

Aug. 24, 1943.

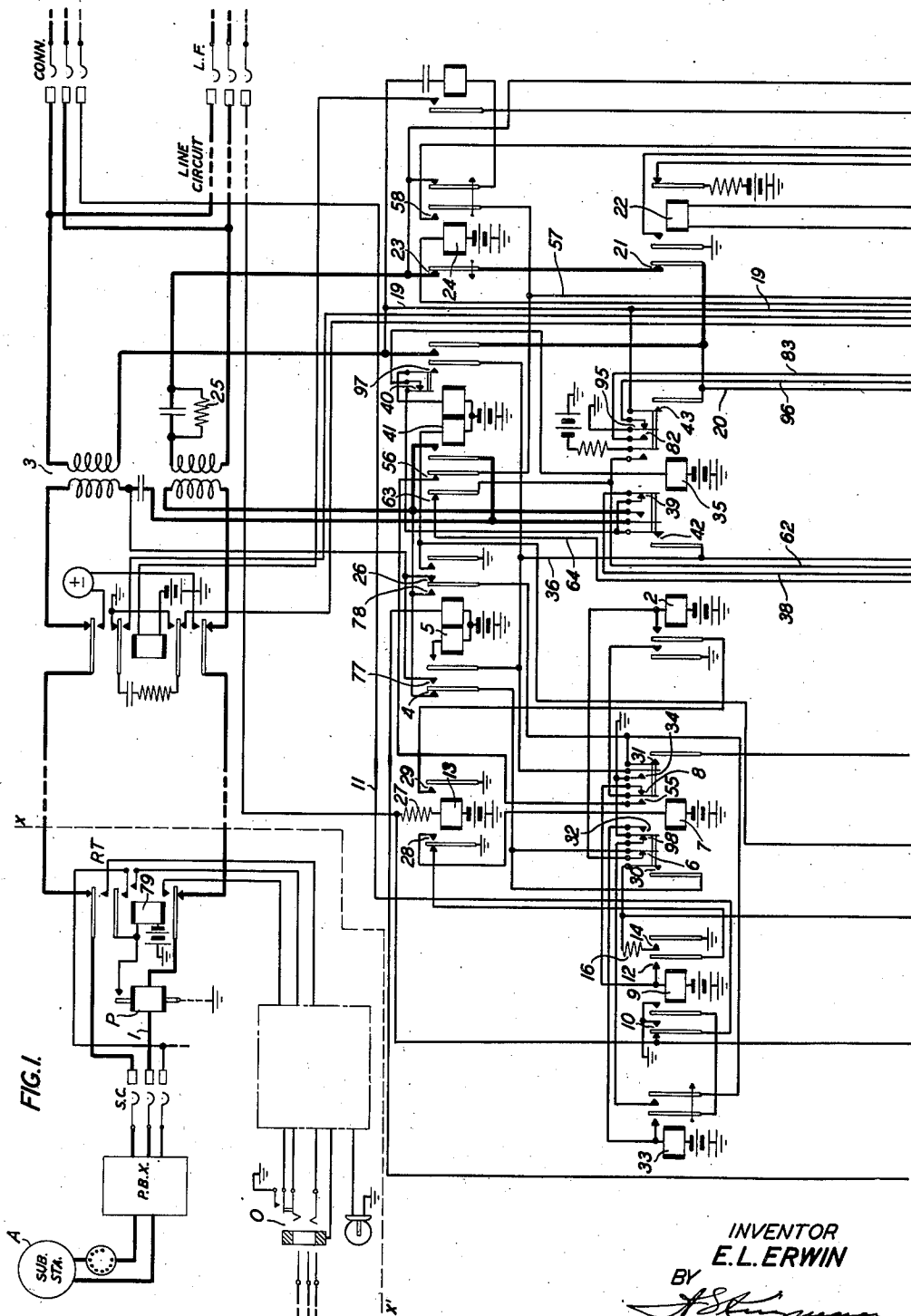
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2,327,877

TELEPHONE CALL DIVERTING SYSTEM

Filed March 31, 1942

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

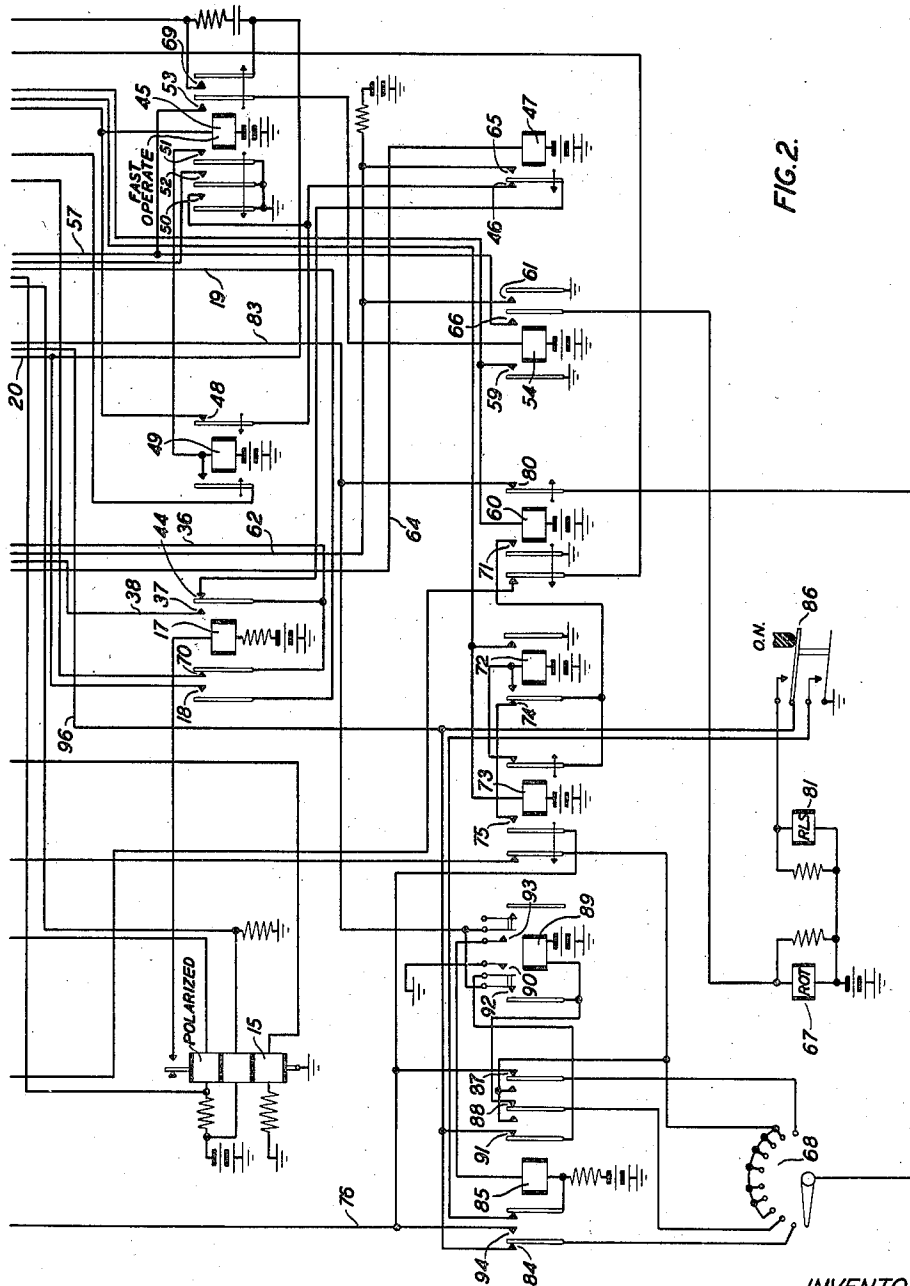


FIG. 2.

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TELEPHONE CALL DIVERTING SYSTEM

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Application March 31, 1942, Serial No. 437,007

9 Claims. (Cl. 179—27)

This invention relates to dial private branch exchange telephone systems in which automatic switches are employed for establishing connections and more particularly wherein automatic switches at an automatic central office are controlled over a trunk circuit by a subscriber of the private branch exchange.

An object of the invention is to prevent subscribers of the private branch exchange from establishing, by dialing, connections over the trunk to certain points in the central office, as for example a toll operator and to automatically divert such calls to an attendant at the private branch exchange and more specifically, the object is to prevent the calling subscriber from circumventing such a diversion by irregular manipulation of his dial or switchhook to obtain an unauthorized connection.

Systems have heretofore been employed in which an attempt by subscribers in a dial private branch exchange to obtain a connection to a toll operator results in the transfer of the calling subscriber's line from the trunk to an attendant at the private branch exchange which is effected by an arrangement employing an auxiliary automatic switch associated with the trunk at the private branch exchange which switch is actuated, by the dialing pulses transmitted to the trunk, in such a manner that when a certain code is transmitted, zero for example, the calling subscriber's line is disconnected from the trunk and connected to an attendant's position at the private branch exchange. Such a system is disclosed and claimed in United States Patent 2,039,668 issued May 5, 1936, to R. L. Stokely.

While systems of this character are effective and satisfactory under normal dialing operations, it has been discovered that by certain irregular manipulations of the subscriber's station dial, either by increasing or retarding its normal speed of operation or by certain manipulations of the station switchhook, the auxiliary automatic switch associated with the trunk can be caused to operate and take a setting different from that of the central office switches which central office switches may take such a position as to permit the undesired connection, while the auxiliary switch having a different setting does not recognize this fact and hence does not cause the call to be transferred to the attendant.

Further it has been known, as disclosed, for example, in United States Patent 2,040,291, issued May 12, 1936, to F. A. Bonomi, to prevent a private branch exchange subscriber from obtaining unauthorized toll service which is accomplished by

a current reversal back over the trunk to the private branch exchange which reversal is initiated by the response of the toll operator, which reversal is effective to cause the calling line to be transferred to the attendant.

A feature of the present invention resides in means whereby if the pulses transmitted to the trunk occur at a rate per second above a predetermined maximum (12 for example) every other pulse will be masked or absorbed and only alternate pulses will be applied to the auxiliary switch and transmitted to the central office switches, which alternate pulses will occur at such a slow rate that both switches should operate in substantial synchronism and although such pulses will result in a "wrong number" setting of the central office switches, if such setting effects a connection to one of the points to which the calling subscriber is not entitled, the auxiliary switch will be standing in a corresponding position and will effect the desired transfer of the calling line to the attendant.

Another feature resides in locating the auxiliary switch and its associated equipment and circuits at the central office end of the trunk instead of at the private branch exchange, whereby the possibility of non-synchronous operation of the auxiliary and central office switches is reduced.

Another feature, whereby the transfer of the calling line to the attendant is effected, resides in means controlled by the auxiliary switch to reverse the polarity of the central office battery supplied to the private branch exchange over the trunk.

Another feature resides in means for effecting a so-called "interdigit" time control whereby if the time interval between successive digits dialed is less than a predetermined minimum (.3 second, for example) a current reversal over the trunk will be effected and the calling line transferred to the attendant.

A further feature resides in means for correcting the pulses transmitted over the trunk and for repeating them to control both the auxiliary automatic switch and the central office switches.

The operation of the circuits and arrangement of the invention embodying the foregoing features, will be understood from the following description and accompanying drawings in which: that portion of Fig. 1 to the left of the broken line XX' represents a dial private branch exchange including a subscriber's station A, automatic switching equipment including a selector connector SC, an attendant's position O, a cen-

tral office trunk RT accessible to the selector connector SC and means including a polarized relay P in series with the ring conductor of the trunk, effective when operated in one direction, i. e., by a current reversal, to transfer the line of the subscriber A from the trunk RT to the attendant's position, and that portion of Fig. 1 to the right of the broken line XX', and Fig. 2, represents the equipment associated with trunk RT at the central office end thereof.

Referring to the drawings it will be assumed that it is not desired to permit the subscribers of the private branch exchange to dial certain joints through the central office, a toll operator for example, over the dial trunks connecting the private branch exchange with the central office, while at the same time permitting the subscribers to dial local stations of the central office without hindrance and therefore the trunks to the central office are arranged in accordance with the present invention, i. e., are arranged to permit calls to local stations of the central office but automatically cause a current reversal back over the trunk to cause the calling station line to be disconnected from the trunk and transferred to the attendant's switchboard when the station dials certain codes, such for example as 0, 110, or 211, which codes are frequently used for calling a toll operator. It will further be assumed that the subscriber at station A dials the designated code to select a central office trunk and then dials the designated code for a toll operator, which may be 0, 110, or 211.

When the subscriber removes his receiver and actuates his dial in accordance with the predetermined trunk code, the automatic equipment at the private branch exchange (not shown) causes the brushes of the selector connector SC to engage the bank contacts to which central office trunk RT is connected, whereupon ground is temporarily connected to the ring conductor 1 of the trunk in a manner described in line 35 et seq. on page 2 of United States Patent 1,868,326 to G. V. King, issued July 19, 1932, whereupon relay 2 at the distant end of the trunk operates in the following circuit, ring conductor of the trunk, lower left winding of repeating coil 3, contacts 4 of relay 5, contacts 6 of relay 7, and winding of relay 2 to battery. Relay 2 operates and completes a circuit including contacts 8 of relay 7 to operate relay 9 which relay, at its contacts 10, connects ground to the sleeve conductor of the central office connector CON; locks at its contacts 12 under control of relay 13, and closes at its contacts 14 a circuit to operate polarized relay 15 over its upper winding, which circuit includes resistance 16 of the order of 1000 ohms.

Relay 15 operates and closes its contacts to operate relay 17 which relay in operating closes at its contacts 18 the loop to the central office equipment which can be traced from the inner terminal of the upper right winding of repeating coil 3, conductor 19, contacts 18 of relay 17, conductor 20, contacts 21 of relay 22, contacts 23 of relay 24, and resistance 25 to the inner terminal of the lower right winding of coil 3.

When the central office line finder LF engages a trunk and ground from the central office is connected to the sleeve terminal, relay 13 operates in series with the high resistance 27 thereby closing its contacts 28 to operate relay 7, opens the locking circuit of relay 9, and by closing its contacts 29 locks relay 2 operated. Relay 9, however, remains operated over its initial circuit. Operation of relay 7 first closes its contacts 30

and 31 to connect tip and ring conductors of the trunk from the private branch exchange, to ground and battery respectively in series with the lower and upper windings of relay 15. Relay 7 continues to attract its outer armature thus opening its contacts 6 to interrupt the original energizing circuit for relay 2, closes its contacts 32 to operate relay 33, and opens its contacts 8 to release relay 9.

Relay 33 performs no function at this time but relay 15 now holds operated over the closed trunk loop from the private branch exchange and responds to the dial pulses. When relay 17 operated in response to the initial operation of relay 15, it closed the trunk loop to the central office over contacts 21 and 23 of relays 22 and 24, respectively, and when the line finder found the line thus causing the operation of relay 7, this relay 7 at its contacts 34 connected ground to operate relay 35 in the following circuit; ground, contacts 34 of relay 7, conductor 36, contacts 37 of relay 17, which relay operated on the initial operation of relay 15, conductor 38, contacts 39 of relay 35, contacts 40 of relay 41, and winding of relay 35 to battery. Relay 35 in operating closes its contacts 42 thereby completing a locking circuit for itself independent of contacts 37 of relay 17 which circuit can be traced from battery, winding of relay 35, contacts 40 of relay 41, contacts 42 of relay 35, and contacts 34 of relay 7 to ground.

Relay 35 also closes its contacts thereby short-circuiting contacts 18 of relay 17 to maintain closure of the loop over contacts 21 and 23 of relays 22 and 24, respectively. On the first interruption of the trunk loop at the dial contacts of the calling station, relay 15 releases thereby releasing relay 17 which closes its contacts 44 to operate relay 45, the circuit for which can be traced from ground, contacts 34 of relay 7, conductor 36, contacts 44 of relay 17, contacts 46 of relay 47, contacts 48 of relay 49, and winding of relay 45 to battery. Relay 45 in operating locks at its contacts 50 under control of relay 49. Closure of contacts 52 of relay 45 operates relay 24 and closure of contacts 53 of this same relay (45) closes a circuit to operate relay 54 which can be traced from ground, outer left contacts of relay 2, contacts 55 of relay 7, contacts 56 of relay 41, conductor 57, contacts 53 of relay 45, and winding of relay 54 to battery. Closure of contacts 58 of relay 24 and contacts 59 of relay 54 close parallel operating paths for relay 60. Closure of contacts 61 of relay 54 completes a circuit to operate relay 47 which can be traced from ground, contacts 61 of relay 54, conductor 62, contacts 63 of relay 41, conductor 64, and winding of relay 47 to battery which latter relay closes its contacts 65 to lock itself under control of the back contacts 44 of relay 17. Further, closure of contacts 66 of relay 54 causes operation of stepping magnet 67 of auxiliary switch 68 which circuit can be traced from ground on conductor 57, over contacts 66 of relay 54, to battery in series with magnet 67. Switch 68 is of the type which steps on the release of its rotary magnet and therefore it does not move from its normal position at this time.

Relay 24 in operating opens its contacts 23 thereby introducing a break in the original loop closure effected when relay 17 operated, but operation of relay 45 prior to the operation of relay 24 closed at its contacts 69 a circuit in parallel with contacts 23 of relay 24 and contacts 21 of

relay 22 and therefore the operation of relay 24 is ineffective to open the loop.

When relay 49 operates, however, it opens its contacts 43 to deenergize the slow-to-release relay 45. When relay 45 finally releases it opens its contacts 69 thereby opening the loop to the central office thereby causing a stepping movement of the switches thereat. Prior to the release of relay 45, relay 49 is held operated over contacts 51 of relay 45 which relay (49) closes its left-hand contact thereby short-circuiting relay 22 and insuring its released condition but when relay 45 operates this short circuit is removed and relay 22 operates in series with relay 49 in a circuit from ground on conductor 36, contacts 70 of relay 17, winding of relay 22, left-hand contacts and winding of relay 49 to battery. Relay 49 remains operated in this circuit. The release of relay 45 opens the circuits of relays 54 and 24 which latter relay, however, is slow to release. Relay 54 in releasing opens its contacts 66 to deenergize the rotary magnet 67 thereby causing the switch 68 to move into its first position. Relay 24 in releasing recloses its contacts 23 but due to its slow-to-release characteristic this does not occur until relay 22 has operated whereby the pulsing loop to the central office remains open at contacts 21 of relay 22.

It will now be noted that auxiliary switch 68 and the central office selector switch have both moved in substantial synchronism into their first positions. When relay 17 reoperates at the end of the first pulse, relays 22, 49 and 47 release and prepare the circuit for the next pulse, i. e., the release of relay 17 which release reoperates relay 45. As before mentioned relays 45 and 24 are slow in releasing and under normal pulsing, i. e., below 12 pulses per second, relay 24 is not fully released to close its contacts 23 until relays 22 and 49 are released by the operation of relay 17. Therefore relay 24 controls the length of the pulse interval at normal speeds. When relay 17 releases for the next pulse relay 45 reoperates as before provided relay 47 has released thereby again closing the loop at its contacts 69. If, however, relay 47 has not released when the contacts 44 of relay 17 close relay 47 remains locked and the circuit of relay 45 is open at contacts 45 of relay 47 and therefore relay 45 does not operate to close the loop and therefore acts to insure a minimum interval during which the loop is open, at dial speed which is slightly higher than normal.

The arrangement just described is substantially similar to the impulse correcting arrangement disclosed in United States Patent 2,249,854 issued July 22, 1941, to T. C. Rehm, in which relays 13, 14 and 15 of both figures, and relay 17 of Fig. 2, respectively correspond to relays 45, 24, 49 and 22 of the present application.

Cancellation of alternate pulses

If the pulses occur at a considerably faster than normal rate, i. e., 12 or more pulses per second, relay 24 which is slow to release will not release until after relay 45 is released and therefore relay 45 controls the length of the closed loop interval.

At this speed relay 47 will not release between the successive openings of contacts 44 of relay 17 and hence only alternate pulses will be transmitted to the central office and to the switch 68 which will occur at such a slow rate that there will be no question of these switches operating

in synchronism. Relay 47, therefore, is effective at a critical speed to cancel alternate pulses.

Interdigit time control

When relay 60 operated as before described it closed its contacts 71 to operate relay 72 which in turn operates relay 73. An alternate energizing circuit for this latter relay was also closed when relay 22 operated. Relay 60 is slow to release and therefore holds operated between pulses.

At the end of the first digit if the interval between the last pulse of the first digit and the first pulse of the second digit is greater than a predetermined interval (six-tenths of a second, for example) relay 60 will release due to the release of relays 24 and 54 and opens the locking circuit of relay 72 which is independent of relay 73. Relay 72 will therefore release and in turn release relay 73 provided relay 22 has released. Relay 73, however, is also slow to release and if the next or second digit is dialed too soon and relay 60 reoperates before relay 73 had fully released, a circuit is completed to operate reversing relay 5 in a circuit as follows: ground, contacts 71 of relay 72, contacts 75 of relay 73, conductor 76 and right-hand winding of relay 5 to battery. Relay 5 in operating opens its contacts 4 and 26 and closes contacts 77 and 78 thereby reversing the polarity of the battery supplied back over the trunk RT to the private branch exchange where it causes operation of polarized relay P in the ring conductor of the trunk. Operation of relay P operates relay 79 which disconnects the line of the calling subscriber from the trunk RT and connects it to the attendant's position O in the manner shown in United States Patent 2,040,291 to F. A. Bonomi, issued May 12, 1936. The attendant thereupon talks with the subscriber to ascertain what number he has dialed. It will therefore be noted that relays 54, 60, 72 and 73 are effective to divert the calling line to the private branch exchange attendant if the interval between successive digits is less than a predetermined minimum.

First digit 1

When the selector 63 has stepped to the first terminal as the result of a single pulse and relay 60 releases, ground is connected at contacts 80 of relay 60 to operate the release relay 81 of the switch to restore it to normal. This circuit can be traced from ground, contacts 82 of relay 35, conductor 83, contacts 80 of relay 60, brush and the first terminal of switch 68, contacts 84 of relay 85, contacts 86 of the off-normal switch ON and winding of the release magnet 81 to battery thereby releasing the switch 68 and restoring it to normal.

The disclosure of the present invention shows an arrangement for preventing the subscriber from obtaining a connection to an operator at the central office whose code may be 110, 211, or 0, depending on the type of central office in which the trunk terminates and we will now assume that the subscriber has dialed the code 110 which, if not interfered with, will call in a toll operator, access to which operator the subscriber is not entitled.

Dialing of the first digit 1 as before described causes the switch 68 to advance one step whereupon the release magnet operates to restore the switch and thus cancelling the digit. The second digit 1 again advances the switch 68 to the first terminal whereupon the switch is released and

returned to normal as before. The third digit 0 consisting of ten pulses causes the switch 68 to advance, step by step, to the tenth terminal whereupon when relay 60 releases, ground on conductor 83 is connected over contacts 80 of relay 60, the brushes 68, at its tenth terminal, contacts 87 of relay 85, and conductor 76 to battery in series with the reversing relay 5 to cause the calling line to be disconnected from the trunk at the private branch exchange and transferred to the attendant as before described. Operation of relay 79 at the private branch exchange causes the trunk loop to be opened whereupon a disconnect is given to the central office equipment. When the central office switches restore the diverting equipment restores to normal.

First digit 2

If we assume that the central office equipment is arranged to call in a toll operator in response to the receipt of the code 211 and that the subscriber dials this code, the first digit 2 will cause the switch 68 to advance to the second terminal and the release of relay 60 will supply ground over the second terminal of the switch and contacts 88 of relay 85 to operate relay 89 which relay in operating closes its contacts 90 to operate the release magnet 81 in a circuit which can be traced from ground, contacts 90 of relay 89, contacts 91 of relay 85 and contacts 36 of the off-normal switch ON to the release magnet. Operation of the release magnet restores the switch 68 to normal. Operation of relay 89 also closes its contacts 92 to lock itself to ground under control of relay 35. Relay 89 also closes its contacts 93 to operate relay 85 which is thereafter also held under control of relay 35. When the second digit 1 is dialed the selector 68 advances as before to the first terminal and when relay 60 releases a circuit is completed to operate the reverse relay 5 over contacts 94 of relay 85, now operating. Operation of relay 5 causes disconnection of the calling line from the trunk and its transfer to the attendant as before.

First digit 0

The third code which the present invention is arranged to intercept is zero or ten pulses and if this digit is first dialed, the result will be the same as in the case when code 110 was dialed, i. e., the advancement of switch 68 to the tenth terminal causes relay 5 to operate thereby diverting the call to the attendant and signaling a disconnect to the central office.

First digit 2 and second digit other than 1

In case a subscriber dials a code in which the first digit is 2 and the second digit some other number than 1, relays 89 and 85 will be operated at the completion of the first digit and the release of relay 60 will connect a ground over the brush of switch 68 and whichever terminal it is standing on, other than 1, to operate relay 41 when relay 73 is released which occurs a short interval after relay 60 releases. Operation of relay 41 opens at its contacts 40 the energizing circuit for relay 35 which releases and closes its contacts 95 to connect ground over conductor 96 to operate the release magnet and restore the selector switch 68.

Relay 41 holds over its right winding and contacts 97 to ground at contacts 34 of relay 7. Relay 41 operated also opens its contacts 56 to prevent operation of relay 54 and any further movement of the selector switch 68 by subsequent pulsing which, however, will be repeated, in the man-

ner previously described, in response to the subscriber's dial to control the central office switches.

First digit other than 1, 2 or 0

If the subscriber dials for the first digit of a code any number from 3 to 9, which will advance switch 68 to a corresponding terminal, which terminals it will be noted are connected together, the release of relay 60 will cause relay 41 to operate and relay 35 to release thus releasing switch 68 and disabling it from further movement in response to further dialing.

Disconnect

When the trunk loop at the private branch exchange is open either by the subscriber disconnecting or due to operation of relay 79 occasioned by operation of the reversing relay 5, relays 15 and 17 release thus causing relay 22 to operate and open the trunk loop towards the central office, which will release the switches thereat in a short time. When the equipment at the central office has released, ground will be removed from the sleeve conductor of the line finder LF and relays 13, 2 and 7 will release. The release of relay 7 releases relay 5, if operated, and reconnects relay 2 to the ring conductor of the trunk. Relay 7 in releasing reconnects ground at its contacts 98 to the tip of the trunk over the outer right contacts of relay 33 which relay operated when relay 7 operated. Release of relay 7 also opens its contacts 32 thereby deenergizing relay 33 but this relay is slow to release and holds ground on the tip of the trunk for a short interval after contacts 31 of relay 7 open.

When relay 33 finally opens its outer right contacts ground is removed from the tip of the trunk causing the equipment at the private branch exchange to return to normal in a well-known manner.

From the foregoing description it will be observed that battery will be reversed back over the trunk to the private branch exchange to call in the attendant and disconnect the calling line from the trunk if the first digit dialed is zero, if the code dialed is 110 or 211, or if, due to manipulation of the dial or switchhook, trains of pulses are transmitted, which trains are separated from each other by less than a predetermined time interval, six-tenths of a second in the arrangement disclosed.

Further, it will be noted that if pulses are transmitted which recur at a rate faster than the central office switch can accurately follow, i. e., twelve or more per second, alternate pulses are masked or absorbed and only every other pulse is permitted to control the auxiliary trunk switch and the central office equipment.

In other words, the auxiliary switch associated with the trunk follows and registers one or more of the first three digits dialed into the central office. When the first digit registered on the auxiliary switch does not form a part of a recognized toll code, i. e., 3 to 9, inclusive, further dialing is ignored and the call goes through in a normal manner. If the first digit dialed is 0, or 0 is preceded by 1, the call is diverted to the attendant. Further, if the first digit is 2 and the second digit is 1 the call will also be diverted.

Further, the pulses transmitted to the central office are corrected and if the rate of recurrence is greater than the ability of the central office switches to correctly register them every other pulse will be absorbed and therefore the pulses

applied to the auxiliary switch, and transmitted to the central office, will be slow enough so that both the auxiliary switch and the central office switches can operate in synchronism. Obviously, such alternate pulsing will result in an improper setting of the central office switches but if a code starts with 0, 10, 21, or 110 the calling line will be diverted to the attendant and further control the central office equipment prevented, if the dial at the station calling is retarded in such a manner that the digit dialed is split into two trains of impulses which are too closely spaced, i. e., if the digits are dialed so as to succeed each other too rapidly, the call is likewise diverted.

It will, of course, be obvious that, by different connections of the terminals of auxiliary switch 68, operation of reversing relay 5 can be effected in response to other digit pulses, either singly or in combination.

What is claimed is:

1. In a telephone system, an automatic exchange, an operator's position thereat, a central office, a trunk line extending from said exchange to said central office and terminating in automatic switches thereat, a subscriber's line terminating in said exchange adapted to transmit groups of dial impulses to extend said line to said trunk and to control said automatic switches at the central office, means in said trunk at the exchange responsive to a reversal of current over said trunk to disconnect said line from the trunk and connect it to the operator's position, and other means in said trunk effective in response to a predetermined minimum time interval between successive groups of dial impulses transmitted to cause a current reversal to be transmitted over said trunk to said exchange.

2. In a telephone exchange system, an automatic exchange, an operator's position thereat, a central office, a trunk line extending from said exchange to said central office and terminating in automatic switches thereat, a subscriber's line terminating in said exchange adapted to transmit groups of dial impulses to extend said line to said trunk and thereafter to control said automatic switches at the central office, means in said trunk for repeating said impulses to said central office switch, an auxiliary switch associated with and responsive to said repeating means adapted to advance in step with said central office switches, means in said trunk at said exchange responsive to a reversal of current over the trunk to disconnect said line from the trunk and connect it to the operator's position, and means responsive to a predetermined setting of said auxiliary switch for reversing current over said trunk, said repeating means being arranged to suppress alternate group impulses when said impulses recur faster than a predetermined rate whereby simultaneous advance of said central office and auxiliary switches is insured.

3. In a telephone exchange system, an automatic exchange, an automatic central office, a trunk line therebetween, a subscriber's line terminating at said exchange, a subscriber's station dial adapted to transmit groups of impulses over said line to connect the line to the trunk and to thereafter transmit impulses over the trunk to the central office, automatic switches at the central office, pulse repeating means including a source of direct current associated with said trunk at the central office and adapted to control said central office switches in accordance with the

pulses transmitted over the trunk, and an auxiliary step-by-step switch at the central office also controlled by said repeating means and arranged to move in substantial synchronism with said central office switches, and means responsive to a predetermined setting of said auxiliary switch by said repeating means for reversing the direction of said direct current source over said trunk to the exchange.

4. In a telephone exchange system, an automatic private branch exchange, an automatic central office, automatic switches thereat, a trunk line therebetween, a subscriber's line terminating at said exchange, means for transmitting impulses over said line to connect the line to the trunk and to thereafter transmit groups of impulses over the trunk, pulse repeating means including a source of direct current associated with said trunk at the central office and adapted to control said automatic switches in accordance with the pulses transmitted, an auxiliary step-by-step switch at the central office also controlled by said repeating means and arranged to move in substantial synchronism with said central office switches and to return to normal at the end of each group of pulses, and means responsive to predetermined first and second settings of said auxiliary switch in response to the first two groups of impulses transmitted to reverse the connection of said current source to the trunk.

5. In a telephone exchange system, an automatic private branch exchange, an automatic central office, automatic switches thereat, a trunk line therebetween, a subscriber's line terminating at said exchange, means for transmitting impulses over said line to connect the line to the trunk, and to thereafter transmit groups of impulses over the trunk, pulses repeating means including a source of direct current associated with said trunk at the central office adapted to control said automatic switches in accordance with the pulses transmitted, an auxiliary step-by-step switch at the central office also controlled by said repeating means and arranged to move in substantial synchronism with the central office switches and to return to normal at the end of each group of pulses, and means responsive to predetermined first, second and third settings of said auxiliary switch in response to the first three groups of impulses transmitted to reverse the connection of said current source.

6. In a pulse repeater and corrector, an incoming line, an outgoing line, a relay associated with said incoming line responsive to impulse trains transmitted thereover, means responsive to an initial operation of said relay for closing said outgoing line, means for opening said outgoing line effective a predetermined time interval after the release of said relay to open said outgoing line, other means responsive to a succeeding reoperation of said relay to close said outgoing line and means effective when the succeeding rate of operation and release of said relay is above a predetermined maximum to prevent every other successive release of said relay from opening said outgoing line.

7. In a pulse repeater and corrector, an incoming line, an outgoing line, a relay associated with said incoming line operated and released in accordance with current of impulses transmitted thereover, means responsive to operation of said relay to close said outgoing line, means responsive to release of said relay to open said

outgoing line, and means responsive to the successive release and operation of said relay at a rate faster than a predetermined maximum to hold said outgoing line closed over every other release interval of said relay.

8. In an impulse repeater, an incoming line, an outgoing line, an impulse receiving relay associated with said incoming line, means for repeating to said outgoing line trains of impulses transmitted over said incoming line and received by said receiving relay, said repeating means comprising a slow-to-release relay for determining the minimum duration of said repeated impulses when and if the rate of the received impulses is lower than a first critical rate, and also comprising a fast-operating relay and a slow-operating relay for determining the minimum duration of said repeated impulses when and if the rate of the received impulses is equal to or in excess of said critical rate, and other means comprising a second slow-release relay for preventing the repetition of every other received im-

pulse if and when the received impulses are equal to or in excess of a second predetermined critical rate higher than said first critical rate.

9. In a telephone system, an automatic exchange, an operator's position thereat, a central office, a trunk line extending to said exchange from said central office and terminating in automatic switches thereat, a subscriber's line terminating in said exchange adapted to transmit groups of dial impulses to extend said line to said trunk and to control said automatic switches at the central office, means in said trunk at the exchange responsive to a reversal of current over said trunk to disconnect said line from the trunk and connect it to the operator's position and other means in said trunk including a slow-release relay, effective in response to a predetermined minimum time interval between successive groups of dial impulses transmitted to cause a current reversal to be transmitted over said trunk to said exchange.

EDSON L. ERWIN.