and accordingly the performance on ringing current, of tube 47J of line L3 is essentially the same as that of tubes 20J and 30J of lines L1 and L2, which have no cathode shunt.

The functioning of the other tubes of line L3, that is, 40W, 40M and 40R, is the same as that of tube 40J.

For the W station of line L3 battery TB- is connected over the ring conductor and the circuit is completed through impedances 47W and 48W over the tip conductor to ground on the normally closed contacts 35 of relay 27. In the case of the M station tripping battery TB+ is connected over the tip conductor through impedances 48M and 47M to local ground at station M, and for station R battery TB+ is connected over the ring conductor through impedances 48R and 47R to local ground at station R.

The invention has been described hereinbefore on the basis of using pulsating current derived from the series connection of a positive and negative battery, respectively, in series with a grounded source of alternating ringing current, providing thereby, what is also known in the art as "superimposed ringing current". It should also be pointed out that this invention is likewise adapted for use with pulsating current obtained directly from a ringing current source, without the use of a series connected source of direct current. This type of pulsating current is unidirectional with alternate half waves entirely suppressed. Accordingly, with this type of ringing current the tubes connected to the side of the line over which ringing current is being transmitted will be ionized only every alternate half cycle.

It is to be understood that although the invention has been described around certain desirable embodiments thereof, it may also be embodied in various other forms without departing from the spirit of the invention, as defined by the appended claims.

What is claimed is:

1. In a selective signaling system in combination, a line, a plurality of stations on said line, a source of pulsating current, means for connecting said source in either polar direction between either side of the line and ground and for grounding the opposite side of the line, a ringing device responsive to said pulsating current and a gas-filled discharge device comprising main and control anodes and a cathode at each station, said discharge devices being so constructed and arranged that current will flow freely between said main anode and cathode when the respective de-

vice is ionized and when said main anode is positive and much less freely when said main anode is negative, and further so constructed and arranged that a higher voltage is required to cause a discharge between said main anode and cathode than between said control anode and cathode, and a connection at each station between one side of the line and ground including the respective discharge and ringing device, the connection at one station extending from the line to the cathode of the respective discharge device and from the main anode through the respective ringing device to ground with an auxiliary high impedance connection to ground from the control anode, and the connection to ground from the same side of the line at another station extending from the line through the respective ringing device to the main anode of the respective discharge device and from the cathode to ground with a high impedance connection between the same side of the line and the control anode.

2. In a four-party selective signaling system in combination, a plurality of subscribers' stations, an electroresponsive ringing device and a gas-filled discharge device comprising main and control anodes and a cathode at each station, a source of pulsating ringing current, means for selectively connecting either pole of said source to either side of the line and ground and the other pole of said source to the opposite side of the line, said ringing devices being adapted to operate in response to said pulsating current and said discharge devices being so constructed and arranged that the main anode-cathode discharge path offers a substantially greater impedance to the passage of current in one direction than in the other direction, and a connection at two of said stations from the tip side of the line to ground and at the other two stations from the ring side to ground, each connection serially including the respective ringing device and two elements of the respective discharge device, one connection from each line conductor extending serially through the ringing device to the main anode and from the cathode to ground with a high impedance in bridge connection from the respective side of the line to the respective control anode and the other connections from each side of the line extending from the line conductor to the cathode and from the main anode serially through the ringing device to ground with a high impedance connected between the respective control anode and the opposite side of the line.

3. In a selective signaling system, a line, a source of pulsating signal current, selective means for connecting either pole of said source to either side of the line and ground and the other pole of said source to the opposite side of the line, a plurality of electroresponsive ringing devices, each device being connected between a conductor of the line and ground, a three element gas-filled discharge device, comprising an anode, a cathode and a control electrode, associated with each ringing device and so connected that the anode-cathode discharge path is in series with the respective ringing device, said discharge devices being so constructed and arranged that said anode-cathode path has a very substantial unilateral current conducting characteristic and a high impedance bridge connection between each anode and the respective control electrode, and a second high impedance connected between each control electrode and its respective cathode.

4. In a four-party selective signaling system in combination, a plurality of subscribers' stations, 75

an electroresponsive ringing device and a gas-filled discharge device comprising main and control anodes and a cathode at each station, a source of pulsating ringing current, means for selectively connecting either pole of said source to either side of the line and ground and the other pole of said source to the opposite side of the line, said ringing devices being adapted to operate in response to said pulsating current and said discharge devices being so constructed and arranged that the main anode-cathode discharge path offers a substantially greater impedance to the passage of current in one direction than in the other direction, and a connection at two of said stations from the tip side of the line to ground and at the other two stations from the ring side to ground, each connection serially including the

respective ringing device and two elements of the respective discharge device, one connection from each line conductor extending serially through the ringing device to the main anode and from the cathode to ground with a high impedance in bridge connection from the respective side of the line to the respective control anode and the other connections from each side of the line extending from the line conductor to the cathode and from the main anode serially through the ringing device to ground with a high impedance connected between the respective control anode and the opposite side of the line, and a second high impedance connected between each control electrode and its respective cathode.

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