

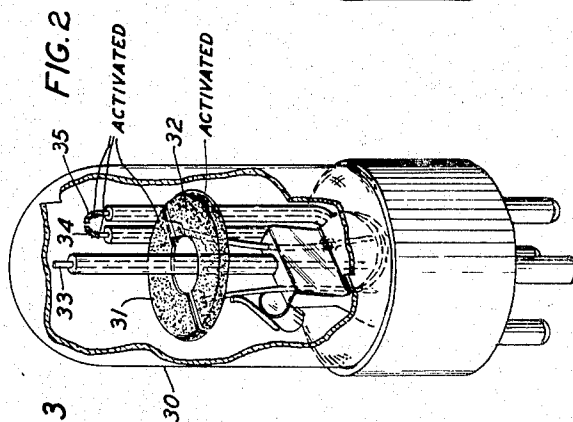
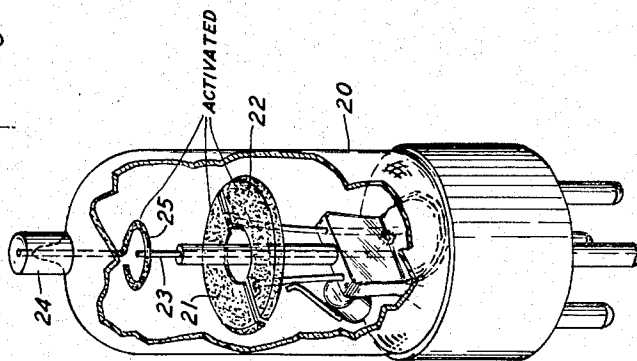
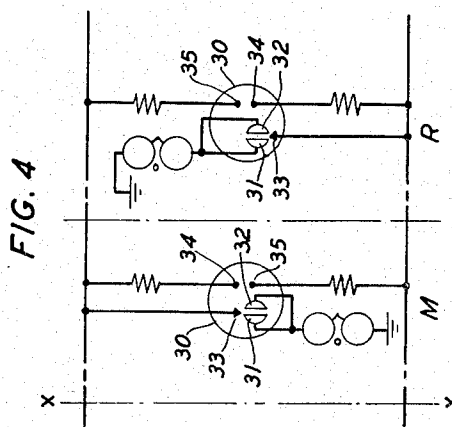
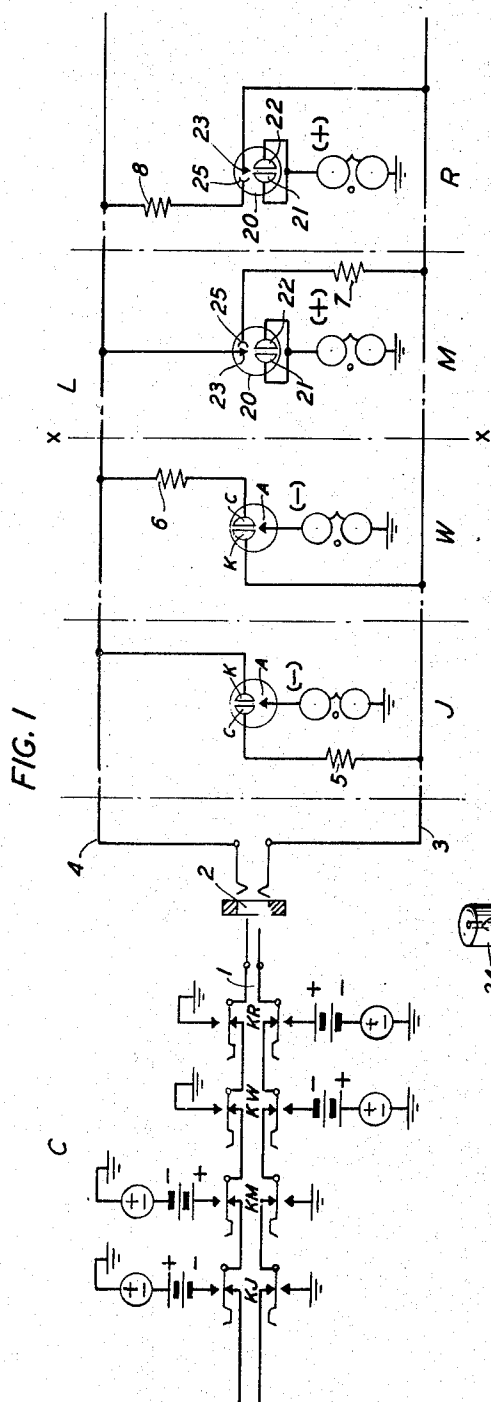
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S. B. INGRAM

2,250,264

TELEPHONE RINGING SYSTEM

Filed April 24, 1940



UNITED STATES PATENT OFFICE

2,250,264

TELEPHONE RINGING SYSTEM

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Application April 24, 1940, Serial No. 331,323

5 Claims. (Cl. 179-86)

This invention relates to selective signaling systems and more particularly to selective ringing systems for telephone lines in which three-electrode cold cathode gas tubes are employed and so connected with the lines and ringers that any one of four stations on a line can be selectively rung to the exclusion of the other three.

Arrangements of the above character, now in use, are satisfactory under all but the most abnormal conditions, i. e., when the earth potential at the stations, or the induced potential from adjacent power lines, etc. is sufficiently high, when added to the potential of the central office battery during the idle or talking condition of the line, to break down some or all of the control gaps of the station tubes, which in practice requires about 70 volts. If such a breakdown occurs while conversation is in progress, such discharge may cause noise in the receivers of the parties talking. Further, if the interfering voltage occurs in the absence of ringing potential, it need only rise to a somewhat higher peak value to cause false operation of one or more of the station bells.

In a copending application, filed December 8, 1939, Serial No. 308,216, in the name of Kenneth L. Maurer, an arrangement is described and claimed employing biased ringers and gas tubes having a bilateral, i. e., non-rectifying anode-cathode gap, characteristic and so connected that noise interference and false ringing due to high ground and induced voltage conditions affecting the line are obviated entirely or greatly reduced. The system therein described is so arranged that whereas complete selective calling of the stations is attained, by the use of mechanically biased ringers, whenever ringing current of either polarity is connected to either side of the line to ring a particular station, a parallel current path also exists between the same side of the line and ground at another station which path includes the coil windings of the ringer thereat. Due to the fact, however, that the ringer at this other station is biased in a direction opposite to the called station, its bell will not ring, but such parallel current paths may not be desired under certain conditions as they may preclude the desired addition of extension ringers at some or all of the stations.

An object of the invention is therefore, to provide a selective ringing arrangement employing gas-filled tubes that will function in a satisfactory manner and permit current to flow only through the selected ringer and at the same time substantially eliminate noise interference and

false ringing under abnormally high ground and induced voltage conditions.

A feature of the present invention resides in employing two characteristically different types of three-electrode cold cathode gas-filled tubes and in a method of associating them with the respective ringers and the line whereby the foregoing object is attained.

Two of the tubes employed are of the well-known rectifying type of the character disclosed in U. S. Patent 2,088,311, issued July 27, 1937, to L. J. Stacy, which employ a poorly emissive anode and two highly emissive closely spaced electrodes which constitute a cathode and a control anode, said tubes being so constructed that a ringing voltage of the proper value (of the order of 70 to 90 volts in practice) applied across the control anode and cathode causes a discharge to take place therebetween, thereby causing ionization of the gas in the tube whereupon, and only then, application of substantially the same potential, in the proper direction, across the main anode and cathode causes current to flow freely therebetween in the direction of the main anode to the cathode and not at all, or at a greatly reduced volume, in the opposite direction.

The other two tubes, which may be of the three-element type, fully described and claimed in a copending application in the name of W. H. T. Holden, Serial No. 331,270, filed April 24, 1940, are, however, differently constructed in that while the cathode and main anode have the same emissive characteristic and are spaced from each other by the same distance as the previously described tubes of the prior art, the third or control electrode is differently constructed and closely spaced with respect to the anode instead of the cathode, whereby a discharge (and ionization) will be effected by normal ringing potential applied thereacross and a much greater potential (of the order of 200 volts) will be required to cause a discharge between said control electrode and cathode in the absence of ionization.

As an alternative, and in some respects a more desirable, arrangement the foregoing two special tubes may comprise a four-element structure also described and claimed in the foregoing copending application, having the same prior art, nonactivated anode and activated cathode and in addition an independent pair of closely spaced electrodes both of which are coated with some suitable electron emitting substance in order to facilitate a bilateral control discharge therebetween.

It should be noted that the characteristic fea-

ture of both of the last described tubes is that the control gap is independent of the cathode, i. e., in the three-element tube, it is formed between the anode and the control or third electrode and in the four-element tube it is independent of both the cathode and the anode as well.

Further describing the feature of the invention, the first two (prior art) tubes and their respective ringers are located at the so-called "negative" stations and connected to the line and ground in the manner shown for stations J and W of Fig. 3 of the above-noted Stacy patent, i. e., the cathode at one station (J) being connected to the tip of the line, the control anode connected to the ring of the line in series with a current limiting resistance of high value and the main anode connected to ground in series with the ringer. At the other negative station (W) the connections between the two sides of the line and the tube are reversed, i. e., the control anode is connected to the tip of the line in series with a current limiting resistance and the cathode is connected to the ring of the line, the anode being connected as before to ground in series with the respective ringer.

The other tubes, which may be either of the previously described special three or four-element types, are located at the so-called "positive" stations. At station M the anode will be connected to the tip of the line and the cathode connected to ground in series with the station ringer and at the last station (R) these connections will be reversed, i. e., the anode will be connected to the ring of the line and the cathode connected in series with the ringer to ground. If the special three-element tube is used the third electrode, which together with the anode constitutes the control gap, will be connected at station M to the ring of the line in series with a current limiting resistance, and at station R this connection will be to the tip of the line. In case the special four-element tube, having a pair of control electrodes independent of either the anode or cathode, is employed, the two control electrodes at each station will be connected to opposite sides of the line, each connection serially including a current limiting resistance.

The invention will be understood from the following description and drawing:

Fig. 1 of which represents, schematically, the calling end of a conventional cord circuit arranged for four-party selective ringing service, and a line arranged for four-party full selective ringing in accordance with said invention;

Fig. 2 represents a three-element gas-filled tube having special characteristics, described in the above-mentioned copending application and used at two of the four stations on the line shown in Fig. 1;

Fig. 3 represents an alternative form of tube having a pair of independent control electrodes, in addition to a cathode and an anode, for use at two of the stations, and;

Fig. 4 represents the two stations on the line at which tubes of the character shown in Fig. 3 are used.

Referring to Fig. 2 of the drawing, 20 represents a tube of conventional shape and size, having two half disc electrodes 21 and 22 supported from the base in any convenient manner and coated in the usual manner with some well-known activating substance. Extending upwardly through the center of the tube and suitably insulated from the electrodes 21 and 22 is

the usual uncoated wire electrode 23 which forms the anode of the device. In the circuit of the present invention, when tubes having the characteristics shown in Fig. 2 are used, the half disc electrodes 21 and 22 form a single electrode (cathode) and therefore these electrodes may either be permanently connected together within the tube structure itself or more preferably by some external connection, as for example, within the socket in which the tube is placed.

Also supported within the tube, as for example from the top, and terminating in an external terminal 24, is an activated, i. e., coated, wire ring 25 which forms the third or control electrode. In the drawing the separation between the wire anode 23 and the control electrode 25 is somewhat exaggerated but in fact the clearance is of the general order of one-eighth of an inch for tubes used for the voltages employed in ringing systems of the type under discussion.

In tubes heretofore furnished, as for example, those used in the system shown in the Stacy Patent 2,088,311, and at stations J and W of Fig. 1 of the present application, the potential required to fire the control gap, i. e., the gap between the cathode and control electrode, is of the order of 70 volts and the voltage necessary to cause a discharge between the anode and either the cathode or control electrode, in the absence of ionization, is of the order of 200 volts, whereas in the tubes as shown in Fig. 2, and used at stations M and R of Fig. 1, the breakdown potential between the cathodes 21, 22 and either the anode 23 or control electrode 25, in the absence of ionization, is of the order of 200 volts, while the breakdown potential between the anode 23 and control electrode 25 is of the order of 70 volts.

As in three-element tubes, the main gaps of the tubes of Fig. 2, i. e., the gap between the disc electrodes 21, 22 and anode 23, have a rectifying characteristic due to the relatively large area of the disc electrodes 21, 22 which are coated with some suitable electron emitting substance and the fact that the uncoated anode 23 presents a very small area. Further, although of no material advantage in the present invention, the control gap, i. e., the gap between the anode 23 and control electrode 25 has some rectifying properties due to the larger surface area of the wire ring 25 with respect to the joint of the anode 23 and also due to the fact that electrode 25 is activated whereas the anode is not.

Referring to Fig. 3 the general structure of the anode and cathode is the same as shown in Fig. 2, but differs therefrom in that the small ring electrode 25 of Fig. 2 is omitted and in place thereof two small wire electrodes 34, 35 are located within the tube and insulated from each other except for their upper extremities which are coated with electron emitting material and brought close together so that normal ringing potential applied thereto will cause a discharge therebetween in either direction.

As mentioned with respect to Fig. 2, the two semi-circular half discs 31, 32 may be joined in any suitable manner to form a single, large area, activated cathode.

The invention will be best understood from a description of the operation of the circuit as shown in the drawing and it will first be assumed that an operator, having control of the cord circuit C, as shown in Fig. 1, desires to ring the bell of subscriber J on the line L. She will accomplish this by inserting plug 1 of her cord C in

jack 2 and closing the contacts of key KJ thereby grounding the ring conductor 3 of line L and connecting negative superimposed pulsating ringing current to the tip conductor 4 in an obvious manner. If it is assumed that the peak voltage of the superimposed ringing current is sufficiently high, i. e., of the order of from 70 to 90 volts, to break down the gap between the control electrodes of the tubes employed, the control gaps of the tubes at all stations will fire thereby ionizing the gas contained therein, the impedance of the control gap at station M, due to the before-mentioned partial rectifying characteristic being insufficient to prevent a breakdown discharge and ionization at this station. As soon as the tube at station J becomes ionized, its main discharge gap, i. e., the gap between the anode A and cathode K breaks down whereupon current flows in a positive direction from ground, through the station ringer, anode A to cathode K, tip conductor 4 of the line contacts of key KJ to the negative pole of the superimposed ringing current source and thence to ground. Sufficient current flows in this circuit to cause the ringer at station J to operate.

As before noted when KJ was operated, the tubes at stations W, M and R were also ionized by the firing of their respective control gaps. At station W the ringer thereat is connected between ground and the anode of the tube in the same manner as in station J and therefore a discharge from the anode to the cathode C tends to be established but due to the inclusion of high resistance 6 in the circuit between the control electrode and tip conductor of the line, a negligible current is permitted to flow and the ringer at that station is therefore unaffected. At station R, although the tube thereat is ionized, and a discharge tends to be established between the cathode and the activated control electrode 25, the value of the high resistance 8 between the control electrode and the tip of the line is such that a negligible current is permitted to flow and the ringer at that station is therefore unaffected. While, as before mentioned, the tube at station M is ionized, due to the rectifying property of the main gap mentioned above, the amount of current flowing thereacross will be insufficient to operate the ringer. Therefore, it will be noted that closure of the contact of ringing key KJ will cause only the ringer at station J to be actuated to the exclusion of the ringers at the other three stations, W, M and R.

Closure of the contacts of key KW connects negative pulsating current to the ring conductor 3 of the line and grounds the tip conductor 4 thereby firing the control gap of all tubes. The tube at station W being ionized, a main gap discharge occurs from ground, through the ringer, across the main gap from the anode to the cathode and back through contacts of key KW to the negative pole of the superimposed source thus causing the ringer at station W to operate. At station J the high resistance 5 prevents sufficient current to flow in the anode-cathode gap at that station to affect the ringer, and at station M the high resistance 7 prevents sufficient discharge between the cathodes 21, 22 and the control electrode 25 to affect the ringer. At station R the current is limited by the rectifying property of the main gap to a value too small to operate the ringer.

If station M is to be signaled, the operator will close the contacts of key KM thereby grounding the ring conductor 3 of the line and connecting positive superimposed current to the tip conductor 4 thereby ionizing the tubes at all stations.

The current to the ringer of station J is limited by the rectifying characteristic of the main gap, that to the ringer of station W by the rectifying characteristic of the main gap and also by the presence of the high resistance 6, and that to the ringer of station R by the high resistance 8.

The tube at station M, however, being ionized, and the anode 23 positive with respect to the cathode 21, 22, allows a main discharge to occur to ground through the ringer thereat which is therefore actuated.

Operation of key KR grounds the tip conductor 4 of the line and connects positive pulsating current to the ring conductor thereby causing a control gap breakdown and consequent tube ionization at all stations.

At station R the anode 23 is positive with respect to the cathodes 21 and 22 and therefore a main gap discharge occurs permitting current to flow through the ringer to ground to cause its operation.

The currents in the ringers at stations J, W, and M are insufficient to actuate them because of the rectifying characteristics of the main gaps of the tubes at J and W and because of the limiting effect of the high resistances 5 and 7 at J and M respectively.

It will be noted from the foregoing that operation of any one of the ringing keys KJ, KW, KM or KR selectively operates the respective ringers at stations J, W, M or R to the exclusion of the others and no appreciable current path through another ringer is established which is an object of the present invention while at the same time eliminating false ringing and noise interference due to high voltage ground and induced voltage conditions, due to the bridged condition of the control gaps across the line instead of being connected to ground at certain of the stations as used in systems where interfering earth potentials are not encountered.

If tubes of the character shown in Fig. 3 are to be used at stations M and R, these stations will be arranged as shown in Fig. 4.

In this circuit it will be observed that at station M the anode 33 is connected to the tip of the line and cathodes 31, 32 to ground in series with the ringer, and at station R the connection of these electrodes is reversed, i. e., the anode is connected to the ring and the cathode to the tip in series with the ringer. It will, of course, be obvious that in this case the ringer at station M could equally as well be connected between the tip of the line and the anode and at station R between the anode and the ring conductor.

At both stations the two control electrodes 34 and 35 are connected to opposite sides of the line in series with an individual current limiting resistance.

Actuation of any ringing key will cause a control gap breakdown at all four stations. If key KM is actuated, which connects positive pulsating current to the tip of the line, a main gap discharge will occur between the anode 33 and cathodes 31, 32 with a consequent flow of current through the respective ringer sufficient to cause it to operate.

At station R, both the anode and cathode are at ground potential and hence no discharge will take place. At stations J and W (shown in Fig. 1) both tubes are connected for negative pulsating operation and hence the main gaps do not break down when positive pulsating current is applied to the line. The actuation of key KR connects positive pulsating current to the ring

instead of the tip and as the anode of the tube at station R is connected to this ring conductor the main gap at this station will fire to the exclusion of the main gaps at the other three stations.

What is claimed is:

1. In a four-party selective ringing telephone system, a line, 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 to the opposite side of the line, four telephone stations associated with said line, a telephone ringer at each station, a cold cathode gas tube and a high resistance element at each of two stations, said tubes comprising main and control anodes and a cathode so constructed and arranged that a substantially higher voltage is required, when said tube is deionized, to cause a discharge between said main anode and cathode than between said control anode and cathode, a connection between the main anode and ground at each of said two stations, serially including the respective ringer, a connection at one of said two stations extending from one side of the line to the cathode of the respective tubes and from the other side of the line through the respective high resistance to the control anode, a similar connection at the other of said two stations from the one side of the line through the respective resistance to the control anode and from the opposite side of the line to the cathode, a cold cathode gas tube and a resistance element at each of the other two stations, said tube comprising a main cathode, a control cathode and an anode so constructed and arranged that a substantially lower voltage is required to cause a discharge between said anode and control cathode than between said anode and main cathode, or control cathode and main cathode, when said tube is deionized, a connection between the main cathode and ground at each of said other two stations serially including the respective ringers, connections at one station between one side of the line and the anode, and between the opposite side of the line and the control cathode including the respective resistance, and similar connections at the other station between the one side of the line and the control cathode, including the respective resistance, and between the other side of the line and the anode.

2. In a four-party selective pulsating ringing telephone system, a line, a plurality of stations, a ringer at each station, a source of pulsating ringing current, means for selectively connecting said source across the line in either polar direction and for grounding one side of the line, a gas-filled discharge tube at each station associated with its respective ringer, line, and ground, each tube comprising an anode, a cathode, and a third electrode, characterized in this that the tubes at stations whose ringers are required to respond to positive pulsating current applied to either side of the line are so constructed that said anode and third electrode are closely spaced with respect to each other, said anode is of relatively small area with respect to the cathode and said anode and third electrode are spaced a relatively

greater and substantially equal distance from said cathode, said anode and third electrode being connected to opposite sides of the line and said ringer between ground and the cathode.

3. In a four-party selective ringing system, a line, 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 to the opposite side of the line, a three-element gas-filled tube at each station comprising an anode, a cathode and a control electrode, said tubes being so constructed that the anode-cathode gap has a substantially unilateral current conducting characteristic and requires a relatively high potential, in the absence of ionization, to cause a discharge therebetween, and a ringer and a high resistance at each station, characterized in this that the tubes at the stations whose ringers are required to respond to positive polarity ringing current are arranged to have a control gap between the anode and control electrode designed to break down at normal ringing potential applied thereto, said positive station tubes being so connected that the cathodes are in series with the respective ringers and ground and the anodes and control electrodes are connected to opposite sides of the line.

4. In a four-party selective ringing telephone system, a line, a source of pulsating ringing current, means for selectively connecting said source in either polar direction between either side of the line and ground, and for connecting the other side of the line and ground, for telephone stations associated with the line, a telephone ringer and a three-element cold cathode gas-filled tube at each station, the tubes at station where ringers are desired to respond to positive pulsating current being so constructed that the control electrode is closely spaced with respect to the anode, and means for connecting the anode and control electrode to opposite sides of the line, and the cathode in series with the respective ringer and ground.

5. In a four-party selective ringing telephone system, a line comprising tip and ring conductors, a plurality of subscriber stations on said line, 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, a gas-filled discharge device at each of two of said stations, each device comprising a pair of independent closely spaced control electrodes, an activated cathode, and an unactivated anode, a connection at one of said two stations between the tip of the line and the anode of the device thereat and at the second of said two stations between the respective anode and the ring conductor, the cathodes at both of said stations being connected to ground, thereby constituting a unilateral discharge path for positive pulsating current in the direction of the anode to the cathode, a ringer in series with each of said discharge paths and connections at said two stations between each side of the line and one of the respective control electrodes.

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