

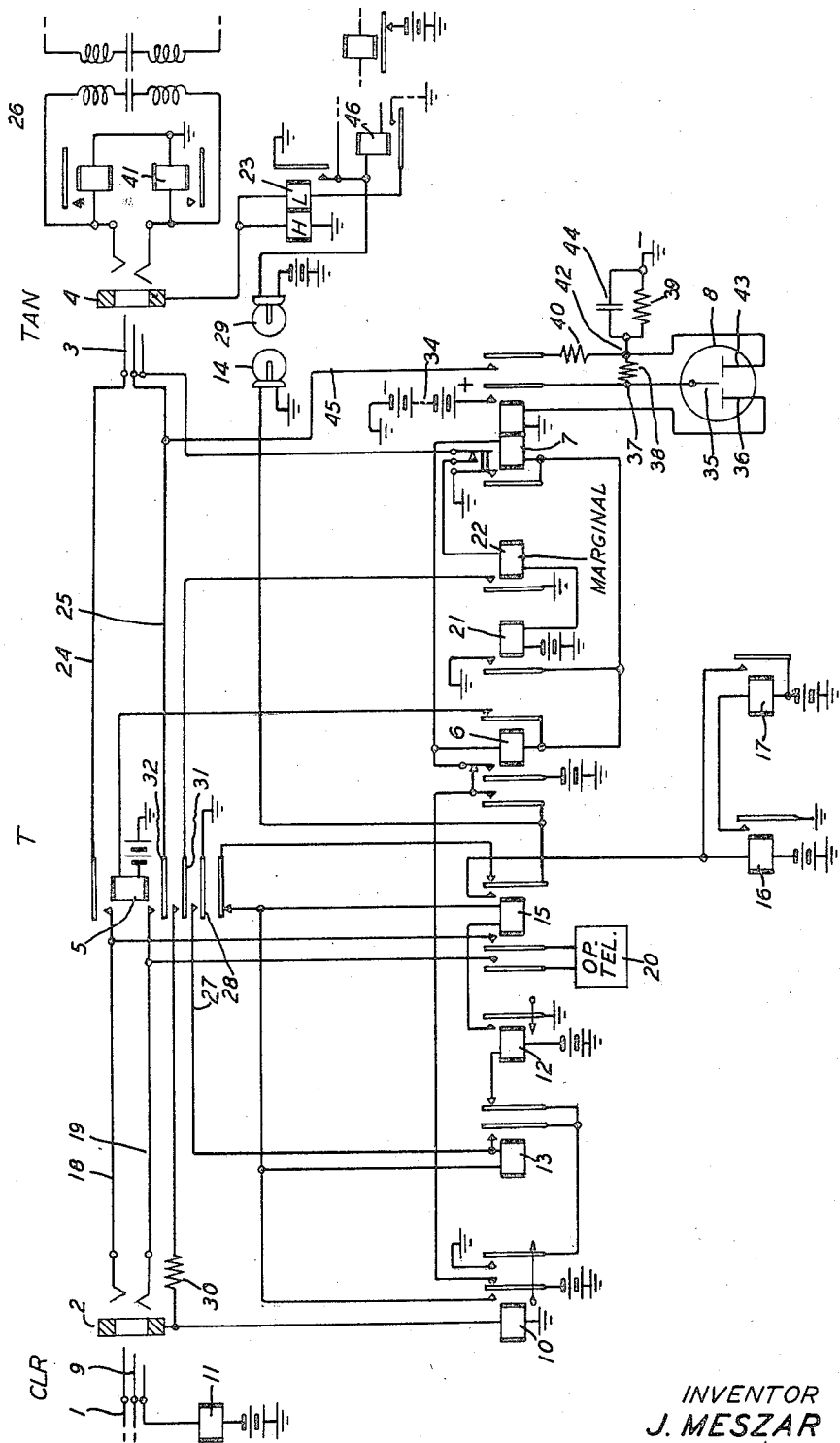
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AUTOMATIC DISCONNECT SYSTEM

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AUTOMATIC DISCONNECT SYSTEM

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This invention relates to trunk circuits arranged to instantaneously disconnect the talking conductors from the inward or plug end of the trunk when the calling or outward end is released prior to disconnection of the trunk plug from the called line.

In systems of this character it has been the practice to operate a disconnect relay at the inward end when the outward end of the trunk is released thereby opening the trunk conductors at that point. Further, in order to completely free the called line so that it can be taken for use by another operator before the trunk plug is removed from the line, the disconnect relay causes the normal sleeve relay circuit of the trunk, which is of relatively low resistance, to be disconnected and substitutes a high resistance relay therefor which causes the sleeve relay in the line to release thereby causing the line to test idle and making it available for another call. In such an arrangement the high resistance relay in the trunk sleeve operates and holds the disconnect relay operated thereby preventing a recall on the trunk from releasing the disconnect relay and reconnecting the trunk through to the called line. When the trunk plug is removed from the called line the trunk circuit restores to normal.

An arrangement of this character is satisfactory in cases where the sleeve circuit of the called line is not employed for other purposes, i. e., when other sensitive relays are not connected thereto which, however, is the case with certain modern toll lines in which various unrelated functions are controlled over the sleeve circuit thereof by means of sensitive apparatus operated by current supplied to the sleeve of the line from a connected cord or trunk.

In such cases to effectively free the line it would be necessary, with the previous circuits, to employ a relay of such high resistance that the current would be of such a low value as to preclude its satisfactory operation.

An object of the present invention, therefore, is to effectively free the connected line, when the outward end of the trunk is released, and prevent its reconnection to the trunk before the trunk plug is disconnected therefrom without interfering with circuit devices or apparatus connected associated with that of that line.

A feature of the invention whereby the foregoing object is attained resides in the provision of a gas-filled discharge device connected to the ring of the trunk plug in such a manner that it is held inactive while the plug is connected to the line, but will discharge and cause the release of the

locked-in trunk disconnect apparatus and restoration of the trunk circuit to normal when the trunk plug is removed from the connected line.

The invention will be understood from the following description when read in connection with the accompanying drawing, which shows a one-way tandem trunk circuit T, arranged according to the invention and extending between two toll switchboards, one of which—switchboard CLR—is indicated at the left of the drawing with part of a cord circuit 1 and a trunk jack 2. The other apparatus of the drawing is associated with a tandem switchboard TAN at which trunk T terminates in plug 3, which has access to a jack 4 of outgoing straight forward toll line 26. When the operator CLR withdraws plug 1 from jack 2 at the end of a conversation between subscribers, relay 5 is caused to immediately release due to the operation of relay 6, which locks up under control of relay 7, which relay also operates at this time. The tip and ring conductors of the trunk are disconnected from plug 3 by the release of relay 5, and the sleeve conductor is disconnected by the operation of relay 7, thereby making the trunk T immediately available for another call at switchboard CLR, and causing straight forward toll line 26 to be indicated as idle at switchboard TAN.

According to a particular feature of the invention, when the operator TAN finally withdraws plug 3 from jack 4, the ionic tube 8 functions to cause the release of relays 7 and 6, thereby restoring the trunk circuit to normal. A more complete understanding of the operation of the invention may be obtained from the following detailed description.

Assume that the operator CLR at a toll switchboard, which is of the type known in the art as a "combined line and recording" switchboard has received a request from a calling subscriber over a trunk circuit (not shown) for a call requiring for its completion a connection to the straight forward toll line 26, the conductors of which terminate on the jack 4. The operator CLR will now insert plug 9 into jack 2, thereby operating sleeve relay 10 over a circuit traced from battery through the winding of cord circuit sleeve relay 11, sleeve contacts of plug 9 and jack 2 and winding of relay 10 to ground. Relay 10 in operating, operates relay 12 through a circuit including battery, the winding of relay 12, outside normally closed contacts of relay 13, and ground on the outside operated mate contacts of relay 10. Relay 12 in operating also operates relay 15 through a circuit from battery on the inner operated make con-

facts of relay 10, through the winding of relay 15 to ground on the contacts of relay 12. Relay 15 in operating, operates relay 16 through a circuit from battery through the winding of relay 16, right-hand operated make contacts of relay 15, and lamp 14 to ground. Relay 16 in operating operates through an obvious circuit relay 17, which in operating connects battery to the upper terminal of relay 16. This short-circuits the winding of relay 16 and applies full battery potential to lamp 14 over the circuit hereinbefore traced. Lamp 14 now lights and relay 16 by reason of the application of the aforesaid short circuit releases. Relay 16 in releasing causes the release of relay 17, thereby disconnecting battery from the upper winding of relay 16 and from lamp 14. Lamp 14 is now extinguished, due to the inclusion of the resistance of the winding of relay 16 in its energizing circuit and relay 16 reoperates over the circuit hereinbefore traced, due to the removal of the short circuit applied by the contacts of relay 17. The cycle of operation and release of relays 16 and 17 is repeated causing the flashing of lamp 14.

When relay 15 operated it also connected, at its left-hand contacts, the tip and ring conductors, 18 and 19, to the operator's telephone and control circuit of the tandem switchboard, which is indicated diagrammatically by a rectangle 20.

It should be explained here that the relays 12 and 15 represent the so-called "sequence relays" of a system of automatic listening, whereby the trunks of a trunk switchboard position are connected one at a time, in sequential order, to the operator's telephone circuit of the trunk position. As this system is well-known in the art, and is unnecessary for a description of the present invention, it is not shown here. It should be understood, accordingly, that the tandem trunk circuit T illustrated in the drawing is one of a number of trunks and that when relay 15 effected its aforesaid connection to the operator's telephone and control circuit 20, no other trunk of the position could be connected as long as the connection is maintained.

When operator's telephone and control circuit 20 is thus connected to the sequentially selected trunk, an order tone is automatically transmitted over the trunk in the well-known manner by circuit arrangements not shown. This order tone is heard simultaneously by the operators CLR and TAN. Operator CLR now requests connection to the toll line terminating in jack 4. The operator TAN observing that the flashing lamp 14 is associated with trunk T, which identifies the trunk to which her telephone and control circuit has been connected, inserts plug 3 into straight forward toll line jack 4, thereby operating relay 21 over a circuit traceable from battery through the windings of relays 21 and 22, normally closed contacts of relay 7, sleeve contacts of plug 3 and jack 4, through left-hand high resistance winding of toll line sleeve relay 23 and other apparatus not shown, to ground.

Relay 22 being marginal does not operate in this circuit but relay 23 operates and closes a circuit, indicated but not shown in detail, to cause the transmission of a ringing signal toward the office of the called subscriber, and also to operate relay 46 which connects ground to the low resistance right-hand winding of relay 23 which is in parallel with the left-hand winding thereby decreasing the resistance of the sleeve circuit and causing marginal relay 22 in the cord circuit to operate which in turn connects ground to re-

sistance 30 through its own contact and contacts 31 and 32 of relay 5, which relay is operated at this time as hereinafter described. Relay 23 in operating also closes a circuit to display a busy signal 29. Resistance 30 is now connected in shunt with the winding of relay 10 thereby lowering the sleeve resistance to ground of jack 2 and plug 9 and causing a supervisory lamp (not shown) associated with cord circuit 1 to light.

When relay 21 operated it caused the operation of relay 5 over a circuit that may be traced from battery through the winding of relay 5, right-hand normally closed contacts of relay 6 to ground on the contacts of relay 21. Relay 5 in operating connects tip and ring conductors 18 and 19 to corresponding conductors 24 and 25 thereby completing a conversational path to the straightforward toll line 26. Relay 5 also operates relay 13 from battery on the inner front contact of relay 10 through the winding of relay 13 to ground on contact spring 28 of relay 5. Relay 13 in operating opens at its normally closed contacts the operating circuit hereinbefore traced for relay 12 which relay now releases. The release of relay 12 opens the obvious operating circuit of relay 15 which also releases thereby disconnecting the operator's telephone and control circuit 20 from conductors 18 and 19 and lamp 14 from the flashing relays 16 and 17. Lamp 14 is thereby extinguished. Relay 13 in operating also locks under control of relay 15 from battery on the inner operated front contacts of relay 10, through winding and inner operated front contact of relay 13 to ground on the outer operated contacts of relay 10.

When the operator at the distant completing central office is connected to the toll line 26, establishes the desired connection to the called subscriber's line and the called subscriber answers by removing his receiver from the switch-hook, apparatus (not shown) associated with the outward end of the line 26 at the TAN operator's position functions to release relay 46 thereby opening the low resistance sleeve circuit previously mentioned through the right-hand winding of relay 23 thus increasing the resistance of the sleeve circuit of jack 4. Under this high resistance condition marginal relay 22 in the cord circuit releases and in so doing disconnects ground from resistance 30 causing thereby an increase in resistance of the sleeve circuit of jack 2, which causes the supervisory lamp (not shown) of cord circuit 1 to be extinguished thereby indicating to the CLR operator that the called subscriber has answered.

At the end of the conversation when the called subscriber replaces his receiver on the switch-hook relay 46 is again caused to operate, thereby shunting the left-hand high resistance winding of relay 23 by the low resistance circuit through its right-hand winding which as before described will cause reoperation of marginal relay 22 in the cord circuit which, in turn, reconnects resistance 30 to ground and reduces the resistance of the sleeve circuit of jack 2 to cause the lighting of the supervisory lamp of cord circuit 1 all as hereinbefore described in connection with the insertion of plug 3 into jack 4 on originating the call.

The operator CLR now observing the lighted supervisory lamp (not shown), recognizes it as a disconnect signal and withdraws plug 9 from jack 2. This opens the circuit of relay 10, which releases causing the release of relay 13 and the operation of relay 6 over a circuit that may be

traced from battery through the back contacts of relay 10, left-hand normally closed contacts and winding of relay 6 to ground on the operated contacts of relay 21. Relay 7 also operates at this time through a circuit traceable from battery on the back contacts of relay 10, through left-hand normally closed contacts of relay 6, left-hand winding of relay 7, to ground on the operated contacts of relay 21.

In operating, relay 7 locks to ground on its left-hand outer make contacts, being energized by battery on the left-hand, inner operated contacts of relay 6, and also opens the sleeve circuit of plug 3 and jack 4. Relays 21, 22 and 23 release, and lamp 29 is extinguished. It will be noted here, that the left-hand contacts of relay 7 are arranged so that the outside contacts close, before the inside contacts break, thereby assuring that relays 6 and 7 are held operated before the operating circuit of relay 21 is opened which relay in releasing disconnects the original operating ground for relays 6 and 7. Relay 6 in operating, locks to battery on its left-hand inner make contacts and to ground at the left-hand contacts of relay 7 and opens at its right-hand contacts the operating circuit, hereinbefore traced, of relay 5 which releases, breaking the continuity of the talking conductors, opening the circuit of resistance 39, removing ground from the winding of relay 13, which releases and closes its own lowermost contacts. It will be noted that straightforward toll line 26, although plug 3 is still in jack 4, is now available through multiple jacks (not shown) for another call, since the tip and sleeve conductors of plug 3 are open, while the ring conductor is connected to ground and battery through very high resistances 38, 39 and 40.

When relay 6 operated it also closed a circuit for lighting lamp 14 as a disconnect signal for the attention of the operator TAN. This circuit may be traced from ground through lamp 14, outer left-hand operated contacts of relay 6 to battery on the back contacts of relay 10.

Let it be assumed now that, before the operator TAN responds to the lighted disconnect lamp 14, by withdrawing plug 3 from jack 4 that this trunk is reselected by the same CLR operator or by another CLR operator having access to trunk T. Relays 10, 12 and 15 will again operate, as hereinbefore described. Relay 15 will reconnect operator's telephone and control circuit 20 to the talking conductors and lamp 14 to the flashing relays 16 and 17. Lamp 14 again flashes and order tone is again heard by operators CLR and TAN as in the case of the original call. The operator CLR now requests that a connection be completed by operator TAN, who observes the flashing lamp 14 and knows thereby that it is the plugged up trunk that has been selected. Operator TAN now removes the trunk plug 3 from jack 4 and the feature of this invention will now be described whereby the release of relays 6 and 7 from their interlocked condition hereinbefore described is effected.

When relay 7 operated and locked to ground on its outer left-hand contacts through its left-hand winding it also prepared a circuit for its right-hand winding that may be traced from battery 34 through right-hand inner contacts of relay 7 to anode 35 of gaseous discharge tube 8, thence through tube 8 to its cathode element 36 and the right-hand winding of relay 7 to ground. Another circuit was closed by the right-hand inside contacts of relay 7 which may be traced from battery 34, junction point 37, through high re-

distances 38 and 39 to ground. Relay 7 also connects junction point 42, between resistances 39 and 40, to the ring conductor of the cord and toll line, which is grounded through a relay 41 whose function is to control ringing over the line. It should be observed that grid element 43 of tube 8 is also connected to junction point 42. Under the circuit condition hereinbefore described tube 8 does not discharge and there is no current flow through the right-hand winding of relay 7, since the potential of grid element 43 is insufficient to effect the ionization of tube 8. When plug 3 is removed from jack 4, the circuit traced through the winding of relay 41 is opened and consequently the current flow therethrough due to the potential of junction point 42 ceases. The effect of this is to decrease the current flow in resistance 38, which raises the positive potential of junction point 42 and consequently of grid element 43, sufficiently to cause the ionization and discharge of tube 8. Consequently, current now flows from battery 34 and between electrodes 35 and 36 of tube 8 through the right-hand winding of relay 7, hereinbefore referred to. The right-hand winding of relay 7 is so connected that, when energized by the ionization current of tube 8 as hereinbefore described, it opposes the magnetic action of its left-hand winding and this opposing action is sufficient to cause the relay to release. When relay 7 releases ground on its left-hand contacts is removed from the winding of relay 6, which also releases, thereby making the trunk available for the new call.

Due to the extremely rapid functioning of tube 8 after grid 43 has reached the ionization potential it has been found desirable to retard the establishment of said ionization potential for the reasons hereinafter given. When relay 7 operates there is a possibility that the necessary ionization potential may be established on grid 43 by the closure of the right-hand inner contacts of relay 7, before the current in resistance 40 has reached its final maximum value following the closure of the right-hand outer contacts of that relay, thereby causing a premature release of relay 7. The desired retardation is obtained by the time required to charge condenser 44 which is connected in parallel with resistance 39, since the potential of grid 43 cannot reach its final maximum value until condenser 44 is completely charged.

In connection with the foregoing description it should be stated that the resistances 38, 39, and 40 used in association with the ionic tube 8 are all of a very high order of resistance. It has been found that a suitable resistance value for resistance 38 is of the order of 2 megohms, for resistance 39, 5 megohms and for resistance 40, 1 megohm. Accordingly, the connection of conductor 45, with its associated apparatus, to ring conductor 25 can have no effect on the transmission of voice currents, nor interfere in any manner with the proper functioning of relays in the straightforward toll line circuit, or other associated circuits. Also, because of this high resistance, there is no interference with the use of straightforward toll line 26, if this line is reselected for use before plug 3 is withdrawn from jack 4.

The arrangement of the invention that has been described refers specifically to means for effecting the release of certain relays in a trunk circuit by the use of an associated control circuit of very high resistance, including an ionic tube, which functions, when the trunk is discon-

5 nected from an associated line to cause the tube to discharge and effect the release of the certain relays. It is to be understood, however, that the invention is also applicable to other circuit conditions, especially to cases where it is essential
10 that the resistance of said control circuit, which may be used to effect the release of relays or perform some other desirable circuit function, shall be of a very high order, avoiding thereby
15 any disturbing effects on transmission or on the performance of associated relays or other circuit apparatus. These other applications will readily occur to one skilled in the art.

What is claimed is:

15 1. In a telephone system, a trunk line having outward and inward ends, means for establishing a connection with the trunk line at the outward end, an outgoing line at the inward end, means for connecting said trunk line to the outgoing
20 line, a guard signal associated with the inward end of said trunk line, means automatically responsive to the release of the trunk line at the outward end while the inward end is connected to the outgoing line to open the talking conductors of
25 the trunk at the inward end, and display said guard signal, and a gas-filled discharge device associated with the inward end of said trunk line responsive to the disconnection of said trunk line from the outgoing line for retiring said guard
30 signal.

2. In a telephone system, a calling line terminating in a plug at its inward end and connected to a called line, means responsive to the release
35 of the calling line at its outward end for disconnecting it from the plug at the inward end, other means also responsive to release of said calling line adapted to lock itself and the first means operated independent of the outward end,
40 and a gas-filled discharge device in a circuit including the ring conductors of the plug and called line and responsive to disconnection of the plug from the called line to unlock said first and second means.

3. In a telephone system, an outward switchboard, an inward switchboard, a trunk line therebetween, an established connection to said line at the outward board, an outgoing line at the inward
45 board, a plug terminating the inward end of said trunk line and connected to said outgoing line, means responsive to the release of the trunk connection at the outward switchboard for disconnecting said trunk line from the plug at the
50 inward board, a second means also responsive to the release of the trunk connection at the outward board for establishing a locking circuit for itself and the first means, and means including a gas-filled discharge device maintained inert
55 over a circuit including the ring conductors of the plug and connected to the outgoing line adapted to cause the release of said first and second means when the connection between said
60 plug and outgoing line broken.

4. In a telephone system, a trunk line having outward and inward ends, a toll line, means for establishing a connection with the trunk line at the outward end thereof, means for establishing
5 a connection between the trunk line and the toll line at the inward end of the trunk line, means at the inward end of the trunk line jointly responsive to disconnection from the trunk line at the outward end and to the connection of the
10 trunk line to the toll line to open the trunk line conductors at the inward end, means at the inward end of the trunk line for locking operated the last-mentioned means independent of the connection to the trunk line at the outward end,
15 and an ionic tube at the inward end of the trunk line for effecting the release of said locked means, said ionic tube functioning in response to the disconnection of the trunk line from the toll line.

5. In a telephone system, a line having outward and inward ends, means for establishing a
20 connection with the line at the outward end, means for establishing a connection with the line at the inward end, means for opening the line conductors at the inward end responsive to the disestablishment of the connection at the outward
25 end, means for causing said line opening means to be locked operated independent of the connection at the outward end, an ionic tube having anode, cathode and grid elements at the inward end and means for effecting the release of said
30 line opening means by causing the ionization of said ionic tube by an increase in potential on said grid element in response to the disestablishment of the connection at the inward end.

6. In a telephone system, a line having outward and inward ends, means for establishing
35 connection with the line at the outward end, means for establishing connection with the line at the inward end, means for opening the line conductors at the inward end responsive to the
40 disestablishment of the connection at the outward end, means for causing said line opening means to be locked operated independent of the connection at the outward end, an ionic tube at the inward end having anode, cathode and
45 grid elements, a relay winding in series with said anode and cathode elements, means for connecting a source of potential in series therewith responsive to the said disconnection at the outward end, other means similarly responsive to
50 the disconnection aforesaid to cause a gradual establishment of a potential on said grid element below the ionization potential of said ionic tube, and means responsive to the disestablishment of the connection at the inward end whereby the
55 potential of said grid element is increased so as to effect the ionization and discharge of said ionic tube to cause a flow of current through the circuit of said relay winding to cause its operation and the release of said locked line opening means.
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