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TELEPHONE SYSTEM

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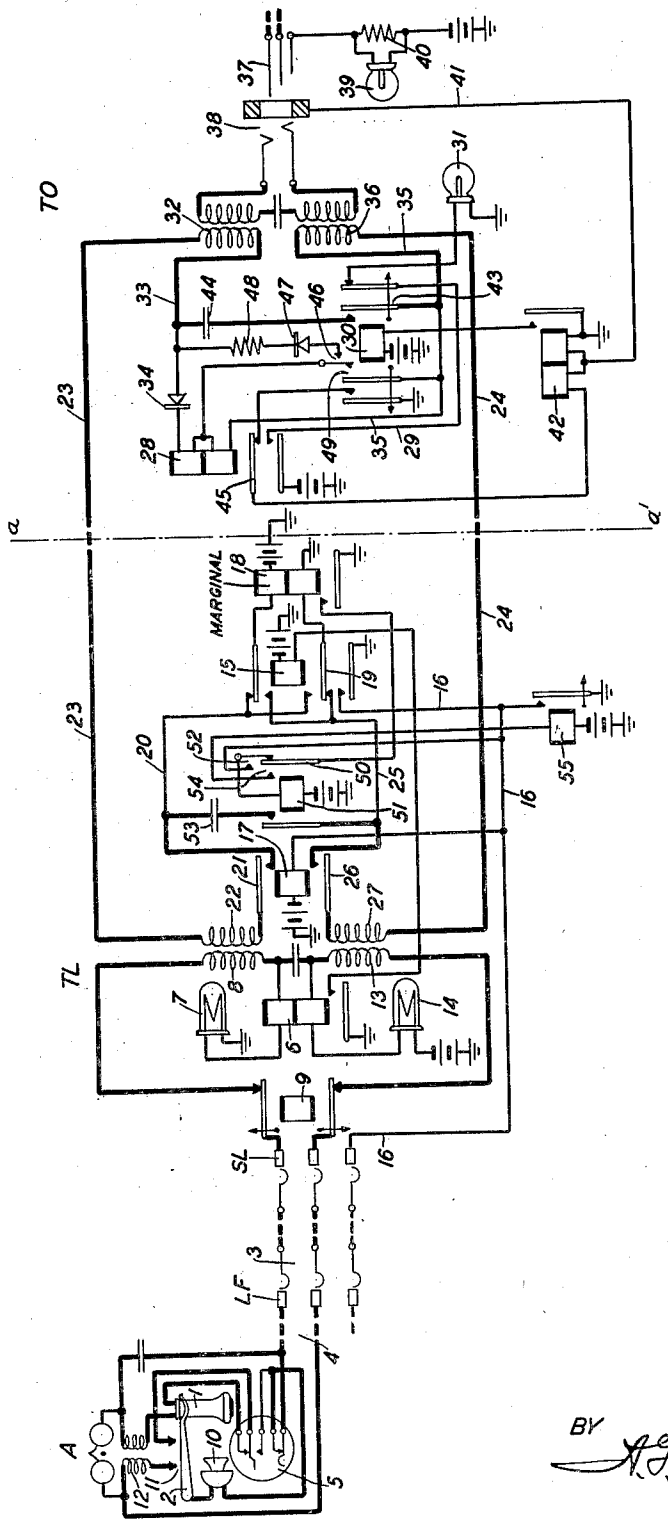

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TELEPHONE SYSTEM

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This invention relates to signaling systems and more particularly to telephone trunk line supervisory relay systems.

In certain trunk lines used at the present time, it has been the practice to use polarized relays at one end which are controlled by reversals of the line battery at the other end. In order that such current reversals shall not affect the condition of apparatus at the said other end, the relays connected in the line at that end are neutral or non-polar, that is, they are energized and maintained energized irrespective of the direction of the current flow through their windings.

It is well known that a neutral relay may be polarized, that is, caused to respond to current flowing in only one direction through its winding by the simple expedient of connecting a unidirectional element, such as a metal oxide rectifier, in series with it. However, such an arrangement per se, while providing an inexpensive means of obtaining polarized operation in a relay for certain purposes, relays made polar by this expedient cannot be used in systems as above described in which other relays in the same circuit must remain operated on reversals of the line current.

An object of the present invention, therefore, is to adapt relays polarized by the use of series rectifying elements for use in circuits of the character described.

A feature of the invention resides in so connecting a second rectifying device in shunt to the relay and its series rectifying element that line current flowing in a direction to be opposed and blocked by the series or polarizing element will be freely passed by the shunt device, thereby maintaining a sufficient current flow in the line to hold energized any other relay connected therein.

The invention will be understood by reference to the accompanying drawing showing one embodiment of the invention in which all apparatus is shown in its normal or non-actuated condition, and whereby a dial subscriber station A is shown terminating in the banks of a line finder switch LF, thence through a line finder circuit and intermediate selector circuits not shown, to the trunk terminals SL of a selector switch having access to the outgoing end of a trunk TL extending to a distant toll office TO over a trunk cable or other line conductors **23**, **24**. At the right of the vertical broken line *a*, *a'* is shown the incoming end of the trunk located in the toll office at which a neutral relay **28** is shown connected thereacross and with which is associated rectifying devices **34** and **47** in accordance with the present invention whereby well-known reversals of the line current at the dial office end of the trunk line release and operate the relay **28** at the toll office without affecting the operative condition of a second relay **18** at the dial office.

Assuming now that subscriber A desires a connection to a distant point which is reached over the trunk line TL through the toll office TO, he removes receiver **1** from the switch-hook **2** whereupon, in a well-known manner, an idle line finder indicated at **3** attaches itself to the multiple terminals of his line **4** indicated at LF. The line finder, for purposes of illustration, is assumed to lead through one or more selector switches which, it will readily be understood, function in response to impulses from the subscriber's dial **5** to connect the subscriber's line with an idle outgoing dial office trunk circuit, such as TL, connected to the selector bank multiple at SL. It will be further assumed, for the purpose of this description, that the subscriber has completed dialing a number code which has connected his line **4** with the outgoing end of the trunk TL leading to the incoming end of the trunk at the toll office TO.

When the selector circuit connects with the bank terminals SL, the subscriber's receiver is off the switch-hook and a circuit is closed for operating the trunk relay **6** traced from ground through ballast lamp **7**, top winding of relay **6**, winding **8** of the trunk repeating coil, through top back contact of relay **9**, thence over one conductor of the extended line **4**, through lower contact on subscriber dial **5**, transmitter **10**, contacts **11** of switch-hook **2**, primary induction coil winding **12**, and back over the other conductor of the extended line **4** to the lower armature and back contact relay **9**, through winding **13** of trunk repeating coil, thence through lower winding relay **6** and ballast lamp **14** to battery. Relay **6** operates and connects ground at its lower armature and front contact through the winding of relay **15** to battery. Relay **15** operates and connects ground at its bottom contacts to the sleeve or holding lead **16** for the purpose of maintaining (in a well-known manner) the calling subscriber's connection through the line finder and selecting switches until the calling subscriber or both subscriber and operator disconnect. Ground connected to lead **16** also operates relay **17** for connecting battery and ground to the toll office end of the trunk circuit which can be traced from ground on lower winding relay **18**, front contacts of arma-

ture 19 and relay 15, lead 20, top front contacts and armature 21 of relay 17, repeating coil winding 22, and thence over conductor 23 of the trunk to the distant toll office. Battery is connected to conductor 24 of the trunk by relay 17 over a path traced from battery through the upper winding of relay 18, top armature and front contacts of relay 15, lead 25, bottom contacts and armature 26 of relay 17, repeating coil winding 27, and thence, over conductor 24 of the trunk to the distant toll office.

Battery and ground connected to the trunk conductors 23 and 24, as described above, cause relay 28 to operate and at its lowermost contacts to connect battery to lead 29, over right armature and back contacts of relay 30 and through trunk lamp 31 to ground. The path for operating relay 28 may be traced from trunk conductor 23 of the talking circuit to winding 32 of the repeating coil, lead 33, rectifier element 34, upper and lower windings of relay 28, lead 35, winding 36 of repeating coil, and back to the other conductor 24 of the trunk.

The lighting of trunk lamp 31 indicates to the toll operator that a call on the trunk is waiting to be answered. The operator thereupon inserts plug 37 of her connecting cord circuit (not shown) in trunk jack 38 thus closing a sleeve circuit traced from battery through lamp 39 and resistance 40 in parallel, through jack 38, to ground over sleeve wire 41 and right winding of relay 42. The cord supervisory lamp 39 does not receive sufficient current at this time to light due to the high resistance of the right-hand winding of relay 42, and its own shunt resistance 40. Relay 42, however, operates to connect ground at its front contacts for operating relay 30. At its right back contact relay 30 opens the circuit for trunk lamp 31 thereby extinguishing it, and indicating, in cases where the trunk has a multiple appearance, that the incoming call has been answered. Relay 30 by attracting its armature 43 connects condenser 44 across the inner ends of the windings 32 and 36 of the repeating coil for transmission purposes. By attracting its outer left armature, relay 30 prepares a circuit for lighting supervisory cord lamp 39 when relay 28 releases, as will later be described. Operation of relay 30 also closes its contacts 46 to connect rectifier element 47 and resistance 48 in shunt to the upper winding of relay 28 and its series rectifier element 34 for maintaining relay 18 operated under battery reversal conditions as will be later described. Further, the operation of relay 30 closes, at its contacts 49, a zero resistance shunt path around the relatively high resistance lower winding of relay 28 which up to this time has prevented marginal relay 18 at the outgoing end of the trunk from operating. This shunt reduces the resistance of the previously traced circuit including relays 18 and 28 to such a value that relay 18 now operates, relay 28 remaining operated by current flowing through its upper winding. Operation of relay 18 closes a circuit from ground through the back contact of armature 50 of relay 51, causing that relay to operate and lock through its contact 52 to ground on sleeve lead 16. Relay 51 remains operated during the rest of the connection and at its left front contact connects condenser 53, over the closed contact of relay 17, across the inner ends of repeating coil windings 22 and 27 for transmission purposes. Relay 51 at its contacts 54 closes a path for operating relay 55 traced from ground at front contact relay 18, over contact 54 to battery through winding of relay 55. The latter relay 55 continues to hold ground on lead 16 as long as relay 18 is operated. Relay 55 is slow to release in order to guard against any momentary opening of the contact of relay 18. The holding of the connection as determined by ground on lead 16 is, therefore, now under control of both the calling subscriber and the toll operator. That is, the calling subscriber's line relay 6 holds relay 15 operated which in turn maintains ground on lead 16. Likewise as long as the toll operator has plug 37 inserted in jack 38, relay 42 remains operated holding relay 30 operated, thereby maintaining a low resistance bridge across the trunk which continues to hold relay 18 operated and in turn relays 51 and 55.

Having now described the completion of a call from the subscriber through the toll switchboard, it will be assumed that the connection remains held for the usual time at the end of which subscriber A wishes to talk with the toll operator. To attract her attention subscriber A momentarily depresses switch-hook 2 several times. At the first break of contact 11, the circuit over line 4, which includes the windings of relay 6, is broken causing that relay to release. This removes ground from relay 15 which releases and thus the battery and ground circuit through windings of relay 18 is reversed with respect to leads 20 and 25 which previously were traced to connect with the trunk leads 23 and 24, respectively. This polarity reversal causes relay 28 to release and connect ground from the outer left contacts of operated relay 30, over back contacts and armature 45 of relay 28, and left winding of relay 42 to sleeve lead 41. The resistance of the left winding of relay 42, being low as compared with its right winding, decreases the overall resistance from lead 41 to ground so that supervisory lamp 39 in the sleeve of the operator's cord circuit lights on the increased current flow. Lamp 39, however, does not remain lighted long for the reason that the subscriber A upon again releasing the switch-hook 2 immediately closes the talking circuit at contacts 11 which causes relay 6 to reoperate thereby reoperating relay 15 and restoring the battery polarity over the trunk to relay 28 to its first condition. This reoperates relay 28 which opens the ground path through the left winding of relay 42 and again increases the sleeve resistance so that lamp 39 goes out. In this manner, every momentary depression of the switch-hook results in a flash of the toll operator's cord supervisory lamp 39. This continues until noted by the toll operator who operates her talking key and inquires the wishes of the subscriber A. Relay 42 under this flashing condition is supposed to remain in an operated condition, but due sometimes to a surge effect it may release for a moment. To guard against this, relay 30 is made slow to release.

In circuits of this kind, it previously has been the custom to employ a polarized relay in place of the ordinary relay 28. By making use of rectifiers 34 and 47, however, all the features of a highly sensitive polarized relay are obtained, as will now be explained. Rectifier 34 has the property of permitting current to flow freely in the circuit toward the winding of relay 28 when the incoming call operates relay 15 which connects ground through lower winding of relay 18 to trunk conductor 23. When the operator answers and relay 30 operates, rectifier 47 is connected, as previously described, in a reverse direction to that of rectifier 34 so that, under

the conditions just described (operator answers), rectifier 47 opposes passage of current and the relay 28, therefore, remains operated, during conversation, by its top winding, the bottom winding at this time being short-circuited at contact 49 of relay 30.

When the subscriber A at the end of a conversation, for instance, begins to flash the end supervisory lamp 39, as previously described, the first depression of the switch-hook 2 causes relays 6 and 15 to release and consequently battery instead of ground potential to be applied over trunk conductor 23 to rectifier 34 and also to rectifier 47 through resistance 48. Rectifier 34, due to its directional connection in the circuit, now prevents current from flowing in the upper winding relay 28 and since the bottom winding is short-circuited at contacts 49 of relay 30, relay 28 will release and light the operator's cord lamp 39 previously described. Were it not for rectifier 47, no current would flow over trunk leads 23 and 24 at this stage and relay 18 would release, thus leading to a probability of momentarily removing ground from the holding lead 16 and prematurely breaking down the connection. To prevent this contingency, it is necessary that the relay 18 remain held in an operated condition by the toll operator as long as the cord plug 37 remains in trunk jack 38. Rectifier 47 is, therefore, provided for this purpose and poled in such a manner that it permits the reversed polarity current to pass freely through trunk conductors 23 and 24, thus maintaining relay 18 operated. Resistance 48 is usually of a low value, equal to the resistance of the top winding of relay 28, so that current in the trunk is the same as when the reverse polarity is present and the current flow is through the upper winding of relay 28. When the calling subscriber A finishes talking with the toll operator, he will replace the receiver (1) on switch-hook 2, thus releasing relay 6 and in turn relay 15. Relay 15 released removes ground at its bottom contacts connected to lead 16. The connection, however, does not break down until the toll operator also disconnects by removing plug 37 from jack 38. This releases relay 42 which in turn releases relay 30 which at contact 49 opens the shunt around the bottom winding of relay 28. Introducing the high resistance bottom winding of relay 28 back into the circuit causes relay 18 to release, which in turn opens the circuit for relay 55. This removes the only remaining ground connected to lead 16 and causes relay 17 to release and open the battery and ground connection to the toll end of the trunk so that relay 28 will release. Thus all switches and circuits are restored to their normal position ready for the next call.

What is claimed is:

1. In a signaling system, a line, a source of direct current and a unidirectional current conducting device serially connected therein, a pair of relays also connected in series with the line both being adapted to be operated when the polarity of the source is such with respect to the series device as to cause current to flow therethrough, means for reversing the polarity of the source to oppose the polarity of the series device, and means including a second unidirectional device so connected to the line as to continue to permit current to flow from said source through one of said relays to hold it operated when the polarity of the source is opposed to the series device.

2. In a trunking system, a trunk line, a first relay bridge across the line at one end, a second relay and a source of direct current in series therewith bridged across the other end of the line, means for reversing the polarity of said source with respect to the line, a unidirectional current conducting device in series with the winding of the first relay, and a second unidirectional device connected in shunt to said first relay and its associated series device, said shunt device being so poled with respect to the line that sufficient current will flow through said second relay to hold it operated irrespective of the direction of such current in the line.

3. In a signaling system comprising a line and a relay at each end thereof and in series therewith, means for controlling the release and reoperation of one relay, while the other relay remains operated, which consists of a source of direct current and a unidirectional current conducting device both also in series with the line, means for reversing the polarity of said source with respect to the line, and a second unidirectional device in shunt to the first unidirectional device and the relay to be controlled, said second device being so connected that it will pass current flowing in the line, the direction of which is opposed by the series device.

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