

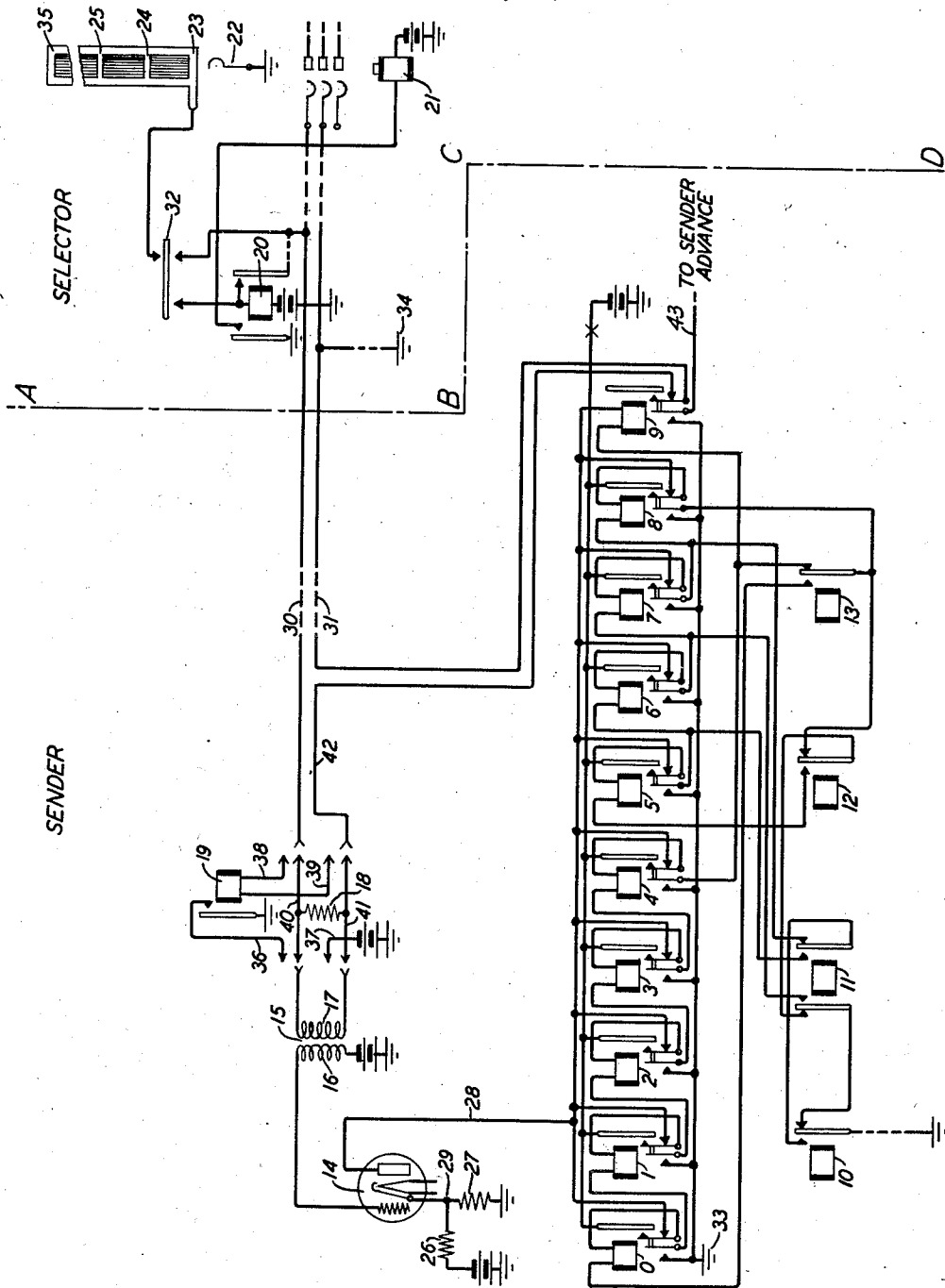
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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This invention relates to telephone systems and more particularly to the utilization in the impulse recording circuits thereof of gaseous discharge or conductor tubes as impulse responsive relays.

5 In a machine switching telephone system of the type employing a common sender which controls the setting of selector switches, the sender is provided with registers which are set by a series of impulses dialed by a subscriber in accordance with the directory number of a desired line. If the sender is employed in a telephone system of the type employing power driven selector switches, for example of the panel type, the setting of the switches is controlled in accordance with the setting of the sender registers by impulses transmitted revertively to the sender by the switches during their selective movement. The control circuit, known as the fundamental circuit, has heretofore comprised a control relay in the selector at the time associated with the sender and an impulse responsive or stepping relay in the sender. When the control circuit is established preparatory to setting the switch both relays operate by battery and ground usually applied at the switch to the two conductors respectively of the fundamental circuit. The operation of the control relay at the switch starts the movement of the brush shaft of the switch and the impulse relay at the sender prepares the sender for controlling the amount of selective movement of the brush shaft of the switch. The switch is provided with a commutator which, as the brush shaft advances, intermittently connects ground to one of the conductors of the control circuit thereby intermittently shunting the impulse relay of the sender. The intermittent operation of the impulse relay controls the successive operations of relays of a train of counting relays, the end relay of the train when operated opening the control circuit to arrest further movement of the brush shaft of the switch. The number of counting relays operated by the impulse relay to control the amount of selective movement of the switch is determined by the setting of the register of the sender at the time rendered effective.

The present invention provides for the replacement of the usual impulse responsive or stepping relay of the control or fundamental circuit by a gaseous conductor or discharge tube. The gaseous conductor tube utilized 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 a certain character-

istic, namely, that the gaseous content will become ionized and thus conducting on one potential determined by the electrode design, the nature of the gaseous content and its pressure but once rendered conducting will remain in this condition of conductivity on a much lower potential.

The invention has for its object the utilization of a gaseous conductor tube as an impulse responsive relay whereby more accurate and faster impulse control may be realized over long fundamental circuits loops.

The present invention has been illustrated schematically by only so much of a sender circuit and a selector switch circuit as are necessary to a complete understanding of the invention. A typical sender circuit to which the invention is applicable is disclosed in detail in Patent No. 1,862,549 granted June 14, 1932 to R. Raymond et al. A typical selector switch circuit is disclosed in detail in Patent No. 1,395,977 granted to F. A. Stearn et al on November 1, 1921.

In the application of the invention to the revertive control of a selector switch, the fundamental or control circuit is established in the well known manner between the sender and the selector switch to be controlled, the control relay of the switch operating and locking over the fundamental circuit and closing the circuit of the up-drive magnet of the switch. At the sender, the fundamental circuit is looped through the primary winding of a transformer, the secondary winding of which is connected in a circuit from the negative or ungrounded terminal of the central station battery to the grid of a gaseous discharge tube. The grid of the tube is thus normally negatively biased preventing the ionization of the tube. The anode of the tube is connected to the winding of one of a train of counting relays through contacts of the relays of a particular register then effective for controlling the selective movement of the switch, to the positive terminal of the central station battery.

As the brush shaft of the selector switch advances under the control of the up-drive magnet, ground is connected to the tip conductor of the fundamental circuit and the primary winding of the transformer becomes short-circuited thereby causing a surge of potential in the secondary winding of the transformer of such polarity as to make the grid less negative. The tube thereupon ionizes and becomes conducting. The particular counting relay connected to the anode circuit of the tube now operates, locking itself operated, shunting the anode circuit momen-

tarly to deionize the tube and reestablishing the anode circuit through the winding of the next succeeding counting relay. Since at the time the next succeeding counting relay is connected to the anode circuit the tube has become deionized, such succeeding counting relay does not operate until the tube reionizes when the commutator again connects ground to the tip conductor of the fundamental circuit. Thus, as the commutator intermittently connects ground to the tip conductor of the fundamental circuit, the tube causes successive counting relays to operate until the end relay operates to open the fundamental circuit and to prepare the sender for the next selection control.

Since the tube ionizes very rapidly when its grid is made sufficiently less negative, a very short application of ground to the tip conductor of the fundamental circuit by the switch commutator is effective to cause the tube to ionize and become conducting and therefore the speed at which the switch shaft may be advanced may be materially increased over the speed hitherto possible. Further, in view of the fact that the tube responds to successive closures of the switch commutator as contrasted with the present fundamental circuit employing an impulse responsive relay which controls the counting relays in response to successive closures and openings of the switch commutator, it is possible to use a train of counting relays having fewer relays than heretofore employed and relays of a simpler and more reliable type.

The invention will be more clearly understood by reference to the accompanying drawing. The apparatus shown to the right of the dotted line ABCD represents schematically in part the apparatus of a selector circuit of the panel type. Since this is well known in the art, only those parts which are necessary for an understanding of the invention are shown. Omitted parts are represented by dotted lines. The drawing to the left of the line ABCD shows apparatus arranged in accordance with this invention, and is a part of a panel type sender circuit. Only those parts necessary for an understanding of the invention are shown. The apparatus schematically illustrated includes a chain of counting relays 0-9, register relays 10-13, a gaseous discharge tube 14, a stepping relay 19, transformer 15, cathode biasing resistance 26 and 27 and a resistance 18 connected across the fundamental circuit. The sender and selector circuits are connected over the fundamental circuit by conductors represented by the dotted lines 30 and 31.

A detailed description of the operation of the arrangement shown in the drawing will now be given. When the fundamental or control circuit is established in the usual manner, between the sender and selector circuit to be controlled, a circuit through selector control relay 20 may be traced from the negative battery terminal through its winding, over the lower contacts of sequence switch cam 32 and conductor 30, thence over conductor 40 through either the primary winding 17 of transformer 15 and non-inductive resistance 18 (which is used to minimize the effect of electrostatic line capacity) in multiple, or over conductor 38 through the winding of relay 19, depending on the optional use of relay 19, the purpose of which will be hereinafter explained. For the present, it is assumed that only transformer 15 is used and accordingly the circuit being traced, continues over conductors 41 and 42 and through normal contacts of relay 9 over con-

ductor 31 to positive ground 34 at the selector. Relay 20 operates and locks through its right-hand contacts over the circuit just traced.

The functioning of gaseous discharge tube 14 will now be described. Current flows from positive ground through resistances 27 and 26 to the negative terminal of the central office battery. The cathode element of tube 14 is connected to junction 29, thereby placing said cathode element at a potential intermediate between that of the positive and negative terminals of the battery. The grid elements of tube 14 is connected to the negative terminal of the central office battery through the secondary winding 16 of transformer 15, thereby maintaining said grid at negative battery potential, and giving it a negative bias with respect to the cathode element.

When current passed through the primary winding 17 of transformer 15 in connection with the operation of relay 20, hereinbefore described, a potential was momentarily induced in secondary winding 16 due to the build-up of current in said primary winding. The windings of transformer 15 are so connected that the said induced potential is added to the potential of the central office battery, resulting in an increase of the negative bias of the grid element of tube 14. Consequently, no current can flow through the circuit of the anode element as a result of the build-up of current through winding 17, just described. When relay 20 operated, it closed through its left-hand contacts an obvious circuit through the winding of up-drive magnet 21, causing thereby the upward movement of selector commutator brush 22 over commutator 35. When brush 22 contacts commutator segment 23, positive ground is connected over brush 22, segment 23, right-hand contacts of sequence switch cam 32, to conductor 30 of the fundamental circuit. This short-circuits the circuit over conductor 30 through winding 17 of transformer 15, which was previously traced, causing the cessation of current in said winding 17 and inducing a momentary potential in secondary winding 16 in a direction opposite to that induced when current was established through relay 20. This results in a momentary reduction of the negative bias of the grid element of tube 14, causing the ionization of tube 14 and a flow of current through the circuit of its anode element, which circuit will now be traced.

Assuming that register relay 11 has been previously operated under control of dial impulses in the usual manner, the anode element of tube 14 is connected over conductor 28, through the back contact and winding of counting relay 7, left front contact of register relay 11, and back contact of register relay 10 to positive ground. Current now flows over the circuit just traced from the anode element of tube 14, through tube 14 to its cathode element, thence through resistance 26 to grounded negative battery. Relay 7 operates and locks through its right-hand front contact to negative battery and also shunts momentarily with negative battery through its back contact the anode circuit of tube 14, deionizing it. The right-hand front contact of relay 7 is arranged so that it closes before the back contact breaks, thereby assuring a continuous circuit through the winding of relay 7. Relay 7 also closes a circuit through its left-hand front contact from positive ground 33 through the winding and back contact of relay 8 to the anode element of tube 14. The left-hand front contact of relay 7 is arranged so that it can not close before the

right-hand front contact closes, thereby assuring the deionization of tube 14 before the winding of relay 8 is connected, avoiding thereby the false operation of relay 8 on the pulse that operated relay 7.

As the advancing selector brush 22 contacts the next insulated segment of commutator 35, current again flows over the fundamental circuit through the winding 17 of transformer 15, thereby inducing potential in the winding 16 due to the build-up of current in the winding 17. This induced potential is added to the potential of the central office battery, resulting in an increase of the negative bias on the grid element of tube 14 and consequently no current can flow over the cathode-anode circuit of the tube. When the brush 22 contacts the next commutator segment 24, positive ground is connected over brush 22, segment 24, right-hand contacts of sequence switch cam 32, to conductor 30 of the fundamental circuit. This short-circuits the circuit over conductor 30 through winding 17 of transformer 15, which was previously traced, causing thereby the cessation of current in winding 17. This induces a potential in secondary winding 16 which opposes the potential of the central office battery connected to the grid element of tube 14, thereby reducing the negative bias of said grid and causing tube 14 to again ionize. As a result of this ionization, current now flows in the anode circuit of tube 14 over a circuit that may be traced from positive ground 33, through left-hand make contacts of relay 7, winding and back contact of relay 8, over conductor 28, anode element of tube 14, through tube 14 to its cathode element, through resistance 26 to negative grounded battery. Relay 8 operates and locks on negative battery through the right-hand make contact and winding of relay 8 and left-hand make contact of relay 7 to positive ground 33. The right-hand front contact of relay 8 is arranged so that it closes before the back contact breaks thereby assuring a continuous circuit through the winding of relay 8. Relay 8, in operating, shunts momentarily with negative battery through its back contact, the circuit of the anode element through the winding of relay 8, which was previously traced, deionizing tube 14, and connects through its left-hand front contact, the winding of counting relay 9 in series with the anode of tube 14 through a circuit which will hereinafter be traced. The left-hand contact of relay 8 is arranged to close after the right-hand front contact, thereby assuring the deionization of tube 14 before the winding of relay 9 is connected.

As the advancing selector brush 22 contacts the next insulated segment of commutator 35, current again flows over the fundamental circuit through the winding 17 of transformer 15 thereby inducing potential in the winding 16 due to the build-up of current in winding 17. This induced potential causes an increase of the negative bias on the grid of tube 14 and consequently no current can flow over the cathode-anode circuit of the tube. When the brush 22 contacts the next commutator segment 25, positive ground is connected over brush 22, segment 25, right-hand contacts of sequence switch cam 32, to conductor 30, through winding 17 of transformer 15, over the circuit which was previously traced, causing thereby the cessation of current in said winding 17. This induces a potential in secondary winding 16 which opposes the potential of the central office battery connected to the grid element of tube 14, thereby reducing the negative

bias of said grid and causing tube 14 to again ionize. As a result of this ionization, current now flows in the anode circuit of tube 14 over a circuit that may be traced from positive ground 33, through the left-hand make contacts of relay 8, back contact of relay 13, winding of relay 9, conductor 28, anode element of tube 14, through the tube to the cathode element thereof, resistance 26 to negative terminal of the central office battery. Relay 9 operates and opens the fundamental circuit over its back contact disconnecting the ground 34 to which relay 20 was locked, over a circuit hereinbefore traced.

As selector brush 22 advances past conducting commutator segment 25, it opens the circuit from 15 ground over brush 22, segment 25, upper contact and lower right and left-hand contacts of sequence switch cam 32, to the front contact and winding of selector control relay 20 and the tip of the fundamental circuit, releasing relay 20. Relay 20 releasing, opens the circuit from ground over its left front contact to negative battery through the winding of selector up-drive magnet 21, causing magnet 21 to deenergize and arrest the upward movement of the selector brush shaft and brush 22, as the sender counting relays have now been satisfied by the reverting ground pulses from the commutator of the particular selector under control of the sender at this time.

The operation of counting relay 9 also connects 30 ground over its left-hand front contact to lead 43 to cause the sender to advance out of the control position of the selection just completed. The said left-hand front contact of relay 9 is arranged to close after the back contact of relay 9 opens, thereby assuring the delay of the sender advance until the upward movement of the selector brush shaft is arrested as hereinbefore explained. The advance of the sender circuit disconnects the negative battery from the windings of the counting relays 7 and 8 which are being held operated. These relays now release. Relay 8 in releasing, opens its left-hand front contact, releasing relay 9 and opening the circuit through the winding of relay 9 and the anode element of tube 14, deionizing tube 14. All counting relays are now released in preparation for their control of the next selection.

As indicated by the foregoing description, the arrangement of this invention is such that each 50 impulse delivered by selector brush 22 to the associated sender over the fundamental circuit results in the operation of one counting relay, and only one, independently of the length of time during which brush 22 contacts a conducting segment of commutator 35. This desirable feature 55 follows from the use of transformer 15, the secondary winding 16 of which can deliver to tube 14 only one impulse for each contacting of brush 22 with a conducting segment of commutator 35, no matter how long said contacting continues. This feature is of especial advantage when there is an undesirable slipping of the drive of the selector switch, which might result in a prolonged contacting by brush 22, and the consequent 65 operation of more than one counting relay per single impulse. For this reason the invention is an improvement over that disclosed in Patent No. 1,963,761 granted to O. H. Williford, June 19, 1934.

In the foregoing description, it was assumed that the setting of the register relays, as controlled in the usual manner by the dial impulses, was such that register relay 11 was operated and register relays 10, 12 and 13 were not operated. 75

For this condition, as hereinbefore described, three reverteive impulses were sufficient to satisfy the sender counting relay chain, operating relays 7, 8 and 9 in that order.

- 5 With other combinations of operated and non-operated register relays, as set up under control of various dial impulses, the circuit illustrated functions in a manner similar to that hereinbefore described, except that the number of reverteive ground impulses required to satisfy the sender counting relay chain depends upon the register relay combination previously set up for that particular selection, as this setting determines which counting relay winding is first connected in the anode circuit of tube 14.
- 10 With no register relays operated, counting relay 9 is connected in the anode circuit of tube 14 and one reverteive impulse from the selector under control, satisfies the sender, operating relay 9.
- 15 With register relay 10 operated, and relays 11, 12, and 13 not operated, relay 8 is first connected in the anode circuit of tube 14. Two reverteive impulses satisfy the sender operating relays 8 and 9 in that order. With only register relay 11 operated, three reverteive impulses are required (as hereinbefore described in detail). Register relays 10 and 11 operated require four reverteive impulses, operating relays 6, 7, 8 and 9 in that order. With register relay 12 only operated, five reverteive pulses are required to operate relays 5, 6, 7, 8 and 9 in that order. With only register relay 13 operated, six impulses are required and operate relays 0, 1, 2, 3, 4 and 9 in the order named. The combination of operated relays 10 and 13 require seven reverteive impulses, operating relays 8, 9, 1, 2, 3, 4 and 9 in that order. Operated register relays 11 and 13 require eight impulses and relays 7, 8, 0, 1, 2, 3, 4 and 9 operate in the order named. With register relays 10, 11 and 13 operated, nine impulses are required and counting relays 6, 7, 8, 0, 1, 2, 3, 4 and 9 operate in that order. Register relays 12 and 13 operated require ten reverteive ground impulses from the selector, operating the full counting relay chain in the following order: 5, 6, 7, 8, 0, 1, 2, 3, 4 and 9.
- 45 The foregoing description is for the case where the transformer 15 and resistance 18 only are used. For some situations it is desirable that there also be used a stepping relay 19 with contacts connected locally to transformer 15. A description of the functioning of this invention when said stepping relay is used will now be given.
- 50 In some cases, where the fundamental circuit is long it is found that with the central office battery voltages available it is not feasible to induce sufficient voltage in secondary winding 16 of transformer 15, due to the application of ground by selector brush 22, as hereinbefore described, to effect the ionization of tube 14, when the fundamental circuit is connected directly to transformer 15. Under this condition the use of a stepping relay 19, enables a local source of current to be applied to the winding 17 of transformer 15. Current through the winding of relay 19 is supplied from the selector circuit over conductors 30 and 42, joined respectively to conductors 38 and 39. The circuit path is the same as that previously traced for winding 17 of transformer 15 and resistance 18, excepting that the winding of relay 19 now closes the fundamental circuit at the sender. Relay 19 in operating connects ground to winding 17 of transformer 15 over conductor 36, the circuit to battery being completed over conductor 37. The windings of transformer 15 are so connected in the circuit that the current
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due to the operation of stepping relay 36 causes a potential to be induced in winding 16 of transformer 15 in such a direction as to increase the negative grid bias of tube 14, which accordingly does not ionize. When the stepping relay 19 releases, due to the short-circuiting of the line at the selector, as hereinbefore described in connection with the operation of the invention using transformer 15 and resistance 18 without relay 19, the circuit is opened through winding 17. This induces a potential in secondary winding 16 which causes the circuit to function and operate the various counting relays in the manner hereinbefore described.

Since gaseous discharge tube 14 ionizes very 15 rapidly, and since the ionization is dependent upon grid potential change only, the selector circuit may be controlled over greater fundamental circuit loops than hitherto possible.

Furthermore, since only a very short application of ground from the switch commutator is sufficient to ionize the tube, the selector brush shaft may be advanced at a materially increased speed. An additional advantage is the fact that since the gaseous discharge tube controls the 25 counting relays in response to successive closures of the switch commutator, as contrasted with the present fundamental circuit which depends entirely on an impulse responsive relay to control the associated counting relays in response to successive closures and openings of the switch commutator, a simplified train of counting relays is used, having less than one-half as many relays as heretofore employed.

What is claimed is:

1. In a telephone system, an impulsing device, an impulse responsive device, a control circuit extending from said impulsing device to said responsive device, a gaseous discharge tube at said responsive device having its grid inductively connected with said circuit and normally negatively biased below the ionization potential of said tube, an impulse counting circuit connected to the anode of said tube, means controlled by said impulse device for causing surges of potential through said inductive connection for intermittently rendering the grid of said tube sufficiently less negative to cause said tube to intermittently ionize and produce impulses in said impulse counting circuit, and means in said impulse counting circuit responsive to each impulse to momentarily shunt said impulse counting circuit to deionize said tube.
2. In a telephone system, an impulsing device, an impulse responsive device, a control circuit extending from said impulsing device to said responsive device, a gaseous discharge tube at said responsive device having its grid inductively connected with said circuit and normally negatively biased below the ionization potential of said tube, a train of counting relays, a connection from the anode of said tube through the winding of one of said relays, and means controlled by said impulsing device for causing surges of potential through said inductive connection for intermittently rendering the grid of said tube sufficiently less negative to cause said tube to intermittently ionize, said tube upon its first ionization operating said one of said counting relays to lock itself operated, to momentarily shunt said connection to 70 said anode to deionize said tube and to then reconnect said anode to the winding of the next succeeding counting relay, succeeding ionizations of said tube causing the similar functioning of successive counting relays.

3. In a telephone system, a selector switch, a sender, a control circuit extending from said switch to said sender, a control relay at said switch in said control circuit, a gaseous discharge tube at said sender having its grid inductively connected with said circuit and normally negatively biased below the ionization potential of said tube, an impulse counting circuit including the cathode-anode circuit of said tube, means controlled by said control relay for advancing said switch in a selective movement, and means controlled in said selective movement for causing surges of potential through said inductive connection for intermittently rendering the grid of said tube sufficiently less negative to cause said tube to intermittently ionize and produce impulses in said impulse counting circuit.

4. In a telephone system, a selector switch, a sender, a control circuit extending from said switch to said sender, a control relay at said switch in said control circuit, a gaseous discharge tube at said sender having its grid inductively connected with said circuit and normally negatively biased below the ionization potential of said tube, an impulse counting circuit including the cathode-anode circuit of said tube, means controlled by said control relay for advancing said switch in a selective movement, means controlled in said selective movement for causing surges of potential through said inductive connection for intermittently rendering the grid of said tube sufficiently less negative to cause said tube to intermittently ionize and produce impulses in said impulse counting circuit, and means in said impulse counting circuit responsive to each impulse to momentarily shunt said impulse counting circuit to deionize said tube.

5. In a telephone system, a selector switch, a sender, a control circuit extending from said switch, to said sender, a control relay at said switch in said control circuit, a gaseous discharge tube at said sender having its grid inductively connected with said circuit and normally negatively biased below the ionization potential of said tube, a train of counting relays, means for establishing an impulse circuit from a source of positive potential through the winding of one of said relays to the anode of said tube, means controlled by said control relay for advancing said switch in a selective movement, and means con-

trolled in said selective movement for causing surges of potential through said inductive connection for intermittently rendering the grid of said tube sufficiently less negative to cause said tube to intermittently ionize, said tube upon its first ionization operating said one of said counting relays to lock itself operated, to momentarily connect a source of negative potential in shunt of said source of positive potential to the anode of said tube to deionize said tube and to then connect said source of positive potential to the anode through the winding of the next succeeding counting relay, succeeding ionizations of said tube causing the similar functioning of successive counting relays.

6. In a telephone system, a selector switch having a control relay and a commutator, a sender for controlling the setting of said switch comprising registering means, impulse counting means and a gaseous discharge tube, a control circuit extending from said sender to said switch, said control circuit having one of its conductors connected through the winding of said control relay to grounded battery and having the other of its conductors connected to ground, a transformer at said sender through the primary winding of which the control circuit is looped, the secondary winding of which is connected between the negative terminal of a source of potential and the grid of said tube whereby said grid is negatively biased below the ionization potential of said tube, said transformer windings being so poled with respect to each other that upon the closure of said control circuit the surge of potential in said secondary winding incident thereto renders said grid more negative, an impulse counting circuit extending from the anode of said tube under the control of said registering means to said impulse counting means, and means controlled by said control relay upon the closure of said control circuit to advance said switch in a setting movement whereby said commutator intermittently short-circuits the primary winding of said transformer causing thereby surges of potential in the secondary winding thereof for rendering the grid of said tube sufficiently less negative to cause said tube to intermittently ionize and upon each ionization to close said impulse counting circuit.

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