

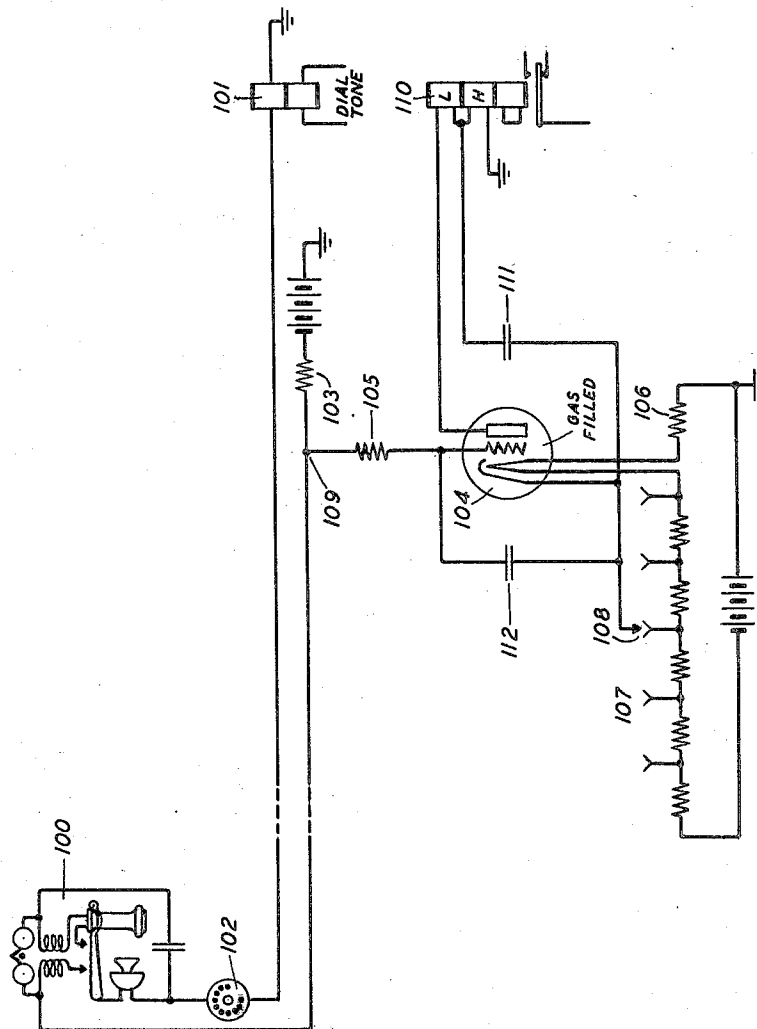
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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This invention relates to a telephone system and more particularly to the utilization in the impulse recording circuit thereof of a gaseous conductor or discharge tube as an impulse responsive relay.

In machine switching telephone systems the impulses dialed by a subscriber or by an operator may control the setting of selector switches directly as, for example, in the well known systems employing step-by-step type selector switches or may control impulse repeaters or may control the setting of digit registers as in systems employing central office senders, as for example in the well known panel or director type system. In order that proper response to dialing impulses may be obtained over both long and short dialing loops, it is essential that the impulse responsive apparatus shall be very accurately adjusted and sensitive. It is therefore the object of the invention to provide an impulse responsive device whereby more accurate and faster impulse response may be realized over either long or short dialing loops.

Heretofore it has been proposed to utilize a gaseous conductor or discharge tube to respond to dial or other sources of impulses and to in turn control an impulse responsive relay which controls the stepping magnet of a selector switch, an impulse repeater or control apparatus for recording the dial impulses as may be desired. The gaseous conductor tube is a tube filled with a low pressure gaseous content which, for purposes of illustration, might be neon, argon, helium, mercury vapor or combinations of gases of this group. The tube has the highly desirable characteristic of causing an almost instantaneous establishment of the full value of anode current permitted by the circuit conditions when the grid bias potential is reduced to a certain critical value. After the discharge or breakdown has taken place, however, the grid no longer has any control over the anode current until the tube is extinguished by opening the anode circuit or by reducing the anode potential. This latter characteristic prevents the operation of the tube from being analogous to that of a magnetic relay and limits its efficient application to many circuits which require a release as well as an operate function to take place.

In accordance with the present invention, a gaseous conductor tube is employed for operating a non-polar magnetic relay in response to dialing impulses in which the best features of this type of tube and those of the ordinary amplifying vacuum tube are combined in one cir-

cuit. That is, the anode current changes are relatively abrupt and representative of a high amplification factor yet the grid retains control, being able in effect to cause the cessation of anode current as well as its establishment. The fundamental principle of its operation is that with a grid bias less than the critical amount, the tube is caused to alternately breakdown and restore at a relatively high frequency within the range, for example, of two hundred or three hundred cycles per second, under control of a condenser paralleling the anode circuit and a high resistance winding of the relay in the positive potential anode supply circuit. The two windings of the relay, one of which is of low resistance and the other of which is of high resistance are connected series-aiding between the source of positive anode potential and the anode of the tube and are so associated with the condenser that one or the other of the windings is always energized in the same direction throughout the period of oscillations. The oscillations continue until the grid bias is increased above the critical value and one-half cycle or less thereafter the tube restores and the oscillation ceases.

In general the circuit functions in the following manner. The grid of the tube is connected to the negative leg of the dialing loop so that a negative bias is applied to the grid. Normally the potential on the cathode, which is taken from a potentiometer in the filament circuit is a few volts less than the 48-volt central office battery potential. The difference of potential between the grid and cathode is such that with the dialing loop open or with a maximum leak on the loop, the potential on the grid is sufficiently negative with respect to the cathode to keep the tube blocked. The anode is connected through the serially connected low and high resistance windings of a non-polar magnetic relay to ground, the difference between the cathode potential and ground potential forming the anode potential. A condenser is also connected in a circuit from the cathode through the high resistance winding of the relay to ground and is thus normally charged.

When the dialing loop is closed, the grid bias is decreased and the tube breaks down, the anode potential for the initial breakdown coming through the two windings of the relay and also from the positive plates of the charged condenser through the low resistance winding of the relay. Upon the breakdown of the tube, the condenser discharges over the anode-cathode path of the tube and operates the relay over its low

resistance winding. After the condenser discharges, the charging circuit of the condenser through the high resistance winding of the relay offers a lower impedance path than the anode-cathode circuit through the tube and consequently the potential across the latter circuit falls to a point where ionization of the tube cannot be maintained and the tube restores. As soon as the condenser becomes sufficiently charged, the potential on the anode rises to a value sufficient to cause the tube to again breakdown provided the grid bias has not increased in the meantime.

The alternate breakdown and restoration of the tube and the discharge and charge of the condenser form an oscillating circuit condition which continues until the bias on the grid is increased by the opening of the dialing loop at the start of a dial impulse. The initial discharge of the condenser through the low resistance winding of the relay operates the relay, and the subsequent charge and discharge circuits, the former through the high resistance winding and the latter through the low resistance winding, hold the relay operated since the frequency of the oscillations, which may be in the order of two hundred or three hundred cycles per second, is high enough and the average currents resulting are strong enough.

When the dial contacts open the dialing loop and the grid bias is increased after a breakdown of the tube has just occurred, this condition continues until the tube is extinguished by the shunting effect of the condenser and the relay releases after which no further breakdown can occur during the period that the dial contacts are opened. If the dial contacts open while the tube is extinguished nothing happens except that the charging of the condenser is completed.

For a clearer understanding of the invention reference may be had to the drawing and the following detailed description thereof:

The present invention has been illustrated schematically by only so much of a subscriber's dialing loop and impulse responsive circuit as are necessary to a complete understanding of the invention. The responsive circuit may, for example, be a central office register sender of the type disclosed in Patent No. 1,862,549 granted June 14, 1932 to R. Raymond et al., and the dialing loop may be established from the subscriber's substation to the sender by switching mechanism such as is disclosed in said patent.

When the subscriber at substation 100 initiates a call and is connected to the sender in the usual manner, the dialing loop is established from the positive grounded terminal of the central office battery through the upper winding of relay 101 over the tip conductor of the dialing loop through the impulse contacts of dial 102, the switchhook contacts, back over the ring conductor of the dialing loop, resistance 103 to the negative terminal of central office battery and ground. Relay 101 operates in this circuit and in the usual manner causes the connection of a source of dial tone through its secondary winding when the sender is properly conditioned to receive dial impulses.

The control electrode or grid of the gaseous conductor tube 104 is branched from the ring conductor of the dialing loop through resistance 105. The grid of the tube is therefore normally negatively biased by negative potential applied thereto from the negative terminal of central office battery through resistances 103 and 105.

The filament of the tube is supplied with heating current from the central office battery through resistance 106 and the potentiometer 107 and potential is applied to the cathode, which is heated conductively from the filament, over the potentiometer tap 108, the potential on the cathode being normally a few volts less than the voltage of the regular 48-volt central office battery. The potential on the cathode is adjusted by the potentiometer so that with the dialing loop open or with the maximum leak on the subscriber's line the potential at the control point 109 on the dialing loop, which is determined by the potential drop across resistance 103, is sufficiently negative with respect to the cathode to keep the tube blocked. The difference between the cathode potential and ground forms the anode potential. Condenser 111 is initially charged in a circuit from the negative terminal of central office battery through potentiometer 107 to ground through the middle high resistance winding of relay 110. Prior to the initial breakdown of the tube anode potential is supplied to the anode from the positive or grounded terminal of central office battery through the high and low resistance windings of relay 110 in series and also from the positively charged plates of condenser 111 through the low resistance winding of relay 110.

When the dialing loop is closed by the removal of the substation receiver from the switchhook to initiate a call, the potential at control point 109 becomes less negative due to the closure of the loop to ground through the upper winding of relay 101 and, as this point is connected to the grid of the tube, the tube is permitted to ionize and complete the cathode-anode circuit therethrough. Condenser 111 then rapidly discharges through the low resistance winding of relay 110 and over the cathode-anode circuit of the tube.

As soon as the condenser becomes discharged it offers a lower impedance path from battery through the high resistance winding of relay 110 to ground than the cathode-anode circuit through the tube thus causing the potential on the anode to drop to such a low value that the tube can no longer maintain its discharge and therefore becomes deionized. After the condenser again becomes fully charged the potential on the anode rises to a value sufficient to cause the tube to again ionize provided the bias on the grid has not been increased negatively in the meantime. The alternate ionization and restoration of the tube and discharge and charge of condenser 111 forms an oscillating circuit condition which continues until the bias on the grid is increased negatively by the opening of the dialing loop at the start of the first dialed impulse.

Upon the initial discharge of condenser 111 through the upper low resistance winding of relay 110, relay 110 operates to prepare the usual impulse recording circuit of the sender, and the subsequent charging and discharging currents flowing through condenser 111, the former through the middle or high resistance winding of relay 110 to ground and the latter through the upper or low resistance winding of relay 110 over the cathode-anode circuit of the tube, hold relay 110 operated. The frequency of the oscillations, which may be of the order of 200 to 300 cycles per second, is high enough and the average currents flowing through the operating windings of relay 110 are great enough to hold the relay securely operated. However, if considered necessary to insure that relay 110 will be

held operated during the oscillations, a third short-circuited winding may be added to relay 110 as shown to make it slightly slow to release or the relay may be made slow to release in any well known manner.

When the dial contacts open to transmit an impulse the control point 109 is made more negative thus increasing the negative bias on the grid of tube 104. If at that time the tube is in an ionized condition this condition will continue until condenser 111 becomes discharged and starts to recharge when the anode potential will become reduced to such a degree that ionization of the tube cannot be further maintained. The tube will not again ionize during the impulse period while the grid of the tube is still biased negatively, and, consequently, relay 110 will release to transmit an impulse to the recording circuits of the sender. As soon as the dial contacts again close the negative bias on the grid of the tube will be again reduced and the oscillatory condition of the tube will again be established to reoperate and hold relay 110 operated. Should the dial contacts open while the tube is deionized nothing occurs except that the charging of condenser 111 is completed after which relay 110 releases and remains released during the open period of the dial contacts. It is thus apparent that there is always from one half to one cycle delay in completely terminating the circuits through the operating windings of relay 110 but with frequencies of oscillation of the order of 200 or 300 cycles per second as hereinbefore stated such a delay is permissible. The frequency of oscillation is controlled primarily by the values of capacity of condenser 111 and the resistances of the operating windings of relay 110.

Resistance 105 limits the grid current and in combination with condenser 112, which is of small capacity, forms a filter circuit to protect the grid against radio interference effects. From experimentation it has been found that the control exercised by the grid of tube 104 to both start and stop the functioning of the tube is very precise.

Although the invention has been illustrated and described as applied to the reception of dialed impulses in a register sender it will be obvious that the invention is equally applicable to the reception of impulses for setting selector switches of the step-by-step type or for impulse repeating.

What is claimed is:

1. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, said control electrode being connected to said impulsing circuit and normally negatively biased when said circuit is open to a potential below the ionization potential of said tube, a relay having two windings serially included in the cathode-anode circuit of said tube, a condenser connected between the cathode and a point between said windings and means operative upon the closure of said impulsing circuit for changing the potential on said control electrode whereby said tube intermittently ionizes and deionizes under the control of said condenser to operate and hold said relay operated.

2. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, said control electrode being connected to said impulsing circuit and normally negatively biased when said circuit is open to a

potential below the ionization potential of said tube, a relay having a low and a high resistance winding serially included in the cathode-anode circuit of said tube, a condenser having a charging path extending from the cathode through the high resistance winding of said relay and a discharge path extending through the low resistance winding of said relay and over the cathode-anode path through said tube, and means operative upon the closure of said impulsing circuit for changing the potential on said control electrode whereby said tube intermittently ionizes and deionizes under the control of said condenser, said relay being first operated upon the initial ionization of said tube and being held operated by the subsequent deionizations and ionizations of said tube.

3. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, said control electrode being connected to said impulsing circuit and normally negatively biased when said circuit is open to a potential below the ionization potential of said tube, a relay having two windings serially included in the cathode-anode circuit of said tube, a condenser connected between the cathode and a point between said windings, and means operative upon the closure of said impulsing circuit for changing the potential on said control electrode whereby said tube intermittently ionizes and deionizes at a frequency determined by said condenser to operate and hold said relay operated.

4. In a signaling system, an impulsing circuit, means for closing said circuit, a gaseous conductor tube having a control electrode, a cathode and an anode, said control electrode being connected to said impulsing circuit and normally negatively biased when said circuit is open to a potential below the ionization potential of said tube, a relay having a low and a high resistance winding serially included in the cathode-anode circuit of said tube, a condenser having a charging path extending from the cathode through the high resistance winding of said relay and a discharge path extending through the low resistance winding of said relay and over the cathode-anode path through said tube, and means operative upon the closure of said impulsing circuit for changing the potential on said control electrode whereby said tube intermittently ionizes and deionizes at a frequency determined by the charging and discharging rate of said condenser, said relay being first operated over its low resistance winding by the first discharge of said condenser upon the initial ionization of said tube and being held operated over its high and low resistance windings by the charging and discharging of said condenser upon subsequent deionizations and ionizations of said tube.

5. In a telephone system, a dialing loop, means for closing said loop, a gaseous conductor tube having a control electrode, a cathode and an anode, said control electrode being connected to said loop and normally negatively biased when said loop is open to a potential below the ionization potential of said tube, a relay having two windings serially included in the cathode-anode circuit of said tube, a condenser connected between the cathode and a point between said windings, means operative upon the closure of said loop for changing the potential on said control electrode whereby said tube intermittently ionizes and deionizes at a frequency determined by said condenser to operate and hold said relay

operated, and dialing means for opening said loop to restore the normal negative bias to said control electrode to prevent further ionization of said tube and to thereby cause the release of said relay.

5 6. In a telephone system, a dialing loop, means for closing said loop, a gaseous conductor tube having a control electrode, a cathode and an anode, said control electrode being connected to
10 said loop and normally negatively biased when said loop is open to a potential below the ionization potential of said tube, a relay having a low and high resistance winding serially included in the cathode-anode circuit of said tube, a con-
15 denser having a charging path extending from the cathode, through the high resistance winding of said relay and a discharge path extending through the low resistance winding of said relay and over the cathode-anode path through

said tube, means operative upon the closure of said loop for changing the potential on said control electrode whereby said tube intermittently ionizes and deionizes at a frequency determined by the charging and discharge rate of said con- 5 denser, said relay being first operated over its low resistance winding by the first discharge of said condenser upon the initial ionization of said tube and being held operated alternately over its high and low resistance windings by 10 the charging and discharging of said condenser upon subsequent deionizations and ionizations of said tube, and dialing means for opening said loop to restore the normal negative bias to said control electrode to prevent further ionization 15 of said tube and to thereby cause the release of said relay.

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