Dec. 10, 1940. C. O. WRIGHT 2,224,497

TELEPHONE SYSTEM

Filed April 15, 1939 3 Sheets-Sheet 1

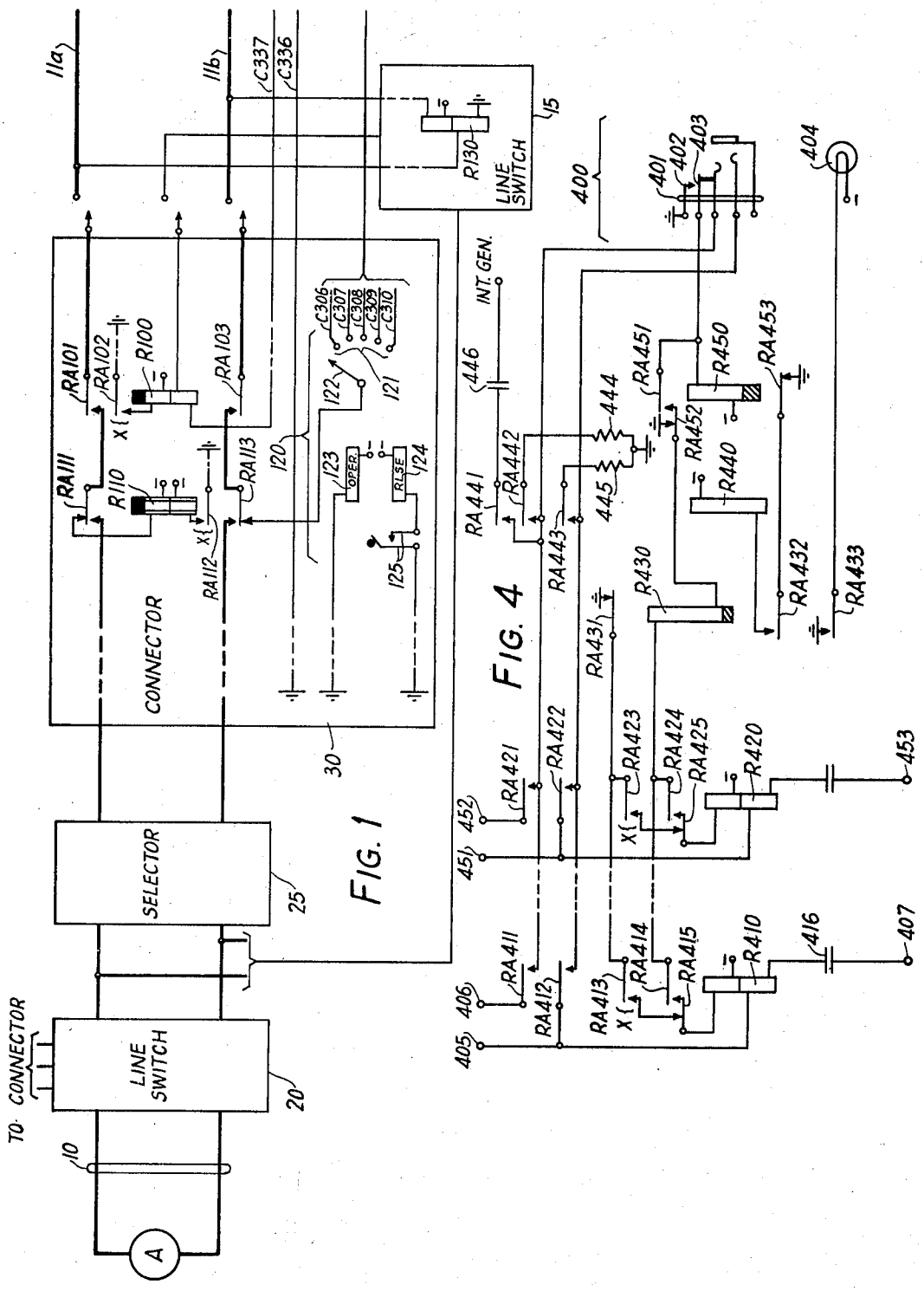

FIG. 1

FIG. 4

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TELEPHONE SYSTEM

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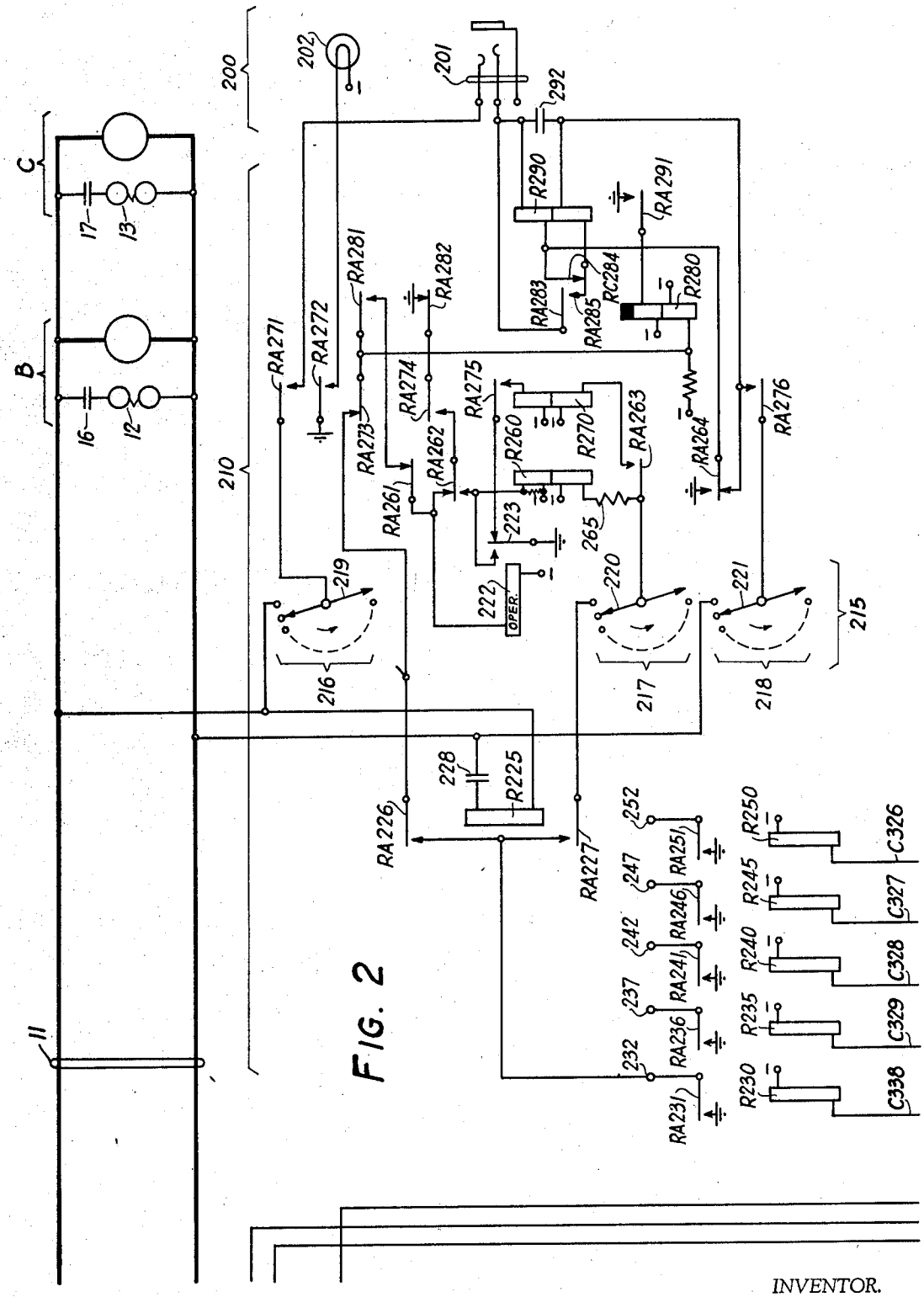

FIG. 2

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TELEPHONE SYSTEM

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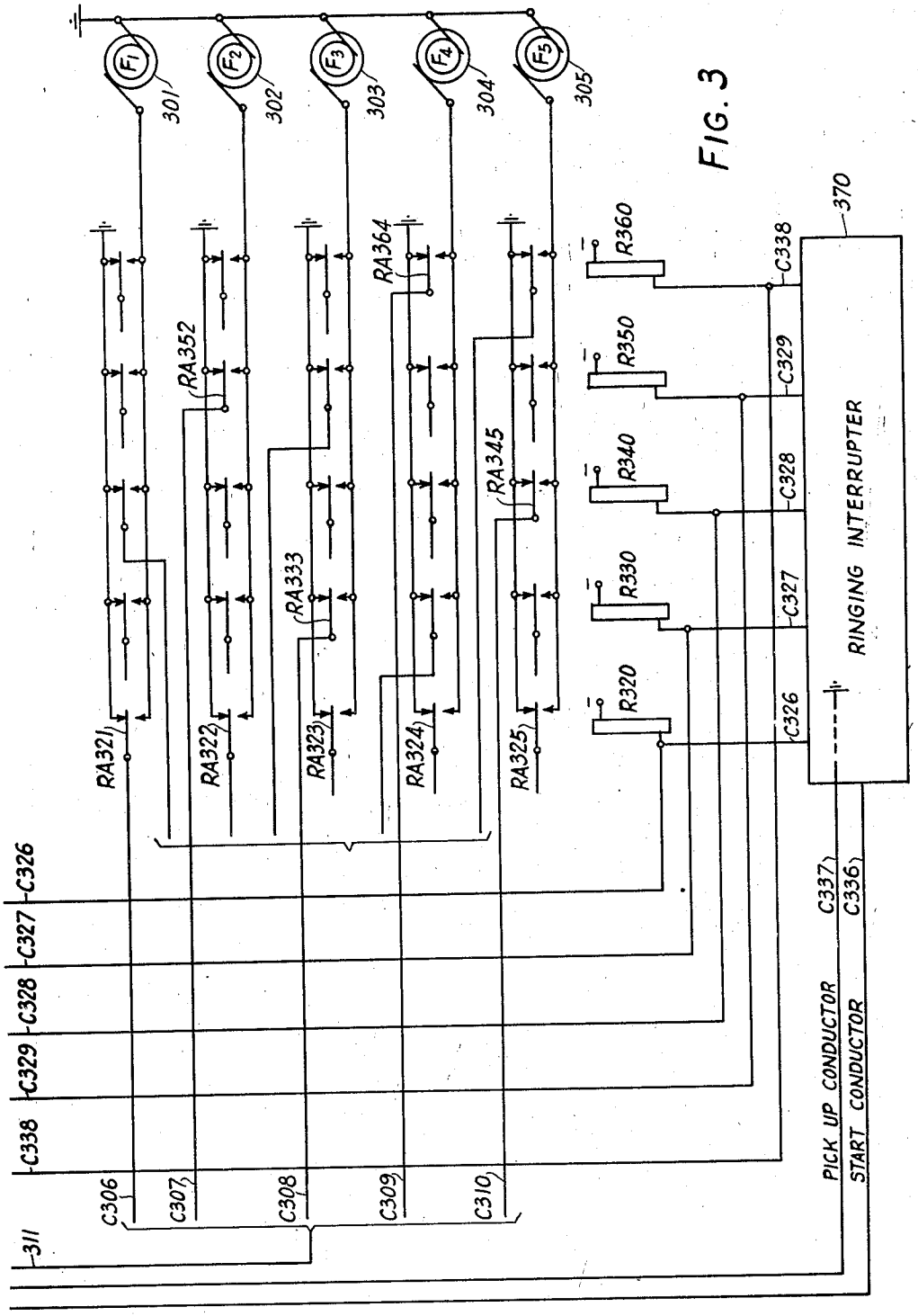

FIG. 3

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

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Application April 15, 1939, Serial No. 267,956

30 Claims. (Cl. 179—27)

The present invention relates to telephone systems and, more particularly, to automatic telephone systems including one or more subscribers' lines of the multiparty type.

As explained in Patent No. 1,267,113, Powell, granted May 21, 1918, in telephone systems of the character indicated, when one or more of the substations associated with a multiparty subscriber's line is taken out of service or disconnected from the line, it is desirable to provide an arrangement whereby calls intended for the disconnected substation are routed to an operator's position so that the calling subscribers can be informed that the called substation is no longer in service. Call intercepting service of this type is also desirable in other instances when calls to substations actually in service are to be routed to an operator's position.

It is an object of the present invention to provide, in an automatic telephone system of the character described, improved apparatus of simple and economical arrangement which operates in a new and improved manner to intercept calls to one or more of the substations associated with a multiparty subscriber's line and automatically to route such calls to an operator's position.

It is another object of the invention to provide improved apparatus of the character described which is so arranged that, by providing a single relay in association with a multiparty subscriber's line, any or all calls routed to the line may be intercepted and routed to an operator's position.

It is a further object of the invention to provide an improved arrangement of the character described wherein calls to be intercepted and intended for substations associated with different multiparty lines may all be routed through the same trunk circuit apparatus to the same operator's position.

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 harmonic type for selectively signaling the substations associated with the multiparty lines. More particularly, this apparatus includes a plurality of ringing current generators having different output frequencies, ringing current conductors individually corresponding to the generators and a cyclically operating interrupter switch for connecting the ringing current conductors to their respective corresponding generators for different periods of each ringing cycle. The automatic switching equipment of the system includes one or more connector switches having access to the subscribers' lines of the multiparty type. Each of these connector switches is equipped with impulse responsive ringing control means which functions to select a desired one of the ringing current conductors for connection to a selected one of the subscribers' lines in order to signal a called one of the substations associated with the selected line. By virtue of the arrangement of the ringing interrupter switch, ringing current of a particular frequency is only projected over a selected called line during one interval of each ringing cycle.

In accordance with the present invention, there is provided, in association with each of the multiparty subscribers' lines with respect to which calls are to be intercepted, an alternating current relay which is energized by and operates when current of any selected frequency is projected over the associated line. There are further provided a plurality of relays individually associated with the ringing current conductors and each connected and arranged to operate when ringing voltage is impressed upon the associated conductor. These relays, in cooperation with the alternating current relays mentioned above, are arranged jointly to control automatic switching apparatus which is provided for extending connections from the multiparty subscribers' lines to an intercepting operator's position on certain calls routed to the multiparty lines.

The invention contemplates two embodiments of the automatic switching apparatus through which calls are routed from the multiparty subscribers' lines to the intercepting operator's position. In one embodiment of this apparatus, there is provided a finder switch having access to the lines with respect to which calls are to be intercepted and arranged to operate in response to the completion of a start circuit therefor which is jointly controlled by the alternating current relays, mentioned above, and the relays which operate when potentials are applied to the ringing current conductors. In the second embodiment of the invention, the automatic switching apparatus comprises line connect relays individually associated with the multiparty lines with respect to which calls are to be intercepted. These line connect relays are so connected and arranged that, when any one thereof is caused to operate to forward a call to the intercepting operator's

position, all of the other similar relays are locked out of service until the call is terminated.

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

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 Figures 1, 2 and 3, taken together, illustrate an automatic telephone system having embodied therein the features of the invention briefly outlined above; and Fig. 4 illustrates a modification of the apparatus for extending connections from the multiparty subscribers' lines of the system to the intercepting operator's position illustrated in Fig. 2.

Referring now to the drawings, the system there illustrated comprises, in general, an exchange, a plurality of single party subscribers' lines, one of which is indicated at **10**, extending to the exchange, and a plurality of subscriber-controlled automatic switches including line switches indicated at **15** and **20**, respectively, a selector switch **25**, and a connector switch **30**, for setting up connections between the various subscribers' lines. The exchange housing the automatic switching equipment also has extending thereto a plurality of multiparty lines, one of which is indicated at **11** as terminating in the line switch **15** and also in the bank contacts of the connector switch **30**. This line has associated therewith a plurality of substations B and C which individually include signal devices in the form of harmonic ringers **12** and **13** bridged across the conductors of the line **11** in series with the condensers **16** and **17**, respectively. The harmonic ringers bridged across the line **11** at the various substations are tuned to respond to ringing currents of different frequencies, so that any desired one of the substations may be signaled to the exclusion of the others by projecting ringing current of the proper frequency over the line **11**. The end of the line **10** remote from the exchange terminates at a subscriber's substation A of the usual common battery type. The line switches **15** and **20** and the other similar switches of the system are nonnumerical switches in the sense that they are ineffective to perform any line selecting functions other than those of selecting idle ones of the selector switches. The selector and connector switches, on the other hand, are commonly known as numerical switches in that they are operative to perform particular line selecting functions in response to impulses transmitted thereto. It will be understood that a plurality of switches of each type, namely, a plurality of line switches, a plurality of selector switches, and a plurality of connector switches, are provided in the system for performing the usual line switching functions. The switches of each type are respectively arranged in groups and, in accordance with universally followed practice, the number of switches in each group is determined by the maximum volume of traffic the particular switch group is required to handle. Further in accordance with conventional practice, each of the subscribers' lines is multipled between the corresponding bank contacts of a group of connector switches, whereby a plurality of such switches are rendered available for setting up connections between each line and every other line of the system. The line switches, on the other hand, are individually associated with the respective subscribers' lines.

Each of the line switches **20**, **35**, etc., is preferably of the well-known rotary type, of which there are several commercial embodiments. Each of the selector and connector switches is preferably of the well-known Strowger type having embodied therein a wiper carriage structure adapted to be translated vertically to bring the wipers thereof to a position opposite a particular level of bank contacts and then rotate to bring the wipers into engagement with a particular set of bank contacts in a selected lever; vertical, rotary and release magnets; and control relays suitably connected and arranged to control the energization of the various magnets and the line switching in accordance with the particular functions of the switch. Obviously, the particular arrangement of the control apparatus embodied in the switches of different type is different in each instance, depending upon the character of the switch.

In order more clearly to explain the operation of the circuits to which the invention pertains, a portion of the relay equipment embodied in the connector switch **30** has been shown in detail. More particularly, this equipment comprises a slow-to-operate ringing control relay R**100**, a slow-acting ring cut-off relay R**110**, and a ringing frequency selecting switch **120** of the well-known minor type. In brief, the switch **120** comprises a single set of bank contacts **121**, a wiper **122**, means comprising an operating magnet **123** for driving the wiper **122** over the contacts of the set **121**, a release magnet **124** for causing the wiper **122** to be returned to its normal or home position, and a pair of off-normal contacts **125** for controlling the operating circuit for the release magnet **124**. As indicated previously, the line switches individually associated with the subscribers' lines are of the well-known rotary type. The switch **25** includes a line relay R**130** which is illustrated in the drawings in order to facilitate an explanation of certain of the circuits referred to hereinafter.

The equipment provided in the line terminating exchange also comprises cyclically operating ringing apparatus for delivering to the various connector switches ringing currents of five different frequencies. The arrangement of this apparatus is such that the ringing currents of different frequencies are delivered to the different groups of connector switches during different periods of each ringing cycle. For example, the arrangement may be such that, during the first ringing period of each ringing cycle, ringing current of the frequency F**1** is delivered to a first group of connector switches, ringing current of the second frequency F**2** is delivered to a second group of the connector switches, ringing current of the third frequency F**3** is delivered to a third group of the connector switches, ringing current of the fourth frequency F**4** is delivered to a fourth group of connector switches, and ringing current of the fifth frequency F**5** is delivered to a fifth group of connector switches; and during the second period of each ringing cycle, ringing current of the first frequency is delivered to the third group of connector switches, ringing current of the second frequency is delivered to the fourth group of connector switches, ringing current of the third frequency is delivered to the first group of connector

switches, etc. With the particular arrangement illustrated, ringing currents of the frequencies F1, F3, F5, F2 and F4 are successively delivered, in the order named, to the connector switches of the group including the switch 30, during different periods of each ringing cycle. More particularly, the ringing apparatus is illustrated in Fig. 3 as comprising five motor driven alternating current generators 301 to 305, inclusive, having output current frequencies F1, F2, F3, F4 and F5, respectively. These generators are arranged to deliver ringing current by way of ringing current conductors to the various connector switches of the system. The ringing current conductors are arranged in groups respectively extending to the different groups of connector switches. One such group of ringing current conductors is illustrated as comprising the conductors C306, C307, C308, C309 and C310, which are arranged to deliver ringing currents to the connector switches of the group including the switch 30. To this end, these conductors are connected by way of the cable conductors of a cable 311 to the respective contacts of the contact set 121 embodied in the frequency selecting switch 120 of the connector switch 30. These same conductors are multipled in the corresponding bank contacts of the frequency selecting switches respectively embodied in the other connector switches of the group including the switch 30. In a similar manner, the ringing current conductors of the bracketed group 312 are terminated in the bank contacts of the various frequency selecting switches respectively embodied in the connector switches forming the second group. The remaining fifteen ringing current conductors are divided into three additional groups for serving three additional groups of connector switches.

For the purpose of connecting the indicated ringing current conductors to the generators 301 to 305, inclusive, there are provided five ringing relays R320, R330, R340, R350 and R360, and a ringing interrupter switch 370 of conventional arrangement. This ringing interrupter switch has extending thereto a start conductor C336 over which the start relay conventionally embodied in the switch is arranged to be energized in response to operation of any one of the connector switches of the system. The interrupter switch 370 also has extending thereto a pick-up conductor C337 by way of which the ringing relays of the various connector switches are controlled to control the application of ringing current of a selected frequency to a selected called line. The ringing interrupter switch 370 is arranged repeatedly to operate through identical cycles. During each cycle of operation, the apparatus embodied in this switch functions to impress ground potential successively upon the conductors C326, C327, C328, C329, and C338 for different periods of substantially equal duration. As a result, the relays R320, R330, R340, R350 and R360 are energized and operate in succession, each thereof functioning, when operated, to connect its associated ringing current conductors to the five alternating current generators. Thus, during the first period of each ringing cycle, the relay R320 operates its armature RA321 to disconnect the ringing conductor C306 from ground and to connect this conductor to the ungrounded terminal of the alternating current generator 301. In a similar manner and at its armatures RA322 to RA325, inclusive, the relay R320 disconnects the four other associated ringing current conductors from ground and connects these conductors to the alternating current generators 302, 303, 304 and 305, respectively. Since the relay R320 is alone operated during the first period of each ringing cycle, only the ringing current conductors associated with this relay are connected to the indicated alternating current generators during such periods. During the second period of each ringing cycle, the second ringing relay R330 operates its armature RA333 to disconnect the ringing current conductor C308 from ground and to connect this conductor to the ungrounded terminal of the alternating current generator 303. In a similar manner, the other ringing current conductors associated with the second ringing relay R330 are disconnected from ground and connected to the corresponding alternating current generators during the second period of each ringing cycle. At the beginning of the third period of each ringing cycle, when the relay R340 is alone operated, this relay, at its armature RA345, disconnects the ringing current conductor C310 from ground and connects this conductor to the ungrounded terminal of the alternating current generator 305. Similarly, the other ringing current conductors associated with the third ringing relay R340 are connected to the ungrounded terminals of their respective corresponding generators during the third period of each ringing cycle. During the fourth period of each ringing cycle, when the fourth ringing relay R350 is alone operated, the armature RA352 is operated to disconnect the ringing current conductor C307 from ground and to connect this conductor to the ungrounded terminal of the generator 302. In a similar manner, the other ringing current conductors associated with the fourth ringing relay are disconnected from ground and connected to their respective corresponding generators during the fourth period of each cycle of operation of the interrupter switch 370. Finally, the ringing relay R360 alone operates during the fifth ringing period of each ringing cycle to disconnect, at its armature RA364, the ringing current conductor C309 from ground and to connect this conductor to the ungrounded conductor of the generator 304. Similarly, the other ringing current conductors associated with the fifth ringing relay R360 are disconnected from ground and connected to the ungrounded terminals of their respective corresponding generators during the fifth period of each ringing cycle. The arrangement of the interrupter switch 370 is such that ground potential is impressed upon the pick-up conductor C337 at the beginning of each cycle of operation thereof. From the foregoing explanation, it will be apparent that the ungrounded terminals of the generators 301, 303, 305, 302 and 304 are connected to the respectively ringing current conductors C306, C308, C310, C307 and C309 during succeeding ringing periods of each ringing cycle.

The system further comprises a call intercepting operator's position 200, to which certain calls, routed to certain of the multiparty lines of the system, may automatically be extended through operation of the improved trunk circuit apparatus indicated generally at 210. The apparatus provided at the operator's position 200 includes an answer jack 201, through which connections are made to the operator's cord circuit, and an incoming call, signal lamp 202.

Neglecting for the present the details of the apparatus 210, the system as described above is,

in general, entirely conventional in form and its operation is well understood in the art. In brief, when a subscriber, such, for example, as the subscriber at the substation A, lifts his receiver from its hook to initiate a call intended for a second subscriber's substation, such, for example, as the substation B, a loop circuit is completed for initiating the operation of the line switch **20** to select a trunk line leading to an idle selector switch. Assuming, for example, that the selector switch **25** is selected by the line switch **20**, when the trunk line leading to this selector switch is seized, the calling loop circuit is extended to this selector switch and the switch is conditioned to respond to the first series of impulses dialed at the calling substation. With the selector switch **25** in this condition, the usual dial tone signal is returned over the established loop circuit to the calling subscriber to indicate that the dialing operation may be started. When the first digit 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 called line **11**. Following this operation and during the interdigit 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 line leading to an idle connector switch of the selected group is found. Assuming 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 stepped into engagement with the contacts terminating the trunk line extending to this connector switch, the subscriber's loop circuit is extended to the switch **30**, thereby to cause this connector switch to be conditioned to respond to the second series of impulses dialed at the calling substation. When the connector switch **30** is seized in the manner just described, certain of the control relays embodied therein, and more particularly the line and hold relays, operate to complete a path for impressing ground potential upon the start conductor **C336** extending to the ringing interrupter switch **370**, thereby to initiate the operation of the interrupter switch in the event it is not already in operation. When operation of the interrupter switch **370** is initiated, the relays **R320**, **R330**, **R340**, **R350** and **R360** function, in the manner previously explained, successively to connect the conductors **C306** to **C310**, inclusive, to the generators **301** to **305**, inclusive, during the different periods of each ringing cycle. In response to the dialing of the second digit, 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 subgroup including the called line **11**. Following this digit and during the interdigit pause between the second and third digits, the connector switch is conditioned to rotate its wipers step by step in accordance with the impulses of the third digit to be dialed at the calling substation. When this third digit is dialed, the wipers of the switch **30** are operated into engagement with the set of bank contacts terminating the called line **11**. During the interdigit pause between the third and fourth digits, circuits are prepared for energizing the operating magnet **123** of the frequency selecting switch **120** in accordance with the impulses of the fourth and final digit. The indicated operating magnet responds to the impulses of the fourth digit by operating the wiper **122** into engagement with the contact of the contact set **121** having impressed thereon ringing voltage of the particular frequency required to operate the harmonic ringer **12** provided at the called substation B. If it be assumed, for example, that the harmonic ringer **12** provided at the called substation B is constructed to respond only to ringing current of the frequency F**2**, the fourth digit dialed at the calling substation will comprise two impulses so that at the conclusion thereof the wiper **122** will be left standing in engagement with the contact terminating the ringing conductor **C307**. During the operation of the switch **120** and when the wiper **122** is stepped to its first off-normal position, the off-normal springs **125** are closed to prepare an incomplete circuit for energizing the release magnet **124**, this circuit being held open until the switch **30** is released.

In accordance with conventional practice, suitable provisions are made for testing the selected called line **11** to determine the idle or busy condition thereof, for returning the usual busy tone signal over the established loop circuit to the calling subscriber in the event the called line is busy, and for projecting ringing current of the selected frequency over the called line in the event this line is idle at the time it is selected. Assuming that the called line is idle, a circuit is prepared, through operation of certain of the relays embodied in the connector switch **30**, for energizing the lower winding of 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 switch **370** when ground is impressed upon the pick-up conductor **C337** and may be partially traced as extending from ground by way of **C337**, the lower winding of **R100**, the test wiper of the connector switch **30**, the private conductor of the line **11**, and through the winding of the cut-off relay conventionally embodied in the line switch **15** to battery. When this circuit is completed, the cut-off relay embodied in the line switch **15** partially operates to disconnect the windings of the line relay **R130** from the conductors 11_a and 11_b of the called line **11**, thereby to clear this line of the shunt impedance represented by these windings. Completion of the circuit just traced also results in the energization and operation of the ringing control relay **R100**. This relay, upon operating, completes, at the "X" contacts associated with **RA102**, a prepared holding circuit for itself, this holding circuit having been previously prepared through operation of certain of the other relays, not shown, embodied in the connector switch **30**. At its armatures **RA101** and **RA103**, the relay **R100** completes a circuit for projecting ringing current of the selected frequency over the conductors of the line **11**. In the present case, the circuit traversed by the ringing current may be traced as extending from the ungrounded terminal of the generator **302** by way of **RA352**, **C307**, the second contact of the set **121**, the wiper **122**, **RA113**, **RA103**, the conductor 11_b, the windings of the ringer **12**, the condenser **16**, the conductor 11_a, **RA101**, **RA111**, the upper winding of **R110** and the exchange battery to the grounded terminal of the generator **302**. Portions of this current are obviously shunted through the harmonic ringers respectively provided at the other substations associated with the line **11**. The ringer **12**, however, is the only ringer which responds to current of the par-

ticular frequency developed by the generator 302. Operation of this ringer serves to signal the called subscriber that he is being called. A portion of the ringing current is also shunted, in the usual manner, over the calling loop circuit to energize the receiver provided at the calling substation, thereby to indicate to the calling subscriber that the called substation is being signaled. It will be apparent from the foregoing explanation with reference to the ringing apparatus shown in Fig. 3 that ringing current of the frequency F2 is only intermittently projected over the line 11 to cause operation of the ringer 12. More particularly, ringing current is projected over this line only during the fourth period of each ringing cycle.

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, a direct current conductive bridge is connected across the conductors 11_a and 11_b of the line 11 to complete a circuit for energizing the upper winding of the slow-acting ring cut-off relay R110. This circuit may be traced as extending from ground by way of RA352, C307, the second contact of the set 121, the wiper 122, RA113, RA103, the conductor 11_b, the bridge across the conductors 11_b and 11_a, the conductor 11_a, RA101, RA111, and the upper winding of R110 to battery. When its upper winding is energized over this circuit, the relay R110 operates to close the "X" contacts associated with RA112, thereby to complete a prepared holding circuit for itself. Thereafter, the relay R110, at its armatures RA111 and RA113 and their respective associated resting contacts, opens two points in its operating circuit and two points in the above-traced circuit for projecting ringing current over the line 11. At these same armatures and their respective associated working contacts, the relay R110 completes the desired conversational circuit between the calling and called substations. 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 loop circuit, thereby to terminate the ring-back-tone signal in the usual manner.

Preferably, the control relays of the connector switch 30 are so arranged that the release of the operated switch train is entirely under the control of the calling subscriber at the substation A. With such an arrangement, when the connection is cleared out at the calling substation, the loop circuit extending through to the operated connector switch 30 is interrupted to cause the release of the line and hold relays conventionally embodied in this switch in the usual manner. When these relays restore, the line and selector switches 20 and 25, respectively, are released and the control apparatus embodied in the connector switch 30 is restored to normal, all in a manner well understood in the art. During the release of the control apparatus embodied in the connector switch 30, the previously traced holding circuits for the two relays R110 and R100 are interrupted, causing these relays to restore. Also, ground potential is removed from the private conductor of the called line 11, whereby the cut-off relay embodied in the line switch 25 is released to reconnect the windings of the line relay R130 to the conductors 11_a and 11_b of the line 11. When ground potential is removed from the private conductor of the line 11, battery potential is impressed upon this conductor through the windings of the cut-off relay embodied in the line switch 25, 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 mechanism embodied in this switch, thereby to cause the wiper carriage structure of this mechanism to be restored to rotary and vertical normal. Similarly, a circuit is completed by way of the off-normal springs 125 for energizing the release magnet 124 of the frequency selecting switch 120, whereby the wiper 122 of this switch is restored to normal. When this wiper attains its normal position, the off-normal springs 125 are opened to interrupt the operating circuit for the release magnet 124. Thus, the switch train is fully released.

Referring now more particularly to the arrangement of the apparatus 210 illustrated in Fig. 2 and provided for the purpose of extending connections from the multiparty subscribers' lines to the operator's position 200, this apparatus comprises a finder switch 215 having access to each of the multiparty subscribers' lines with respect to which calls are to be intercepted and operative to extend a connection from any one of these lines to the operator's position 200. This finder switch is of the well-known rotary type and comprises three sets of contacts 216, 217 and 218; wipers 219, 220 and 221 respectively associated with the enumerated contact sets in the order named; and means comprising a motor magnet 222 and a ratchet and pawl mechanism, not shown, for driving the indicated wipers over the contacts of their respective associated contact sets. In order to initiate the operation of this finder switch, there is provided, in association with each of the multiparty subscribers' lines, a device operative in response to alternating current projected by way of the associated line. More particularly, a relay R225 having a winding bridged across the conductors of the line 11 in series with a condenser 228 is provided in association with the line 11 and is arranged to control a start circuit, described hereinafter, provided for the purpose of initiating the operation of the finder switch 215. Alternating current relays corresponding to the relay R225 are individually associated with the other multiparty subscribers' lines of the system for the purpose of controlling the finder switch start circuit. This circuit is also arranged to be controlled by predetermined ones of the relays R250, R245, R240, R235 and R230, which relays are energized in parallel with the ringing relays R320, R330, R340, R350 and R360, respectively, of the ringing apparatus shown in Fig. 3. In view of the foregoing explanation, it will be apparent that the relay R250 is energized and operates during the first period of each cycle of operation of the ringing interrupter switch 370. Similarly, the relays R245, R240, R235 and R230 respectively operate during the second, third, fourth and fifth ringing periods of each ringing cycle. The call intercepting apparatus 210 further comprises a plurality of control relays R260, R270, R280 and R290 which are arranged to control the operation of the finder switch 215 to seize a line to which a call to be intercepted has been extended, and also to switch the called line through to the operator's posi-

tion 200 in the manner more fully explained subsequently.

Referring now more particularly to the operation of the apparatus 210 to intercept a call routed by way of the connector switch 30 to the line 11, if it be assumed, for example, that the substation C has been disconnected from service or that, for some other reason, calls intended for this substation are to be intercepted, and, further, that the ringing current frequency designating the substation C is the frequency F4 of the generator 304, it will be apparent that, in an attempt to signal the substation C, the wiper 122 of the frequency selector switch 120 will be operated into engagement with the contact terminating the conductor C309 during the frequency selecting digit dialed at the calling substation. With the wiper 122 of the switch 120 occupying this position, each time the ringing relay R360 operates to complete the circuit for projecting ringing current over the called line, the relay R230 is energized in parallel therewith and operates to prepare, at RA231, the previously mentioned start circuit for the finder switch 215. Simultaneously with the operation of the relay R230, the alternating current relay R225, which is bridged across the conductors of the line 11, is energized by the ringing current projected over this line and operates to complete the start circuit for the finder switch 215. More particularly, with the two relays R225 and R230 operated at the same time, a circuit is completed for energizing the lower winding of the slow-to-operate relay R280, this circuit extending from ground at RA231 by way of RA226, RA273 and the lower winding of R280 to battery. When energized over this circuit, the relay R280 operates to complete, at RA281, a circuit for energizing the operating magnet 222 of the finder switch 215. This circuit extends from ground at RA231 by way of RA226, RA273, RA281, RA261 and the winding of the magnet 222 to battery. When energized in this manner, the magnet 222 attracts its associated armature 223 to complete an obvious circuit for energizing the upper winding of the slow-to-release pulsing relay R260. The last-named relay, in turn, operates to prepare a circuit for energizing the relay R270 and interrupts, at RA261, the circuit, just traced, for energizing the magnet 222. When the magnet 222 is deenergized, it operates to advance the wipers 219, 220 and 221 one step and to interrupt the operating circuit for the relay R260 causing this relay to restore to recomplete the circuit for energizing the magnet 222. The interrelated operation of the magnet 222 and the relay R260 continues until the wipers of the finder switch 215 are stepped into engagement with the contacts terminating the conductors of the called line 11. Since several steps on the part of the wipers of the switch 215 may be required before the contacts terminating the conductors of the line 11 are encountered and the two relays R225 and R230 are energized only for short intervals of approximately one second each during each ringing cycle, it will be apparent that a plurality of operations of the two indicated relays, covering an interval including several ringing cycles, may be required before the wipers of the finder switch 215 are operated to the position corresponding to the line 11. When the wipers 219 and 221 encounter the contacts terminating the conductors of the line 11, a circuit is completed for energizing the lower winding of the pulsing relay R260, this circuit extending from ground at RA231 by way of RA227, the wiper 220, the resistor 265 and the lower winding of R260 to battery. When energized over this circuit, the relay R260 remains in its operated position to prevent further energization of the magnet 222. At RA263, the relay R260 completes a circuit for energizing the lower winding of the relay R270, this circuit extending from ground at RA231 by way of RA227, the wiper 220, RA263, and the lower winding of R270 to battery. The relay R270 now operates to complete a holding circuit for itself, this circuit extending from ground at the armature 223 by way of RA275 and the upper winding of R270 to battery. At RA274, the relay R270 prepares a holding circuit for the relay R260. At RA273, the relay R270 opens a further point in the above-traced operating circuit for the magnet 222. At RA272, the relay R270 completes an obvious circuit for energizing the signal lamp 202, thereby to inform the operator attending the position 200 that a call has been extended through the apparatus 210 to this position. At RA271 and RA276, the relay R270 connects the conductors of the called line 11 to the tip and ring contacts, respectively, of the jack 201. The relay R270 also interrupts, at RA273, the previously traced operating circuit for the slow-to-operate relay R280 causing the last-mentioned relay to restore and complete, at RA282, the above-mentioned holding circuit for the relay R260, this holding circuit extending from ground at RA282 by way of RA274, RA262 and the upper winding of R260 to battery. Following the operation of the two relays R260 and R270, no further operation of the intercepting apparatus 210 occurs until the call is answered at the operator's position 200 or is abandoned at the calling substation. It will be apparent, however, that the relays R225 and R230 continue to operate, without effect, during each ringing period when ringing current is projected over the line 11.

Assuming that the call is answered at the operator's position 200, when the operator inserts the answer plug terminating her cord circuit in the jack 201, a direct current bridge is connected between the tip and ring contacts of this jack to complete a circuit for energizing the upper winding of R290 in series with the upper winding of the ring cut-off relay R110 embodied in the operated connector switch 30. This series circuit may be traced as extending from ground by way of RA264, the upper winding of R290, the bridging path between the tip and ring contacts of the jack 201, RA271, the wiper 219, the conductor 11_a, RA101, RA111 and the upper winding of R110 to battery. When energized over this circuit, the relay R290 immediately operates to complete, at RA291, an obvious circuit for energizing the upper winding of R280. The ring cut-off relay R110 also operates to arrest the ringing operation and to establish the desired talking circuit between the calling subscriber and the operator's position 200, all in the manner previously explained. Upon operating, the relay R110 also connects negative battery potential to the line conductor 11_a of the line 11, this potential being derived from one winding of the back bridge relay conventionally embodied in the connector switch 30. Accordingly, the relay R290 is not deenergized when the ring cut-off relay R110 operates. The relay R280, upon operating, opens, at RA282, the previously traced holding circuit for the relay R260, causing the latter relay to re-

store. At RA281, the relay R280 reprepares the operating circuit for the magnet 222, this circuit being held open at this time at the operated armature RA273 of the relay R270. At RA283 and RA285, the relay R280 completes an obvious circuit for serially including the lower winding of R290 in the established loop circuit extending from the operator's telephone set through the windings of the back bridge relay embodied in the connector switch 30. At RA285 and RC284, the relay R280 interrupts the previously traced operating circuit for the relay R290. Following the operation of the relay R280 in the manner just explained, no further operation of the call intercepting apparatus 210 occurs until the connection is released.

When the established connection is released at the calling end thereof or the operator attending the position 200 clears out the connection by withdrawing the answer plug of her cord circuit from the jack 201, the established loop circuit extending between the operator's position 200 and the connector switch 30 is interrupted, so that the upper winding of the relay R290 is deenergized and this relay restores. Upon restoring, the relay R290 opens, at RA291, the circuit for energizing the upper winding of R280, causing the last-named relay to restore. The relay R280, upon restoring, completes, at RA282, an alternative circuit for energizing the magnet 222, this circuit extending from ground by way of RA282, RA274, RA262 and the winding of the magnet 222 to battery. The magnet 222 now operates to open, at its armature 223, the previously traced holding circuit for the relay R270. Upon operating, the magnet 222 also completes, at its armature 223, the above-described operating circuit for the slow-to-release relay R260. The relay R270, upon restoring, opens, at RA275, a further point in its holding circuit; opens, at RA271 and RA276, two additional points in the connection between the line 11 and the contact springs of the answer jack 201; and interrupts, at RA272, the circuit for energizing the signal lamp 202. At RA274, the relay R270 interrupts the alternative operating circuit for the magnet 222, causing this magnet to restore to advance the wipers 219 to 221, inclusive, one step and to interrupt the operating circuit for the relay R260. Thus, all of the control relays embodied in the trunk circuit apparatus 210 are released and this apparatus is conditioned for use in routing another call to the operator's position 200. The release of the operated switch train including the connector switch 30 is effected in the exact manner previously explained.

In the event the call as routed to the operator's position 200 in the manner just described is not answered by the operator attending this position, the apparatus 210 is released when the calling subscriber abandons the call to initiate the release of the operated switch train. More particularly, when the calling subscriber hangs up, the connector switch 30 is released, in the manner previously explained. During the release of this connector switch and when ground potential is removed from the private conductor of the line 11, the cut-off relay embodied in the line switch 25 restores to reconnect the windings of the line relay R130 to the line conductors 11_a and 11_b.

When this occurs, a circuit is completed for energizing the lower winding of the relay R290, this circuit extending from ground by way of RA264, RC284, RA285, the lower winding of R290, RA276, the wiper 221, the conductor 11_b and through the upper winding of the line relay R130 to battery. Since only one winding of the line relay R130 is energized over this circuit, this relay does not operate. The relay R290, however, operates to complete, at RA291, the circuit for energizing the upper winding of the slow-to-operate relay R280. At RA283 and RA285, the relay R280, upon operating, completes a circuit for energizing the two windings of relay R290 in series with the upper winding of the relay R130, this circuit extending from ground at RA264 by way of the upper winding of R290, RA283, RA285, the lower winding of R290, RA276, the wiper 221, the conductor 11_b and the upper winding of R130 to battery. Following the completion of the circuit just traced, the original circuit for energizing the lower winding of R290 in series with the upper winding of R130 is interrupted at RA285 and RC284 of the relay R280. The relay R280, upon operating, opens, at RA282, the previously traced holding circuit for the relay R260, causing the last-mentioned relay to restore to reprepare the above-traced alternative circuit for energizing the magnet 222. At RA264, the relay R260 opens the holding circuit for the relay R290, causing the latter relay and the relay R280 sequentially to restore in the order named. The relay R280, upon restoring, completes, at RA282, the prepared circuit for energizing the magnet 222. As a result, this magnet operates to advance the wipers 219 to 221, inclusive, one step, thereby to interrupt the holding circuit for the relay R270 and to complete the operating circuit for the relay R260. The relay R270, upon restoring, opens, at RA274, the alternative circuit for energizing the magnet 222 with the result that this magnet retracts its armature 223 to open the operating circuit for the relay R260, and the wipers 219, 220 and 221 are advanced one step. The relay R270, upon restoring, opens, at RA272, the circuit for energizing the signal lamp 202, thus indicating that the intercepted call has been abandoned. Thus, the apparatus 210 is fully released and is conditioned for further use.

From the foregoing explanation it will be apparent that the use of the apparatus 210 is not limited to the interception of calls to a single substation associated with the line 11. With the arrangement illustrated, calls intended for as many as five different substations may be intercepted by properly arranging the above-described start circuit for initiating the operation of the finder switch 215. More particularly, if the terminal 232 is disconnected from the armature RA231 of the relay R230 and connected to the terminal 237, calls intended for a substation associated with this line and normally signaled by ringing current of the frequency F2 produced by the generator 302 will be intercepted through operation of the apparatus 210 while calls to the other substations associated with the line 11 will be routed to the desired substations without interference on the part of the apparatus 210. In this case, the relay R235 and the relay R225 jointly control the start circuit for the finder switch 215, this start circuit only being completed during the period of each ringing cycle when current of the frequency F2 is transmitted over the line 11 since this is the only period of each ringing cycle during which the relays R225 and R235 are operated at the same time. Obviously, if the terminal 232 is connected to the terminal 237 without discon-

necting the terminal 232 from the armature RA231 of the relay R230, calls routed to the line 11 and intended for the substation C and a substation normally signaled by ringing current of the frequency F2 will all be routed to the operator's position through operation of the apparatus 210. It will further be apparent that, by connecting the terminal 232 to one or more of the other terminals 242, 247 and 252, calls to any desired ones of five different substations associated with the line 11 may be intercepted and routed to the operator's position 200 through operation of the apparatus 210.

It will also be apparent from the foregoing explanation that the use of the apparatus is not limited to the interception of calls routed to a single multiparty subscriber's line of the system. On the contrary, this apparatus may be connected to serve any desired number of subscribers' lines through the provision of additional relays corresponding to the relay R225 in individual association with the lines with respect to which call interception is desired. For example, if a second relay corresponding to the relay R225 is provided in association with a second of the multiparty subscribers' lines of the system, the armature of this relay corresponding to RA226 of the relay R225 will be multipled to RA226 and the armature corresponding to RA227 of the relay R225 will be connected to a second of the contacts included in the contact set 217 of the finder switch 215. The connected contacts respectively associated with these armatures of the second relay will be connected to one or more of the terminals 232, 237, 242, 247, and 252, these latter connections being determined by the particular substation or substations associated with the second line with respect to which calls are to be intercepted. With the armature of the second relay, corresponding to RA227 of the relay R225, connected to a second of the terminals embodied in the contact set 217, the wipers of the finder switch 215 are guided into engagement with the contacts terminating the conductors of the second line. When a call routed to this second line is to be intercepted and routed to the operator's position 200, the manner in which the apparatus 210, as modified to include the second line relay, operates to extend the connection to the operator's position 200 is exactly the same as described above. Additional line relays individually associated with others of the multiparty lines may be included in the apparatus in an obvious manner.

Obviously, the apparatus 210 is only capable of handling one call at a time. Provisions are made, therefore, for locking this apparatus out of service following its operation to route a connection to the operator's position 200. More particularly, when the relay R270 is caused to operate during the operation of the apparatus to extend a connection to the operator's position 200, and in the manner previously explained, it interrupts, at RA273, a point in the common portion of the start circuits individually controlled by the line relays associated with the subscribers' lines with respect to which calls are to be intercepted. Since the relay R270 is held operated until the connection routed by way of the apparatus 210 is fully released, it will be apparent that an established connection routed by way of this apparatus to the operator's position 200 is guarded against intrusion occasioned by calls routed to others of the multiparty lines which should normally be intercepted.

Referring now more particularly to Fig. 4, there is illustrated a modified arrangement of the improved apparatus for intercepting calls and routing the calls to an operator's position. This apparatus is adapted to be used in conjunction with the control relays R230, R235, R240, R245 and R250 illustrated in Fig. 2 and may be substituted for the intercepting apparatus 210 and the apparatus provided at the operator's position 200. More particularly, the arrangement shown in Fig. 4 comprises an operator's position 400 which includes an answer jack 401 and an incoming call signal lamp 404. The apparatus further comprises a plurality of line relays R410, R420, etc., individually associated with the multiparty subscribers' lines with respect to which calls are to be intercepted. In addition, there is provided in the apparatus shown in Fig. 4 a cut-off relay R430 and a pair of control relays R440 and R450, the last-mentioned of which is of the slow-to-release type. In order to substitute the apparatus shown in Fig. 4 for the apparatus shown in Fig. 2 so that calls routed to the line 11 and intended for the substation C may be intercepted through operation of the apparatus shown in Fig. 4, the terminals 405 and 406 are connected to the line conductors 11_b and 11_a of the line 11 and the terminal 407 is connected to the terminal 232 extending to the armature RA231 of the relay R230. The terminals 451 and 452 associated with the second line relay R420 may be similarly connected to opposite line conductors of a second multiparty line with respect to which calls are to be intercepted, it being pointed out that the particular calls to be intercepted are selected by connecting the terminal 453 to an appropriate one or ones of the terminals 232, 237, 242, 247 and 252 individually associated with the control relays R230, R235, R240, R245 and R250 shown in Fig. 2. Additional line relays connected in a similar manner and associated with the other multiparty subscriber's lines of the system may, if desired, be included in the apparatus shown in Fig. 4.

With the apparatus shown in Fig. 4 connected in the manner explained in the preceding paragraph, if a call intended for the substation C is routed by way of the connector switch 30 to the line 11, ringing current of the frequency F4 is projected over the line 11 during the period of each ringing cycle when the relay R230 is energized, all in the exact manner previously described. This ringing current serves to energize the lower winding of the relay R410 over a circuit which may be traced as extending from the ungrounded terminal of the ringing current generator 304 by way of RA364, C309, the switch wiper 122, RA113, RA103, the conductor 11_b, the terminal 405, the lower winding of R410, the condenser 416, the terminal 407, and RA231 to the grounded terminal of the ringing current source. When its lower winding is energized by ringing current projected over the circuit just traced, the relay R410 partially operates to complete, at the "X" contacts associated with RA413, a circuit for energizing its upper winding, this circuit extending from ground at RA431 by way of RA413, RA415 and the upper winding of R410 to battery. When its upper winding is energized over the circuit just traced, the relay R410 fully operates to complete a circuit including the winding of R430 and the upper winding of R410 in series. This circuit extends from ground by way of RA452, the winding of R430, RA414,

RA415 and the upper winding of R410 to battery. At its armatures RA411 and RA412, the relay R410, upon fully operating, connects the conductors of the line 11 to the tip and ring contacts of the answer jack 401. The relay R430 operates, when its winding is energized in series with the upper winding of R410 and, upon operating, opens, at RA431, a point in the common portion of the operating circuits for the line relays R410, R420, etc., individually associated with the subscribers' lines with respect to which calls are to be intercepted. Thus, the line relays associated with the other subscribers' lines, such, for example, as the relay R420, are prevented from fully operating when energized by ringing current projected over their respective associated lines. The relay R430, upon operating, also completes, at RA433, an obvious circuit for energizing the incoming call signal lamp 404. At RA432, the relay R430 completes an obvious circuit for energizing the relay R440. The relay R440, upon operating, completes, at RA 442, a circuit for energizing the upper winding of the cut-off relay R110 embodied in the connector switch 30. This circuit extends from ground by way of the resistor 444, RA442, RA411, the terminal 406, the conductor 11_a, RA101, RA111 and the upper winding of R110 to battery. When energized over this circuit, the relay R110 operates to arrest the ringing operation and to establish a loop circuit to the answer jack 401 provided at the operator's position 400. The relay R440, upon operating, also connects, at its armatures RA442 and RA443, a direct current bridge including the resistors 444 and 445 across the conductors of the line 11, thereby to energize the back bridge or called party answer relay conventionally embodied in the connector switch 30. At RA441, the relay R440 completes a path including the condenser 446 for connecting the ungrounded terminal of one of the ringing current generators intermittently to the line conductor 11_a of the called line 11, thereby to transmit the usual ring-back tone signal to the calling subscriber. In this regard it is pointed out that, when the ring cut-off relay R110 embodied in the connector switch 30 operates, it interrupts the path provided in this connector switch for conducting ring-back tone current over the calling loop circuit to the calling subscriber's substation. Hence, the provision of the auxiliary path, including the condenser 446, for conducting ring-back tone current to the calling substation, is required in order to prevent the calling subscriber from releasing the connection before the call is answered at the operator's position 400.

When the operator answers the call by inserting the answer plug terminating her cord circuit in the jack 401, the desired talking circuit is established between the calling subscriber's substation and the operator's telephone set. Also, the contact springs 402 and 403 of the jack 401 are moved into engagement to complete an obvious circuit for energizing the slow-to-release relay R450, which relay, upon operating, interrupts, at RA453, the operating circuit for the relay R440. At RA451, the relay R450 completes an alternative series circuit including the upper winding of R410 and the winding of R430 and thereafter interrupts the initially completed circuit serially including these windings. This alternative circuit extends from ground at the contact spring 402 by way of the spring 403, RA451, RA452, the winding of R430, RA414, RA415 and the upper winding of R410 to battery. The relay R440, upon restoring in response to the operation of R450, disconnects, at its armatures RA442 and RA443, the bridge comprising the resistors 444 and 445 from across the conductors of the called line 11 and opens, at its armature RA441, the above-traced path for transmitting ring-back tone current by way of the calling loop circuit to the calling subscriber's substation. Thus, the ring-back tone signal is terminated.

The release of the apparatus shown in Fig. 4 is entirely under the control of the operator who answers the call at the operator's position 400. Thus, the relays R410, R430 and R450 are held operated until such time as the answer plug terminating the operator's cord circuit is withdrawn from the answer jack 401. When this operation is performed, the springs 402 and 403 of the jack 401 are disengaged to interrupt the operating circuit for the relay R450 and to open the above-traced alternative circuit for energizing the winding of R430 in series with the upper winding of R410. When the last-named circuit is interrupted, the relays R410 and R430 immediately restore, the relay R430 functioning to open a point in the operating circuit for R440 and to interrupt, at RA443, the circuit for energizing the signal lamp 404. Shortly following the restoration of R430, the relay R450 releases to reprepare the operating circuit for R440 and to reprepare, at RA452, the above-traced circuit for energizing the relay R430 in series with the respective upper windings of the line relays R410, R420, etc. Following the release of the relay R450, the apparatus illustrated in Fig. 4 is fully restored to normal and is available for further use.

Although the two embodiments of the trunk circuit apparatus shown in Figs. 2 and 4, respectively have been described with reference to the interception of calls routed to lines arranged for bridged ringing, it will be understood that the circuits are also adapted for use in association with multiparty subscribers' lines arranged for divided ringing, in which case the line relays individually associated with the lines with respect to which calls are to be intercepted may be arranged to be bridged between both sides of their respective associated lines and ground through the provision of impedance bridge arrangements. As thus connected, each of the line relays would be energized by ringing current projected over either side of its associated lines. In the embodiment of the intercepting circuit shown in Fig. 4, provisions are made for operating the ring cut-off relay of an operated connector switch arranged for divided ringing. Thus, in the operation of the apparatus described above, the ring cut-off relay R110 embodied in the connector switch 30 was energized in response to the operation of the relay R440 over a circuit including the resistor 444. A similar circuit would be completed if the connector switch 30 were arranged for divided ringing and ringing current was projected therefrom over the side of a selected called line connected to the terminal 406. Assuming the connector switch 30 to be arranged for divided ringing and, further, that ringing current is projected over the side of the line connected to the terminal 405 on a call intended for a substation with respect to which calls are to be intercepted, the ring cut-off relay is energized over a circuit including the other resistor 445 in response to operation of the relay R440. Thus, it will be apparent that the ar-

rangement illustrated in Fig. 4 is adapted, without modification, for use in conjunction with automatic switching apparatus arranged for either divided ringing, bridged ringing, or both types of ringing.

Although the operation of the two embodiments of the trunk circuit apparatus and associated equipment has been described with reference to calls routed to the line 11 from a substation associated with another line of the system, it is pointed out that this apparatus will operate in the exact manner described to intercept reverting calls when the automatic switching apparatus of the system is arranged, in accordance with conventional practice, so that the directory number method of completing reverting calls is utilized. If this method of completing reverting call connections is used, a call initiated on the multiparty subscriber's line 11 at the substation B, for example, and intended for the substation C, is routed by way of the line switch 15, one of the selector switches and one of the connector switches of the system back to the line 11. The operated connector switch responds to the frequency selecting digit dialed at the calling substation B in the manner previously explained to select the particular ringing frequency designating the called substation C. Following this operation on the part of the operated connector switch, ringing current of the selected frequency is projected over the line 11 when the calling subscriber hangs up following the dialing operation. Accordingly, the call will be intercepted through operation of the apparatus 210 or the similar apparatus shown in Fig. 4 in the exact manner previously explained.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein, and it is intended 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 an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus including means for providing ringing voltages of different station selecting characteristics, cyclically operating means controlled by said ringing apparatus, an automatic switch having access to said line and including means for selectively impressing ringing voltage of any one of said characteristics upon said line, a device connected to be energized by ringing voltage impressed upon said line, an operator's position, and means jointly controlled by said device and said cyclically operating means for extending to said operator's position a connection routed to said switch.

2. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus including a plurality of ringing current conductors and cyclically operating means for applying ringing potentials of different station selecting characteristics successively to different ones of said conductors, an automatic switch having access to said line and including means for selectively associating said conductors with said line to project ringing current thereover, thereby selectively to signal said substations, a device connected to be energized by ringing current projected over said line, an operator's position, and means jointly controlled by said device and said cyclically operating means for extending to said operator's position a connection routed to said switch.

3. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus including means for impressing ringing voltage upon said line during any one of a plurality of different ringing intervals, a device controlled by said ringing apparatus and operative only during one of said intervals, an automatic switch having access to said line and including means for selecting the ringing interval during which ringing current is projected over said line from said ringing apparatus, an operator's position, and means controlled by said device for extending to said operator's position a connection routed to said switch only in the event the selected ringing interval at least partially overlaps said one interval.

4. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus including means for impressing ringing voltage upon said line during any one of a plurality of different ringing intervals, a device controlled by said ringing apparatus and operative only during one of said intervals, an automatic switch having access to said line and including means for selecting the ringing interval during which ringing current is projected over said line from said ringing apparatus, an operator's position, automatic switching apparatus operative to extend to said operator's position a connection routed to said automatic switch, a normally incomplete start circuit for said automatic switching apparatus, and means including said device for completing said start circuit only in the event the selected ringing interval at least partially overlaps said one interval.

5. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including alternating current generators having different output frequencies, ringing current conductors corresponding to said generators and means for connecting said conductors to the corresponding generators during different periods of each ringing cycle, a device controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said automatic switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, an operator's position, and means controlled by said device for extending to said operator's position a connection routed to said switch only in the event said one ringing period of each ringing cycle at least partially overlaps said predetermined period of each ringing cycle.

6. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including alternating current generators having different output frequencies, ringing current conductors corresponding to said generators and means for connecting said conductors to the corresponding generators during different periods of each ringing cycle, a device controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said automatic switch including means

for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, an operator's position, automatic switching apparatus operative to extend to said operator's position a connection routed to said switch, a normally incomplete start circuit for said automatic switching apparatus, and means including said device for completing said start circuit only in the event said one ringing period of each ringing cycle at least partially overlaps said predetermined period of each ringing cycle.

7. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including generating apparatus, a plurality of ringing current conductors and means for connecting said ringing current conductors to said generating apparatus during different periods of each ringing cycle, a relay associated with one of said conductors and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, a device connected to be energized by ringing current projected over said line, an operator's position, and means jointly controlled by said relay and said device for extending to said operator's position a connection routed to said switch only in the event said device and said relay are operated at the same time during at least a portion of said predetermined period of each ringing cycle.

8. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including generating apparatus, a plurality of ringing current conductors and means for connecting said ringing current conductors to said generating apparatus during different periods of each ringing cycle, a relay associated with one of said conductors and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, a device connected to be energized by ringing current projected over said line, an operator's position, automatic switching apparatus operative to extend to said operator's position a connection routed to said switch, and a start circuit for said automatic switching apparatus, said start circuit being jointly controlled by said relay and said device and only being completed when said relay and said device are operated at the same time during at least a portion of said predetermined period of each ringing cycle.

9. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including a plurality of ringing current conductors and means for impressing alternating ringing potentials of different frequencies upon different ones of said conductors during different periods of each ringing cycle, a relay controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, a device connected to be energized by ringing current of any one of said frequencies projected over said line, an operator's position, and means jointly controlled by said relay and said device for extending to said operator's position a connection routed to said switch only when said device and said relay are operated at the same time during at least a portion of said predetermined period of each ringing cycle.

10. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including a plurality of ringing current conductors and means for impressing alternating ringing potentials of different frequencies upon different ones of said conductors during different periods of each ringing cycle, a relay controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, a device connected to be energized by ringing current of any one of said frequencies projected over said line, an operator's position, automatic switching apparatus operative to extend to said operator's position a connection routed to said switch, and a start circuit for said automatic switching apparatus, said start circuit being jointly controlled by said device and said relay and being completed only when said relay and said device are operated at the same time during at least a portion of said predetermined period of each ringing cycle.

11. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus, an automatic switch having access to said line and including ringing control means for associating said ringing apparatus with said line, thereby selectively to signal said substations, an operator's position, a finder switch having access to said subscriber's line and operative to extend a connection from said subscriber's line to said operator's position, and means controlled by said ringing control means and said ringing apparatus for initiating the operation of said finder switch.

12. In an automatic telephone system, a plurality of subscribers' lines each adapted to have a plurality of substations associated therewith, ringing apparatus, automatic switching apparatus including ringing control means for associating said ringing apparatus with said lines, thereby selectively to signal said substations on calls routed by way of said switching apparatus to said lines, an operator's position, a finder switch having access to said subscribers' lines and operative to extend connections from said subscribers' lines by way of said trunk line to said operator's position, and means controlled by said ringing control means and said ringing apparatus for initiating the operation of said

finder switch on predetermined calls routed through said automatic switching apparatus to said lines.

13. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus including means for providing ringing voltages of different station selecting characteristics, cyclically operating means controlled by said ringing apparatus, an automatic switch having access to said line and including means for selectively impressing ringing voltage of any one of said characteristics upon said line, a device connected to be energized by ringing voltage impressed upon said line, an operator's position, a finder switch having access to said line and operative to extend a connection from said line to said operator's position, and means jointly controlled by said device and said cyclically operating means for initiating the operation of said finder switch.

14. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus including means for impressing ringing voltage upon a selected line during any one of a plurality of different ringing intervals, a device controlled by said ringing apparatus and operative only during one of said intervals, an automatic switch having access to said line and including means for selecting the ringing interval during which ringing current is projected over said line from said ringing apparatus, an operator's position, a finder switch having access to said line and operative to extend a connection from said line to said operator's position, and means controlled by said device for initiating the operation of said finder switch only in the event the selected ringing interval at least partially overlaps said one interval.

15. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including alternating current generators having different output frequencies, ringing current conductors corresponding to said generators and means for connecting said conductors to the corresponding generators during different periods of each ringing cycle, a device controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said automatic switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, an operator's position, a finder switch having access to said line and operative to extend a connection from said operator's position to said line, and means controlled by said device for initiating the operation of said finder switch only in the event said one ringing period of each ringing cycle at least partially overlaps said predetermined period of each ringing cycle.

16. In an automatic telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including a plurality of ringing current conductors and means for impressing alternating ringing potentials of different frequencies upon different ones of said conductors during different periods of each ringing cycle, a relay controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said line, said switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to said line, whereby ringing current is projected over said line during one period of each ringing cycle, a device connected to be energized by ringing current of any one of said frequencies projected over said line, an operator's position, a finder switch having access to said line and operative to extend a connection from said line to said operator's position, and means jointly controlled by said relay and said device for initiating the operation of said finder switch only in the event said one ringing period of each ringing cycle at least partially overlaps said predetermined period of each ringing cycle.

17. In an automatic telephone system, a plurality of subscribers' lines each adapted to have a plurality of substations associated therewith, ringing apparatus including means for providing ringing voltages of different station selecting characteristics, cyclically operating means controlled by said ringing apparatus, automatic switching apparatus having access to said lines and including means for selectively impressing ringing voltage of any one of said characteristics upon selected ones of said lines, an operator's position, line connect relays individually associated with said lines and each operative to cause a connection to be extended from the associated line to said operator's position, means controlled by said ringing apparatus for causing the operation of said relays on predetermined calls routed to the associated lines, and means responsive to the operation of any one of said relays for preventing the other relays from operating.

18. In an automatic telephone system, a plurality of subscribers' lines each adapted to have a plurality of substations associated therewith, ringing apparatus including means for providing ringing voltages of different station selecting characteristics, cyclically operating means controlled by said ringing apparatus, automatic switching apparatus having access to said lines and including means for selectively impressing ringing voltage of any one of said characteristics upon selected ones of said lines, an operator's position, line connect relays individually associated with said lines and each operative to extend a connection from its associated line to said operator's position, each of said relays including an operating circuit adapted to be energized by ringing current projected over the associated line, means controlled by said ringing apparatus for completing the operating circuit for one of said relays, and means repsonsive to the operation of said one relay for preventing the other relays from operating.

19. In an automatic telephone system, a plurality of subscribers' lines each adapted to have a plurality of substations associated therewith, ringing apparatus including means for impressing ringing voltage upon a selected one of said lines during any one of a plurality of different ringing intervals, a device controlled by said ringing apparatus and operative only during one of said intervals, an automatic switch having access to said lines and including means for selecting the ringing interval during which ringing current is projected over a selected one of said lines from said ringing apparatus, an operator's

position, line connect relays individually associated with said lines and each operative to extend a connection from its associated line to said operator's position, each of said relays including an operating circuit adapted to be energized by ringing current projected over the associated line, means including said device for completing the operating circuit for one of said relays during said one interval, whereby said one relay is energized in the event ringing current is projected over the line associated with said one relay during said one interval, and means responsive to the operation of said one relay for preventing the other relays from operating.

20. In an automatic telephone system, a plurality of subscribers' lines each adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including generating apparatus, ringing current conductors and means for connecting said conductors to said generating apparatus during different periods of each ringing cycle, a device controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said lines, said automatic switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to a selected one of said lines, whereby ringing current is projected over the selected line during a predetermined period of each ringing cycle, an operator's position, line connect relays individually associated with said lines and each operative to extend a connection from its associated line to said operator's position, each of said relays including an operating circuit adapted to be energized by ringing current projected over the associated line, means including said device for completing the operating circuit for the one relay associated with said selected line, whereby said one relay is energized in the event said one period of each ringing cycle at least partially overlaps said predetermined period of each ringing cycle, and means responsive to the operation of said one relay for preventing the other relays from operating.

21. In an automatic telephone system, a plurality of subscribers' lines each adapted to have a plurality of substations associated therewith, cyclically operating ringing apparatus including alternating current generators having different output frequencies, ringing current conductors corresponding to said generators and means for connecting said conductors to the corresponding generators during different periods of each ringing cycle, a device controlled by said ringing apparatus and operative only during a predetermined period of each ringing cycle, an automatic switch having access to said lines, said automatic switch including means for selecting one of said ringing current conductors and means for connecting the selected conductor to conduct ringing current to a selected one of said lines, whereby ringing current is projected over the selected line during a predetermined period of each ringing cycle, an operator's position, line connect relays individually associated with said lines and each operative to extend a connection from its associated line to said operator's position, each of said relays including an operating circuit adapted to be energized by ringing current projected over the associated line, means including said device for completing the operating circuit for the one relay associated with said selected line, whereby said one relay is energized in the event said one period of each ringing cycle at least partially overlaps said predetermined period of each ringing cycle, and means responsive to the operation of said one relay for preventing the other relays from operating.

22. In an automatic telephone system, a plurality of subscribers' lines each adapted to have a plurality of substations associated therewith, ringing apparatus including means for providing ringing voltages of different station selecting characteristics, cyclically operating means controlled by said ringing apparatus, automatic switching apparatus having access to said lines and including means for selectively impressing ringing voltage of any one of said characteristic upon selected ones of said lines, an operator's postion, line connect relays individually associated with said lines and each operative to cause a connection to be extended from the associated line to said operator's position, and means controlled by said ringing apparatus for causing the operation of said relays on predetermined calls routed to the associated lines.

23. In a telephone system, a subscriber's line adapted to have a plurality of substations associated therewith, ringing apparatus including means for impressing ringing voltage upon said line during any one of a plurality of different time intervals, a device controlled by said apparatus and operative only during one of said time intervals, means for selecting the ringing interval during which ringing voltage is impressed on said line, an operator's position, and means controlled by said device for extending to said operator's position a connection routed to said line only in the event the selected ringing interval at least partially overlaps said one interval.

24. In a telephone system including a line and ringing apparatus for impressing ringing voltage on the line during any one of a plurality of time intervals, apparatus for routing to an operator's position a call intended for said line only in the event ringing voltage is impressed upon said line during a predetermined one of said intervals.

25. In a telephone system, apparatus according to claim 24 wherein a finder switch having access to said line and to other lines of the system also arranged for call interception is provided for routing intercepted calls from said lines to the operator's position.

26. In a telephone system, apparatus according to claim 24 wherein line relays individually associated with said line and other lines of the system, also arranged for call interception, are provided for routing calls from said lines to the operator's position.

27. In a telephone system, a multiparty line, a call intercepting circuit, ringing apparatus for providing ringing signals designating different stations, means for transmitting one of said signals over said line, means for transmitting a control signal to said intercepting circuit concurrently with the transmission of said one signal over said line, and means jointly controlled by said one signal and said control signal for causing said intercepting circuit to intercept the call.

28. In a telephone system, a multiparty line, a call intercepting circuit, ringing apparatus for providing ringing signals designating different stations, means for transmitting one of said signals over said line, means for transmitting a control signal to said intercepting circuit concurrently with the transmission of said one signal over said line, and means responsive to the con-

current transmission of said one signal over said line and control signal to said intercepting circuit for causing said intercepting circuit to intercept the call.

29. In a telephone system, a multiparty line, ringing apparatus for generating ringing signals designating different stations, an automatic switch having access to said line and including means for selecting any one of said signals for transmission over said line, a call intercepting circuit, means for transmitting a control signal to said intercepting circuit concurrently with the generation of one of said ringing signals, and means jointly responsive to the transmission of said one ringing signal over said line and the transmission of said control signal to said intercepting circuit for causing said intercepting circuit to intercept the call.

30. In a telephone system, a multiparty line, ringing apparatus for generating ringing signals designating different stations, an automatic switch having access to said line and including a ringing signal selector for selecting any one of said signals for transmission over said line, a call intercepting circuit, and means controlled from said ringing apparatus jointly over one control path including the contacts of said automatic switch and said selector and a second control path extending directly to said ringing apparatus for causing a call routed through said switch to said line to be intercepted by said intercepting circuit.

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