Dec. 30, 1941. W. H. RYAN 2,268,424

TELEPHONE SYSTEM

Filed May 23, 1940 2 Sheets-Sheet 1

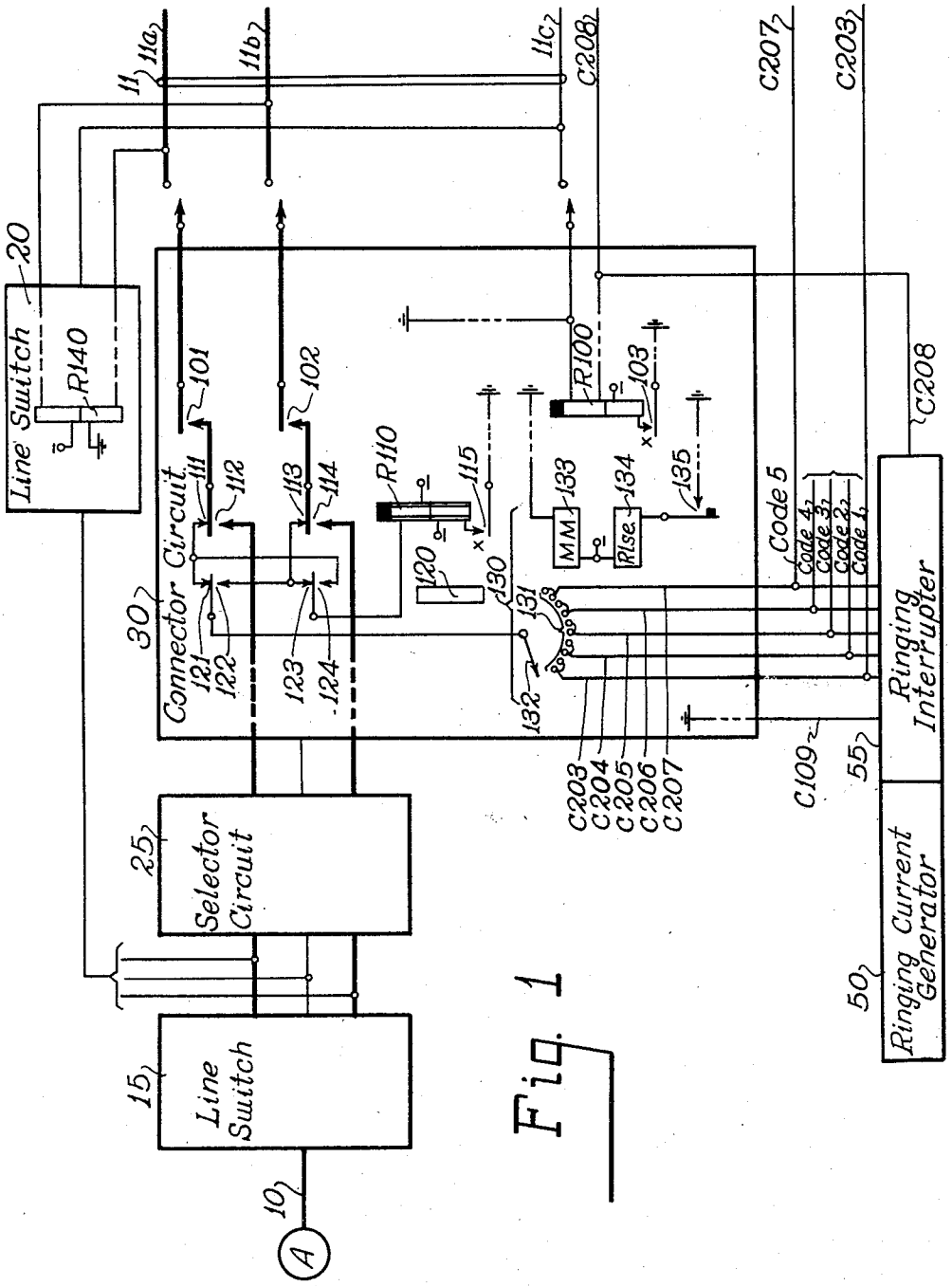


Fig. 1

INVENTOR
William H. Ryan
BY
Davis, Lindsey, Smith & Shonts
ATTORNEYS.

Dec. 30, 1941. W. H. RYAN 2,268,424

TELEPHONE SYSTEM

Filed May 23, 1940 2 Sheets-Sheet 2

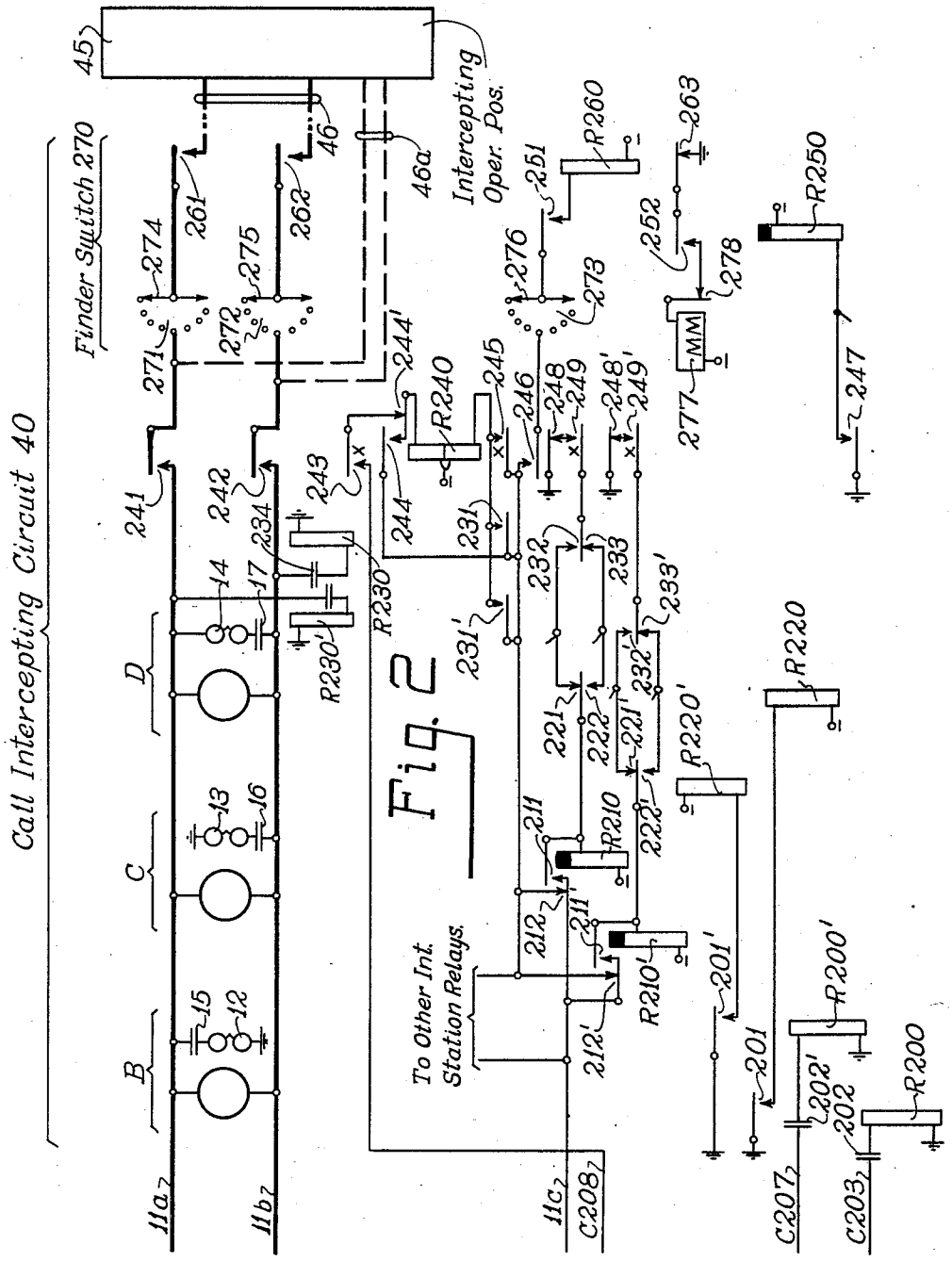


Fig. 2

INVENTOR
William H. Ryan
BY
Davis, Lindsey, Smith & Shontz
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,268,424

TELEPHONE SYSTEM

William H. Ryan, Cambridge, Mass., assignor to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application May 23, 1940, Serial No. 336,710

15 Claims. (Cl. 179—27)

The present invention relates to telephone systems, and more particularly to improvements in apparatus for providing call intercepting service in an automatic telephone system.

In telephone systems of the automatic type it is frequently desirable to provide facilities whereby, when one or more of the substations associated with a multiparty subscriber's line of the system is taken out of service or disconnected, calls intended for the disconnected substation are automatically routed to an operator's position so that the calling subscribers may be informed that the called substation is no longer in service. Call intercepting service of this character is also desirable in other instances where calls to substations actually in service are to be intercepted and routed to an operator's position.

It is an object of the present invention to provide improved call intercepting apparatus of the character indicated, which is of simple and economical arrangement, is positive and reliable in its operation to intercept calls intended for predetermined lines or substations of the system and is so arranged that it cannot be falsely operated.

It is another object of the invention to provide improved call intercepting apparatus of the character described, which is arranged to be used in the interception of calls to predetermined substations served by the multiparty lines of the system, is primarily controlled by the ringing equipment common to the lines of the system, and requires a minimum of equipment individual to the lines which are served thereby.

It is a further and more specific object of the invention to provide improved call intercepting apparatus of the character described, which only operates to intercept a call to one of the associated lines after ringing voltage of the code or frequency designating a call to be intercepted has been applied to the line for a predetermined time interval defined by one complete operating cycle of the ringing interrupter embodied in the associated ringing apparatus.

The invention is illustrated in its embodiment in an automatic telephone system which comprises a plurality of subscribers' lines, several of which are of the multiparty type, together with automatic switching equipment for setting up connections between the lines. The system further comprises ringing apparatus of the coded ringing type which is common to the lines of the system and is arranged to be used in selectively signaling the substations associated with the multiparty lines of the system. More specifically, this apparatus comprises a pickup lead and a plurality of ringing code leads, together with cyclically operating apparatus for impressing differently coded ringing voltages upon the various ringing leads during each cycle of operation thereof, and for impressing a pickup pulse upon the pickup lead at the beginning of each code cycle. This interrupting equipment is arranged to control a group of relays individually corresponding to the ringing codes and each operative during each ringing interval of the corresponding code. The automatic switching equipment of the system comprises directively controlled selector and connector switches, each of the connector switches being equipped with a code selecting switch which is directively controllable to select the code of the ringing current to be transmitted over a called one of the multiparty subscribers' lines. Each connector switch is also equipped with a ringing relay which operates in response to a pickup pulse applied to the pickup lead and functions to impress ringing voltage of the selected code upon the selected line. After a call has been routed through this apparatus to a called line arranged for call interception, apparatus jointly controlled by the application of ringing voltage to the selected line, the operation of a predetermined one of the code relays, and the application of a second pickup pulse to the pickup lead, functions to intercept the call only in the event ringing voltage is impressed upon the selected line concurrently with the operation of a predetermined one of the code relays during the cycle of operation of the ringing interrupter defined by the first and second pickup pulses applied to the pickup lead. In the event the application of ringing voltage to the selected line is not concurrent with the operation of this particular code relay, the call intercepting apparatus is positively prevented from responding to ringing current impressed upon the selected line during further cycles of operation of the ringing interrupter.

Further features of the invention pertain to the particular arrangement of the circuit elements whereby the above and additional operating features are obtained.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings in which Figs. 1 and 2, when placed end to end in the order named, illus-

trate an automatic telephone system having embodied therein the features of the invention briefly outlined above.

Referring to the drawings, the system there illustrated comprises an exchange at which are terminated a plurality of subscribers' lines of the single party type, one of which is indicated at 10, and a plurality of subscribers' lines of the multiparty type, one of which is indicated at 11. As illustrated in the drawings, the line 10 is arranged to serve the substation A and the line 11 is arranged to serve a plurality of substations including the three substations B, C and D. In the system illustrated, provisions are made for bridged and divided ringing, as indicated by the fact that the ringer 12 provided at the substation B is bridged between the positive line conductor 11a of the line 11 and ground in series with a condenser 15; the ringer 13 provided at the substation C is bridged between the negative line conductor 11b of the line 11 and ground in series with a condenser 16; and the ringer 14 provided at the substation D is bridged across the conductors 11a and 11b of the line 11 in series with a condenser 17.

For the purpose of setting up connections between the various lines of the system, there is provided, in the exchange terminating these lines, automatic switching equipment which comprises a pair of line switches 15 and 20, individually associated with the lines 10 and 11 and having access to a plurality of selector switches, one of which is indicated at 25. This equipment further comprises a plurality of connector switches, one of which is indicated at 30 as being accessible to the selector switch 25 and as having access to the multiparty subscriber's line 11. It will be understood that a plurality of selector and connector switches, corresponding to the switches 25 and 30, respectively, are provided for serving the subscribers' lines of the system, the number of switches of each type depending upon the traffic which the exchange is required to handle. The line switches of the system are, on the other hand, individual to the various subscribers' lines of the system. Preferably, the line switches are of the well-known rotary type, although any desired commercial form of this switch may be used. Similarly, the selector and connector switches of the system may be of any desired commercial arrangement, although preferably these switches are of the well-known Strowger type. In order more clearly to explain the operation of certain of the circuits to which the present invention pertains, a portion of the control equipment embodied in the connector switch 30 has been shown in detail. More particularly, this equipment comprises a slow-to-operate ringing control relay R100, a slow-acting ring cut-off relay R110, and a third relay R120, which is provided for the purpose of determining the side of a selected line over which ringing current is to be projected. The equipment further comprises a ringing code selecting switch 130 which is directively controllable from a calling substation to select the code of the ringing current to be transmitted over a selected called line. This station selecting switch is of the well-known minor type and comprises a single set of contacts 131 at which the ringing leads are terminated, a wiper 132, a motor magnet 133 for driving the wiper over the contacts of the contact set 131, and a release magnet 134 which is operative to release the wiper 132 so that this wiper may be restored to its normal position under the influence of a biasing element, not shown. For the purpose of controlling the release magnet 134, the switch is provided with a pair of off-normal contacts 135 which are arranged to be operated into engagement when the wiper 132 is stepped from its normal position to a position in engagement with one of the contacts of the contact set 131. Although the two line switches 15 and 20 have been only schematically illustrated, it is pointed out in the interests of clarifying the following description, that each of these switches comprises line and cut-off relays, in addition to the usual rotary trunk selecting switch. Thus, the line switch 20 is illustrated as comprising a line relay R140 having windings normally bridged across the conductors of the line 11 through the restored contacts of an associated cut-off relay, which is not shown but is arranged to be energized over a circuit including the private conductor 11c of the associated line 11.

In order to develop the differently coded ringing voltages which are utilized in selectively signaling the subscribers served by the multiparty subscribers' lines, ringing apparatus is provided which includes a ringing current generator 50 and a ringing code interrupter 55. These pieces of apparatus are common to the entire exchange and may be of any desired type and construction. Accordingly, they have been only schematically illustrated in the drawings. It is pointed out, however, that in accordance with conventional practice, operation of this apparatus is initiated in response to the application of ground potential to the ringing apparatus start conductor C109. After operation of the ringing apparatus is thus initiated, the ringing interrupter 55 operates in a cyclic manner to impress differently coded ringing voltages upon the five ringing leads, C203 to C207, inclusive, during each cycle of operation thereof. More particularly, the coded voltage pulses respectively impressed upon these leads are repeated during each cycle of operation of the interrupter. Also in accordance with conventional practice, the ringing interrupter 55 is arranged to impress a pickup pulse of ground potential upon the pickup lead C208 at the beginning of each cycle of operation thereof, the purpose of these pulses being to control the ringing relays of the various connector switches so that these relays will only be operated to impress ringing voltage on the line selected by the associated switch at the beginning of a ringing cycle. The transmission of mutilated ringing codes over selected called lines is thus prevented.

For the purpose of intercepting calls intended for predetermined lines or substations of the system, there is provided call intercepting apparatus which comprises an intercepting operator's position 45, and a call intercepting circuit 40, the operator's position 45 terminating one end of an intercepting trunk 46 by way of which the intercepting calls are routed to this position. Since the trunk circuit apparatus terminating the trunk 46 at the operator's position 45 may be of any conventional arrangement, this apparatus has been only schematically illustrated in the drawings. Briefly described, the call intercepting circuit 40 comprises a plurality of code relays, two of which are indicated at R200 and R200', which are individual to the five codes developed through operation of the ringing interrupter 55. Each of these code relays is arranged to be energized in response to the application of ringing voltage to the associated ringing lead. As indicated by the

circuit connections illustrated, the relays R200 and R200' are individual to the codes 1 and 5, these two relays being respectively energized in series with condensers 202 and 202' over the ringing leads C203 and C207. Each of these code relays is arranged to control an associated slave relay which performs various circuit control operations described hereinafter, the slave relay R220 being individually controlled by the code 1 relay R200, and the slave relay R220' being individually controlled by the code 5 relay R200'. The intercepting circuit 40 further comprises a plurality of slow-to-operate lockout relays which are individual to the lines arranged for call intercepting service. Each of these relays corresponds to a particular code, the relays R210 and R210' being provided in conjunction with the multiparty subscriber's line 11 and individually corresponding to the codes 1 and 5, respectively. The individual line equipment of the intercepting circuit further includes from one to three alternating current relays in association with each line arranged for call intercepting service, the number of relays in each instance being determined by the character of the ringing utilized in signaling the substations for which call intercepting service is provided. Thus there is provided a relay R230 in association with the line 11 which is bridged between the negative line conductor 11b and ground in series with a condenser 234, so that it will respond to ringing current projected over the negative side of the line when divided ringing is utilized in signaling the substation C, for example. If the circuit is to be arranged for the interception of calls intended for the substation B, for example, a second relay R230', corresponding to the relay R230 and bridged between the positive line conductor 11a and ground, is required. Further, if calls intended for a substation arranged for bridged ringing and associated with the line 11 are to be interrupted, a third relay, bridged between the conductors of the line 11 in series with a condenser, is required. The intercepting circuit 40 also includes a line switching relay R240 associated with the line 11, similar relays being provided which are individually associated with the other lines arranged for call intercepting service. For the purpose of selecting the lines occupied with calls which should be intercepted, a finder switch 270 is provided. This switch comprises a switching mechanism of the well-known rotary type, a slow-to-operate start relay R250, and a combined line test and line switching relay R260. More specifically, the rotary finder switch comprises three sets of bank contacts, 271, 272 and 273, wipers 274, 275 and 276 individually associated with the enumerated contact sets, and means comprising a rotary magnet 277 for driving the wipers over the contacts of their respective associated contact sets.

In considering the operation of the system it may be assumed, for example, that a call intended for the substation B associated with the line 11, is initiated at the telephone station A. When the call is initiated a loop circuit is completed which includes the two conductors of the line 10 and extends to the line switch 15. The completion of this loop circuit results in operation of the line switch 15 to select a trunk line leading to an idle one of the selector switches, and the marking of the calling line 10 as busy in the bank contacts of the connector switches having access thereto. Assuming that the selector switch 25 is seized by the line switch 15, certain of the control relays embodied in this selector switch operate to condition the switch to respond to the first series of impulses dialed at the calling substation. These relays, in operating, also function to complete a circuit for transmitting the usual dial tone signal over the established calling loop circuit for the purpose of informing the calling subscriber that the dialing operation may be started.

When the first digit of the directory number designating the called substation B is dialed at the calling substation, the switch 25 elevates its wipers to a position opposite the level of bank contacts terminating the trunks leading to the connector switches having access to the desired line 11. Following this operation and during the inter-digit pause between the first and second digits, the wipers of the switch 25 are automatically stepped over the contacts of the selected level until a trunk leading to an idle connector switch of the selected group is found. Assuming, for example, that the connector switch 30 is the first available idle connector switch in the selected group, when the wipers of the selector switch 25 are positioned on the contacts terminating the trunk line extending to this connector switch, the subscriber's loop circuit is extended to the switch 30 and operation of the selector switch is arrested in the usual manner. When the calling loop circuit is cut through to the connector switch 30 in the manner just explained, certain of the relays embodied in the selector switch 25 operate to interrupt the dial tone signal circuit, and certain of the control relays embodied in the connector switch 30 operate to complete a circuit extending by way of the private conductor of the trunk incoming to this switch for holding the preceding switches 25 and 15 operated. More specifically, the private or release conductor of the trunk incoming to the connector switch 30 is grounded in response to operation of the line and hold relays embodied in this switch when the calling loop circuit is extended to the switch. These relays also function to complete a path for impressing ground potential upon the ringing apparatus start lead C109, thereby to initiate operation of the generator 50 and the ringing interrupter 55 in the event this apparatus is not already in operation. Following the operations just described, the connector switch 30 is conditioned to respond to the three remaining digits of the directory number designating the desired substation B. In response to the dialing of the second digit at the calling substation A, the wipers of the connector switch 30 are stepped vertically to a position opposite the level of bank contacts at which are terminated the lines of the ten-line subgroup including the called line 11. Following this digit, and during the inter-digit pause between the second and third digits, the connector switch 30 is conditioned to rotate its wipers step by step in accordance with the impulses of the third digit of the directory number designating the substation B. When this third digit is dialed, the wipers of the switch 30 are operated into engagement with the set of bank contacts terminating the conductors of the line 11. During the inter-digit pause between the third and fourth digits, circuits are prepared for energizing the operating magnet 133 of the ringing code selecting switch 130, and for determining the position of the relay R120, all in accordance with the impulses of the fourth and final digit. The arrangement of the circuits for controlling the switching relay R120 may be

such that this relay is energized in response to the dialing of a code-selecting digit having an odd number of impulses such, for example, as one, three or five impulses, and is not energized in response to the dialing of a code-selecting digit having an even number of impulses. With such an arrangement, if a code-selecting digit comprising one impulse is dialed at the calling substation, the relay R120 will be energized at the end of the digit, and ringing voltage having the code 1 will be selected through operation of the switch 130 so that ringing voltage of the code 1 will be impressed upon the negative line conductor 11b. In the case under consideration, however, wherein the ringer 12 provided at the substation B is bridged between the positive line conductor 11a and ground, ringing current must be transmitted over this positive line conductor in order to energize the ringer 12 and thus signal the substation B. Accordingly, the code-selecting digit designating this substation will, with the arrangement described, comprise an even number of impulses. Assuming, for example, that the code-selecting digit designating the substation B is the digit 4, the wiper 132 will be operated to engage its associated fourth contact during the dialing of this digit and will be left standing in engagement with the second of the two contacts terminating the ringing lead C204 at the end of the digit. More specifically, the impulses of the code-selecting digit are transmitted to the operating magnet 133 of the switch 130 so that the wiper 132 is operated one step in response to each impulse of the digit. When this wiper is moved off normal, the off-normal contacts 135 are operated into engagement to prepare a circuit for energizing the release magnet 134. Also, the relay R120 is, in the case assumed, not energized and remains in its restored position at the end of the code-selecting digit.

In accordance with conventional practice, suitable provisions are made in the connector switch 30 for testing a selected line, in this case the line 11, for the purpose of determining the idle or busy condition thereof. In the event the line tests busy, the usual busy tone signal is returned over the established connection to inform the calling subscriber that the desired connection cannot immediately be obtained. On the other hand, if the called line 11 tests idle, ringing current of the selected code is transmitted over the selected side of the line for the purpose of energizing the ringer provided at the called substation. More specifically, if the called line is idle, certain of the relays embodied in the connector switch 30 operate to prepare a circuit for energizing the slow-to-operate ringing control relay R100. This circuit is thereafter completed at the beginning of the next cycle of operation of the ringing interrupter 55 when ground potential is impressed upon the pickup lead C208, and extends by way of the grounded lead C203, the upper winding of R100, the private wiper of the switch 30, and through the winding of the cut-off relay embodied in the line switch 20 to battery. When energized over this circuit, the relay R100 operates to close its preliminary make contacts 103, thereby to complete a prepared circuit for energizing its lower winding. Thereafter, the relay R100 completes its operation further to prepare a talking circuit between the calling and called substations, and to complete a path for transmitting ringing current of the selected code over the selected side of the line 11. Following the operation of the relay R100, a path is completed for impressing ground potential upon the private wiper of the connector switch 30, thereby directly to energize the cut-off relay embodied in the line switch 20. This relay now operates to disconnect the windings of the line relay R140 from across the conductors of the line 11, thereby to clear this line of the shunt impedance represented by the line relay windings. With the relay R100 operated, ringing current is caused to traverse the windings of the ringer 12 provided at the substation B over a circuit which extends by way of the selected ringing lead C204, the wiper 132, the contacts 121, 111 and 101, the positive line wiper of the connector switch 30, the conductor 11a, the condenser 15, and the windings of the ringer 12 to the grounded terminal of the ringing current generator. This current is, of course, interrupted in accordance with the No. 2 code and accordingly the subscriber at the substation B is informed that a call intended for his substation has been routed to the line 11 and should be answered. Portions of the ringing current transmitted over the crcuit traced above are obviously shunted through the ringers respectively provided at the other substations associated with the line 11 which are bridged between the positive line conductor 11a and ground. The coded character of the ringing current, as reproduced by these ringers, indicates to the other substation users, however, that the call is intended for the substation B. A portion of the ringing current is also transmitted over the calling end of the connection in the usual manner, thereby to signal the calling subscriber that the called substation is being signaled.

The desired conversational circuit between the calling and called substations is fully completed when the call is answered at the called substation B. More particularly when the receiver at this substation is removed from its supporting hook or cradle, a direct current conductive bridge is conducted across the conductors 11a and 11b of the line 11 to complete a circuit for energizing the upper winding of the ring cut-off relay R110. This circuit may be traced as extending from ground by way of the ringing lead C204, the wiper 132, the contacts 121, 111 and 101, the conductor 11a, the bridge across the conductors of the line 11, the conductor 11b, the contacts 102, 113 and 123, and the upper winding of the relay R110 to battery. When its upper winding is energized over this circuit, the relay R110 operates to close its preliminary make contacts 115, thereby to complete a prepared circuit for energizing its lower winding. Thereafter, the relay R110 at its contacts 111 and 113, opens two points in its own operating circuit, and two points in the above traced circuit for transmitting ringing curernt over the line 11. At its contacts 112 and 114, the relay R110 completes the desired conversational circuit between the calling substation A and the called substation B. When the relay R110 operates, it also functions to open the path, not shown, by way of which ring-back tone current is projected over the calling end of the connection, thereby to terminate the ring-back tone signal in the usual manner.

As indicated above, if the ringer provided at a called substation is bridged between the negative conductor of the associated line and ground, the switching relay R120 will be operated at the end

of the code-selecting digit dialed at the calling substation. For example, if the substation C is being called and the code designating this substation is the code 4, the wiper 132 of the code-selecting switch 130 will be left standing in engagement with its associated seventh contact at the end of the code-selecting digit, and the relay R120 will be operated. In such case, the path traversed by the ringing current extends by way of the ringing lead C206, the wiper 132, the contacts 122, 113 and 102, the line conductor 11b, the condenser 16, and the windings of the ringer 13 to the grounded terminal of the ringing current generator 50. Further, when the call is answered at the called substation C, the upper winding of the ring cut-off relay R110 is energized over a circuit extending by way of the grounded ringing lead C206, the wiper 132, the contacts 122, 113 and 102, the conductor 11b, the bridge across the conductors of the line 11, the conductor 11a, the contacts 101, 111 and 124, and the upper winding of R110 to battery. Thus, it will be seen that the ring cut-off relay R110 is energized regardless of whether the relay R120 is energized or deenergized at the time the call is answered. In the event the desired substation such, for example, as the substation D, is arranged for bridged ringing, the code designating this substation may be selected by dialing either the odd or the even-numbered digit designating the code corresponding to this substation. In such case, the return path for the ringing current extends by way of the upper winding of the ring cut-off relay R110 and the exchange battery to the grounded terminal of the ringing current source. Thus, it will be seen that provisions are made for both divided and bridged ringing, and that the ring cut-off relay R110 is caused to operate in response to the answering of a call routed through the switch 30 regardless of the type of ringing utilized or the side of the selected line over which ringing current is projected.

Preferably, the control equipment of the connector switch is so arranged that the release of the operated switch train is entirely under the control of the calling party at the substation A. With such an arrangement, when the connection is cleared out at the calling substation, the loop circuit extending through the switches 15 and 25 to the connector switch 30 is interrupted to cause the release of the line and hold relays embodied in this switch, in the usual manner. When these relays restore, holding ground potential is disconnected from the private or release conductor of the trunk incoming to the connector switch 30 so that the line and selector switches 15 and 25, respectively, are released. When these relays restore, the control apparatus embodied in the connector switch 30 is restored to normal or in a manner well understood in the art. During the release of the control apparatus embodied in the connector switch 30, the previously described holding circuits for the relays R110 and R100, and the operating circuit for the relay R120, are interrupted causing these relays to restore. Also, ground potential is removed from the private conductor 11c of the called line 11, whereby the cut-off relay embodied in the line switch 20 is released to reconnect the windings of the line relay R140 across the conductors of this line. When ground potential is removed from the private conductor of the line 11, battery potential is impressed upon this conductor through the winding of the cut-off relay embodied in the line switch 20, thereby to mark the line as idle in the bank contacts of the connector switches having access thereto. When the line and hold relays embodied in the connector switch 30 restore, a circuit is also completed for energizing the release magnet of the Strowger switching mechanism embodied in this switch, thereby to cause the wiper carriage structure of this mechanism to be restored to rotary and vertical normal. Similarly, the prepared operating circuit for the release magnet 134 is completed, whereby the wiper 132 is restored to its normal position. When this wiper is restored to normal, the off-normal springs 135 are disengaged to open the circuit for energizing the magnet 134. Thus, the apparatus involved in setting up the connection is fully released.

Referring now more particularly to the operation of the call intercepting circuit 40 to intercept a call routed by way of the connector switch 30 to the line 11, it may be assumed, for example, that a substation normally designated by the code 1, and including a ringer bridged between the negative line conductor 11b and ground, has been disconnected from service. In order to intercept calls intended for this substation, the relays R210, R230 and R240 are provided, which relays are connected in the manner illustrated, and the conductors of the line 11 are connected through the normally open contacts 241 and 242 of the relay R240 to an available set of blank contacts in the finder switch 270. Further, the operating circuit for the lockout relay R210 is connected to be controlled by the No. 1 code slave relay R220.

With the circuit arranged in this manner, if ringing current of the code 1 is projected over the negative side of the line 11 in the manner just explained, a portion of the current is caused to traverse the condenser 234 and the winding of the relay R230. The relay R230 will thus operate at the beginning of the first ringing interval which follows the operation of the ringing relay R100 embodied in the connector switch 30. In operating, the relay R230 completes, at its contacts 231, a primary operating circuit for the lower winding of the line switching relay R240, this circuit extending by way of the grounded private conductor 11c, the contacts 212 and 231, and the lower winding of R240 to battery. When its lower winding is energized over this circuit, the relay R240 partially operates to close its X contacts 243, 245, 249 and 249' only. At its contacts 245, the relay R240 completes an obvious circuit for maintaining its lower winding energized independently of the relay R230. At its contacts 243, the relay R240 prepares a circuit for energizing its upper winding. At its contacts 249, the relay R240 prepares two alternative operating circuits for the lockout relay R210. At its contacts 249', the relay R240 similarly prepares two alternative operating circuits for the lockout relay R210'. If calls intended for substations associated with the line 11 and designated by one or more of the remaining three codes are to be intercepted, the relay R240, in partially operating, also prepares a pair of operating circuits for each of the additional lockout relays individually corresponding to the other codes. In this regard it will be understood that the circuits provided for any required additional lockout relays are identical with those provided in association with the two relays R210 and R210'.

During each period when ringing current is passed through the winding of the relay R230, a portion of the current is transmitted by way of the lead C203 and the condenser 202 to en-

ergize the winding of the No. 1 code relay R200. This code relay, in operating, completes at its contacts 201, an obvious circuit for energizing the associated slave relay R220. Thus, the control device or slave relay R220 and the relay R230 are concurrently operated during each ringing period of the selected code No. 1. The relay R220, in operating, opens, at its contacts 221, one of the prepared operating circuits for the relay R210 and prepares, at its contacts 222, a second operating circuit for the relay R210. Concurrently with these operations, the relay R230 opens, at its contacts 233, the second operating circuit for the relay R210, and prepares, at its contacts 232, the first mentioned operating circuit therefor. Thus, the operating circuit for the relay R210 is held open due to the concurrent operation of the two relays R220 and R230. The concurrent operation of the relays R220 and R230 to maintain the operating circuit for the relay R210 interrupted, continues throughout the cycle of operation of the ringing interrupter 55 which follows operation of the ringing relay R100 embodied in the operated connector switch 30. In this regard it will be noted that the relay R210 is of the slow-to-operate type and, accordingly, will not operate if one of the operating circuits therefor is inadvertently closed for short time intervals occasioned by a difference in the operating periods of the relays R220 and R230.

During this first cycle of operation of the ringing interrupter 55, the lockout relays associated with the line 11, and individual to the codes other than the code 1, are all caused to operate. Thus, in the case under consideration, ringing current is not projected over the positive side of the line 11, and accordingly the relay R230' is not energized. When, therefore, the code 5 relay R200' first operates to complete, at its contacts 201', the operating circuit for the relay R220', the latter relay functions to complete one of the prepared operating circuits for the code 5 lockout relay R210'. This operating circuit extends from ground by way of the contacts 248', 249, 233' and 222', and the winding of the relay R210 to battery. The ringing interval during which the relay R210' is energized over this circuit is sufficiently long to permit the operation of this relay. Upon operating, the relay R210' completes a locking circuit for itself, this circuit extending by way of the grounded private conductor 11c, the contacts 211', and the winding of R210' to battery. After this circuit is completed, the relay R210' opens one of the multiple circuits for energizing the lower winding of the line switching relay R240 at the contacts 212'. Thus, the lockout relay R210' corresponding to the code 5 is locked up for the duration of the call. In a similar manner, the other lockout relays individually corresponding to the codes 2, 3, and 4, if provided in association with the line 11, are locked up for the duration of the call. In this regard it will be apparent that if any one of the lockout relays is controlled by the relay R230, which is being energized by ringing current of the code 1 transmitted over the line 11, this latter relay will be nonconcurrently operated or restored at a time when the code relay corresponding to the lockout relay is not operated or restored. Accordingly, the lockout relay controlled by the relay R230 will operate and lock to the grounded private conductor 11c. Thus, all of the lockout relays with the exception of the relay R210, which corresponds to the code of the ringing current being transmitted over the line 11, will be energized and locked up during the cycle of operation of the ringing interrupter 55 which follows operation of the relay R100.

At the end of this cycle of operation of the ringing interrupter 55, and during the initial portion of the succeeding cycle of operation of this interrupter, a second ground pulse is impressed upon the pickup lead C208, thereby to energize the upper winding of the relay R240. The circuit for energizing this winding extends by way of the grounded pickup lead C208, the contacts 243 and 244', and the upper winding of R240 to battery. When its upper winding is energized over this secondary operating circuit the relay R240 completes its operation, and in so doing closes a locking circuit for itself which extends by way of the grounded private conductor 11c, the contacts 212 and 244, and the upper winding of R240 to battery. After this circuit is completed, the relay R240 disconnects the pickup lead C208 from its upper winding terminal at the contacts 244'. At its contacts 241 and 242, the relay R240 connects the conductors of the line 11 to one set of line contacts in the banks of the finder switch 270. At its contacts 246, the relay R240 prepares a test circuit over which the test relay R260 is operated when the wipers of the finder switch 270 have been positioned on the contacts terminating the conductors of the line 11. At its contacts 248, the relay R240 opens a point in each of the two circuits for energizing the relay R210, whereby the last-mentioned relay is prevented from operating during succeeding cycles of operation of the ringing interrupter 55. At its contacts 248', the relay R240 opens a point in the two operating circuits for the code 5 lockout relay R210'. In a similar manner, the operating circuits for the other lockout relays provided in conjunction with the line 11 are opened in response to the operation of the line switching relay R240. At its contacts 247, the relay R240 completes an obvious circuit for energizing the slow-to-operate finder start relay R250. When thus energized the relay R250 operates further to prepare, at its contacts 251, the operating circuit for the test relay R260. At its contacts 252 the relay R250 completes a circuit for energizing the operating magnet 277 of the finder switch. This circuit extends from ground by way of the contacts 263, 252 and 278, and the winding of the magnet 277 to battery. Due to the circuit interrupting action of the magnet controlled contacts 278, this magnet operates buzzer fashion and in cooperation with its associated ratchet and pawl mechanism operates to drive the wipers 274 to 276, inclusive, over the contacts of their respective associated contact sets until the line 11 is found. More specifically, when the wiper 276 engages the test contact corresponding to the line 11, the above-mentioned circuit for energizing the test relay R260 is completed. This circuit extends by way of the grounded private conductor 11c, the contacts 212 and 246, the wiper 276, the contacts 251, and the winding of R260 to battery. When energized over this circuit, the relay R260 immediately operates to open, at its contacts 263, the above-traced operating circuit for the magnet 277, whereby the stepping operation of the finder switch is arrested. At its contacts 261 and 262, the relay R260 connects the conductors of the line 11 to the con-

ductors of the trunk 46 extending to the intercepting operator's position 45.

Following the operation of the relay R260, and during continued operation of the ringing interrupter 55, coded ringing current is transmitted over the line 11, through the operated contacts 241 and 242, the wipers 274 and 275, the operated contacts 261 and 262, and over the conductors of the trunk 46 to the trunk circuit terminating the distant end of this trunk. This ringing current as thus transmitted to the operator's position 45, may be utilized to control a signal device in the form of a drop or signal lamp, whereby the operator attending this position is informed that a call is present on the trunk 46 which should be answered. When the call is answered at this operator's position, a direct current conductive bridge is connected across the conductors of the trunk 46, thereby to complete one of the previously traced operating circuits for the ring cut-off relay R110. This relay in operating completes a talking circuit which extends from the calling substation to the telephone set in use at the operator's position 45, whereby the operator attending this position may converse with the calling subscriber and dispose of the call in the usual manner by informing the subscriber that the called substation has been taken out of service or that the desired party may be reached by dialing another number. The release of the call intercepting circuit 40 is entirely under the control of the calling subscriber. More specifically, when the control equipment of the connector switch 30 operates in the manner described above to disconnect the private conductor 11c of the line 11 from ground, all of the operated relays, namely the relays R240, R250, R260 and the operated lockout relays R210', etc., are deenergized and restore. When these relays restore, the call intercepting circuit 40 is fully released and is prepared for further operation. In this regard it is pointed out that the finder switch 270 is of the non-homing type, i. e., the wipers thereof are left standing in engagement with the contacts corresponding to the line 11 until further operation thereof is initiated in response to the routing of another call to the intercepting circuit.

In the event the above-traced call routed to the line 11 is not intended for a substation arranged for call interception, the call intercepting circuit 40 will be prevented from operating regardless of the side of the line over which ringing current is projected during the ringing period. In such case the called substation will necessarily be designated by a ringing code other than the code 1. Accordingly, if the ringing current is transmitted over the negative line conductor 11b to energize the ringer provided at a called substation and incidental thereto the relay R230, this relay will be nonconcurrently operated with the No. 1 code relay R200 during one or more intervals of the first cycle of operation of the ringing interrupter 55 which follows the operation of the ringing relay R100. When the relay R230 first operates in response to ringing current transmitted over the line 11, it functions to complete the previously traced circuit for energizing the lower winding of the relay R240. The relay R240 is thus caused partially to operate to prepare the respective operating circuits for the lockout relays R210, R210', etc. When, thereafter, the relay R230 is operated during an interval when the relay R220 is restored, or vice versa, one of the two operating circuits for the relay R210 is completed. This circuit may extend from ground by way of the contacts 248, 249, 232 and 221, and the winding of the relay R210 to battery, or alternatively from ground by way of the contacts 248, 249, 233 and 222, and the winding of R210 to battery, depending upon which of the two relays R230 and R220 is operated. When energized over one of the two circuits just traced, the relay R210 operates after a short interval to complete a locking circuit for itself, this circuit extending by way of the grounded private conductor 11c, the contacts 211, and the winding of R210 to battery. After this circuit is completed, the relay R210, at its contacts 212, opens one of the parallel locking circuits for the relay R240. In a manner similar to that just described, the other lockout relays associated with the line 11 and corresponding to the other ringing codes are energized in response to nonconcurrent operation of the code and ringing relays by which they are respectively controlled. Each of these lockout relays, in operating, locks to the grounded private conductor 11c of the called line 11. Since all of the lockout relays associated with the line 11 are held energized over the grounded private conductor 11c of the line 11, it will be apparent that these relays are only released in response to the release of the switch train through which the call is routed to the line 11. In other words, the lockout relays are held operated for the duration of the call. With these relays operated the intercepting circuit 40 is positively prevented from intercepting or otherwise interfering with the call which has been routed to one of the substations associated with the line 11. Thus, with all of the lockout relays R210, R210', etc., energized, the primary operating circuit for the relay R240 is opened at the contacts 212, 212', etc., so that this relay is fully released. When the connection involving the line 11 is subsequently released and the control equipment operates to disconnect the private conductor 11c from ground, the operated lockout relays are deenergized and restore. The call intercepting circuit 40 is thus fully restored to normal.

From the foregoing explanation it will be apparent that if ringing voltage of the code 5 is impressed upon the positive line conductor 11a to energize the ringing relay R230' and thus cause the partial operation of the line switching relay R240, the ringing relay R230' by concurrently operating with the No. 5 code relay R200' will hold the operating circuit for the code 5 lockout relay R210' open at the contacts 221', 222', 232' and 233'. All of the other lockout relays associated with the line 11 will be energized in a manner clearly apparent from the preceding description. With the relay R210' deenergized, however, the primary circuit for energizing the lower winding of the line switching relay R240 is not interrupted. Accordingly, at the end of the ensuing cycle of operation of the ringing interrupter, when ground potential is again impressed upon the pickup lead C208, the line switching relay R240 will be caused to complete its operation whereby the call is intercepted and routed to the operator's position 45. In a similar manner, calls intended for substations associated with the line 11 and designated by ringing currents of the other three codes may be intercepted through the provision of additional lockout relays.

If desired, each of the lines arranged for call intercepting service may be terminated in a line circuit individual to the line and provided at the intercepting operator's position 45, thus permitting the lines occupied with intercepted calls to be identified by the operator. This mode of arranging the circuit is indicated by the dash-line trunk 46a, the conductors of which extend from the contacts 241 and 242 of the line switching relay R240 directly to a line jack provided at the operator's position 45. In this case, the finder switch 270 and the circuits for controlling this switch may be dispensed with. More specifically, if the finder switch 270 is omitted and a straight connection 46a to the intercepting operator's position 45 is used, the contacts 246 and 247 embodied in the relay R240 may be omitted from this relay. Otherwise, the circuit arrangement will be exactly as disclosed.

From the foregoing explanation it will be understood that the intercepting circuit 40 is so arranged that operation of this circuit inadvertently to intercept calls routed to the lines served thereby, is positively prevented. This is true for the reason that the ringing voltage impressed on a line arranged for intercepting service is, during the first code cycle of each voltage, utilized for test purposes. If the character of the ringing voltage impressed on the line during this first ringing period indicates that the call is not to be intercepted, the call intercepting apparatus individual to that line is locked up and positively prevented from operating to route a connection to the operator's position 45. On the other hand, if the call is to be intercepted, the intercepting operation is performed in response to the pickup pulse applied to the pickup lead C208 at the end of the first ringing cycle. This, of course, means that the interception of the call is only delayed for a short time interval.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein and it is contemplated to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a telephone system, a line, an operator's position, cyclically operating ringing apparatus for developing one or more pulses of ringing voltage during each cycle of operation thereof, a control device operative in accordance with said voltage pulses, means for routing a call to said line from another line of the system and for impressing said ringing voltage pulses upon said line, a control relay energized by ringing voltage impressed upon said line, a line switching relay partially operative in response to operation of said control relay, means for causing said line switching relay to complete its operation in the event said control device and said control relay are substantially concurrently operated during one cycle of operation of said apparatus, and means responsive to the complete operation of said line switching relay for extending a connection from said line to said operator's position.

2. In a telephone system, a line, an operator's position, cyclically operating ringing apparatus for developing one or more pulses of ringing voltage during each cycle of operation thereof, a control device operative in accordance with said voltage pulses, means for routing a call to said line from another line of the system and for impressing said ringing voltage pulses upon said line, a control relay energized by ringing voltage impressed upon said line, a line switching relay partially operative in response to operation of said control relay, means for causing said line switching relay to complete its operation in the event said control device and said control relay are substantially concurrently operated during one cycle of operation of said apparatus, means responsive to non-concurrent operation of said control relay and said control device during said one cycle of operation of said apparatus for deenergizing said line switching relay, and means responsive to the complete operation of said line switching relay for extending a connection from said line to said operator's position.

3. In a telephone system, a line including talking conductors and a private conductor, an operator's position, cyclically operating ringing apparatus for developing one or more pulses of ringing voltage during each cycle of operation thereof, a control device operative in accordance with said voltage pulses, an automatic switch having access to said line and including means for impressing said ringing voltage upon said line, means including said switch for routing a call to said line from another line of the system, a control relay energized by ringing voltage impressed upon said line, a line switching relay, a primary operating circuit for said line switching relay, said primary operating circuit including said private conductor and being completed to cause the partial operation of said line switching relay in response to seizure of said line by said switch and the operation of said control relay, a secondary operating circuit for said line switching relay, said secondary operating circuit being prepared in response to the partial operation of said line switching relay, means for completing said secondary operating circuit to cause said line switching relay to complete its operation in the event said control device and said control relay are substantially concurrently operated during one cycle of operation of said apparatus, and means responsive to the complete operation of said line switching relay for extending a connection from said line to said operator's position.

4. In a telephone system, a line including talking conductors and a private conductor, an operator's position, cyclically operating ringing apparatus for developing one or more pulses of ringing voltage during each cycle of operation thereof, a control device operative in accordance with said voltage pulses, an automatic switch having access to said line and including means for impressing said ringing voltage upon said line, means including said switch for routing a call to said line from another line of the system, a control relay energized by ringing voltage impressed upon said line, a line switching relay, a primary operating circuit for said line switching relay, said primary operating circuit including said private conductor and being completed to cause the partial operation of said line switching relay in response to seizure of said line by said switch and the operation of said control relay, a secondary operating circuit for said line switching relay, said secondary operating circuit being prepared in response to the partial operation of said line switching relay, means for completing said secondary operating circuit to cause said line switching relay to complete its operation in the event said control device and said control relay are substantially concurrently operated during

one cycle of operation of said apparatus, means responsive to non-concurrent operation of said control relay and said control device during said one cycle of operation of said apparatus for deenergizing said line switching relay, and means responsive to the complete operation of said line switching relay for extending a connection from said line to said operator's position.

5. In a telephone system, a line including talking conductors and a private conductor, an operator's position, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing one or more pulses of ringing voltage during each cycle of operation of said apparatus, a control device operative in accordance with said voltage pulses, an automatic switch having access to said line, means including said switch for routing a call to said line from another line of the system, said switch including means operative in response to a first pickup pulse impressed upon said lead to impress said ringing voltage upon said line, a control relay energized by ringing voltage impressed upon said line, a line switching relay, a primary operating circuit for said line switching relay, said primary operating circuit including said private conductor and being completed to cause the partial operation of said line switching relay in response to seizure of said line by said switch and the operation of said control relay, a secondary operating circuit for said line switching relay, said secondary operating circuit including said pickup lead and being completed to cause said line switching relay to complete its operation in response to the partial operation of said line switching relay followed by the application of a second pickup pulse to said lead only in the event said control device and said control relay are substantially concurrently operated during the cycle of operation of said apparatus defined by said first and second pickup pulses, and means responsive to the complete operation of said line switching relay for extending a connection from said line to said operator's position.

6. In a telephone system, a line including talking conductors and a private conductor, an operator's position, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing one or more pulses of ringing voltage during each cycle of operation of said apparatus, a control device operative in accordance with said voltage pulses, an automatic switch having access to said line, means including said switch for routing a call to said line from another line of the system, said switch including means operative in response to a first pickup pulse impressed upon said lead to impress said ringing voltage upon said line, a control relay energized by ringing voltage impressed upon said line, a line switching relay, a primary operating circuit for said line switching relay, said primary operating circuit including said private conductor and being completed to cause the partial operation of said line switching relay in response to seizure of said line by said switch and the operation of said control relay, a secondary operating circuit for said line switching relay, said secondary operating circuit including said pickup lead and being completed to cause said line switching relay to complete its operation in response to the partial operation of said line switching relay followed by the application of a second pickup pulse to said lead only in the event said control device and said control relay are substantially concurrently operated during the cycle of operation of said apparatus defined by said first and second pickup pulses, means responsive to non-concurrent operation of said control relay during said one cycle of operation of said apparatus for deenergizing said line switching relay, thereby to prevent the complete operation of said line switching relay in response to said second pickup pulse, and means responsive to the complete operation of said line switching relay for extending a connection from said line to said operator's position.

7. In a telephone system, a line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including means for developing a plurality of differently coded ringing voltages during each cycle of operation thereof, control relays individually corresponding to the ringing codes and each operative during each ringing interval of the corresponding code, means for routing a call to said line from another line of the system and for impressing ringing voltage of a selected code upon said line, and means jointly controlled by the application of ringing voltage to said line and the operation of a predetermined one of said relays for intercepting said call only in the event the operation of said one relay is concurrent with the application of ringing voltage to said line for one complete cycle of operation of said ringing apparatus.

8. In a telephone system, a line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including means for developing a plurality of differently coded ringing voltages during each cycle of operation thereof, control relays individually corresponding to the ringing codes and each operative during each ringing interval of the corresponding code, means for routing a call to said line from another line of the system and for impressing ringing voltage of a selected code upon said line, means jointly controlled by the application of ringing voltage to said line and the operation of a predetermined one of said relays for intercepting said call only in the event the operation of said one relay is concurrent with the application of ringing voltage to said line for one complete cycle of operation of said ringing apparatus, and means operative in response to operation of said one relay at a time when ringing voltage is not impressed upon said line or to the application of ringing voltage to said line at a time when said one relay is not operated for preventing the operation of said last-named means.

9. In a telephone system, a line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing differently coded ringing voltages during each cycle of operation of said apparatus, control relays individually corresponding to said codes and each operative during each ringing interval of the corresponding code, line switching apparatus for routing a call to said line from another line of the system and including means operative in response to a first pickup pulse applied to said lead for impressing ringing

voltage of a selected code upon said line, and means jointly controlled by the application of ringing voltage to said line, the operation of a predetermined one of said relays, and the application of a second pickup pulse to said lead for intercepting said call only in the event the operation of said one relay is concurrent with the application of ringing voltage to said line during the cycle of operation of said apparatus defined by said first and second pickup pulses.

10. In a telephone system, a line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing differently coded ringing voltages during each cycle of operation of said apparatus, control relays individually corresponding to said codes and each operative during each ringing interval of the corresponding code, line switching apparatus for routing a call to said line from another line of the system and including means operative in response to a first pickup pulse applied to said lead for impressing ringing voltage of a selected code upon said line, means jointly controlled by the application of ringing voltage to said line, the operation of a predetermined one of said relays, and the application of a second pickup pulse to said lead for intercepting said call only in the event the operation of said one relay is concurrent with the application of ringing voltage to said line during the cycle of operation of said apparatus defined by said first and second pickup pulses, and means operative in response to operation of said one relay at a time when ringing voltage is not impressed upon said line or to the application of ringing voltage to said line at a time when said one relay is not operated for preventing the operation of said last-named means.

11. In a telephone system, a multiparty line, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing differently coded ringing voltages during each cycle of operation of said apparatus, line switching apparatus for routing a call to said line from another line of the system and including means operative in response to a pick-up pulse applied to said lead for impressing ringing voltage of a selected code upon said line, a code marking path individual to one of said codes and to which ringing voltage of said one code is applied by said ringing apparatus, and means operative in response to the application of a succeeding pickup pulse to said pickup lead for intercepting said call only in the event the code of the ringing voltage applied to said multiparty line matches the code of the ringing voltage applied to said marking path.

12. In a telephone system, a multiparty line, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing differently coded ringing voltages during each cycle of operation of said apparatus, line switching apparatus for routing a call to said line from another line of the system and including means operative in response to a pickup pulse applied to said lead for impressing ringing voltage of a selected code upon said line, a code marking path individual to one of said codes, means including at least a portion of said ringing apparatus for transmitting signals of said one code over said marking path, and means operative in response to the application of a succeeding pickup pulse to said pickup lead for intercepting said call only in the event the code of the ringing voltage applied to said multiparty line matches the code of the signals transmitted over said marking path.

13. In a telephone system, a multiparty line, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing differently coded ringing voltages during each cycle of operation of said apparatus, line switching apparatus for routing a call to said line from another line of the system and including means operative in response to a pickup pulse applied to said lead for impressing ringing voltage of a selected code upon said line, a code marking path individual to one of said codes, means including at least a portion of said ringing apparatus for transmitting signals of said one code over said marking path, and means operative in response to the application of a second pickup pulse to said pickup lead for intercepting said call only in the event the code segments of the ringing voltage applied to said multiparty line match tne code segments of the signals transmitted over said marking path during the cycle of operation of said ringing apparatus which is defined by said first and second pickup pulses.

14. In a telephone system, a multiparty line, an automatic switch having access to said line through its outlet contacts, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing differently coded ringing voltages during each cycle of operation of said apparatus, means including said switch for routing a call to said line from another line of the system, said switch including means operative in response to the application of a pickup pulse to said lead for impressing ringing voltage of a selected code on said multiparty line, a code marking path individual to one of said codes, means including at least a portion of said ringing apparatus for transmitting signals of said one code over said marking path, and means jointly controlled over the outlet contacts of said switch and over said marking path and operative in response to the application of a succeeding pickup pulse to said pickup lead for intercepting said call only in the event the code of the ringing voltage applied to said multiparty line matches the code of tne signals transmitted over said marking path.

15. In a telephone system, a multiparty line, an automatic switch having access to said line through its outlet contacts, cyclically operating ringing apparatus including a pickup lead, means for impressing a pickup pulse upon said lead at the beginning of each cycle of operation of said apparatus and means for developing differently coded ringing voltages during each cycle of operation of said apparatus, means including said switch for routing a call to said line from another line of the system, said switch including means operative in response to the application of a pickup pulse to said lead for impressing ringing voltage of a selected code on said multiparty line, a code marking path individual to one

of said codes, means including at least a portion of said ringing apparatus for transmitting signals of said one code over said marking path, means operative in response to the application of a succeeding pickup pulse to said pickup lead for intercepting said call, and means controlled jointly over said marking path and through the outlet contacts of said switch for preventing said call from being intercepted in the event the code of the ringing voltage applied to said multi-party line fails to match the code of the signals transmitted over said marking path.

WILLIAM H. RYAN.