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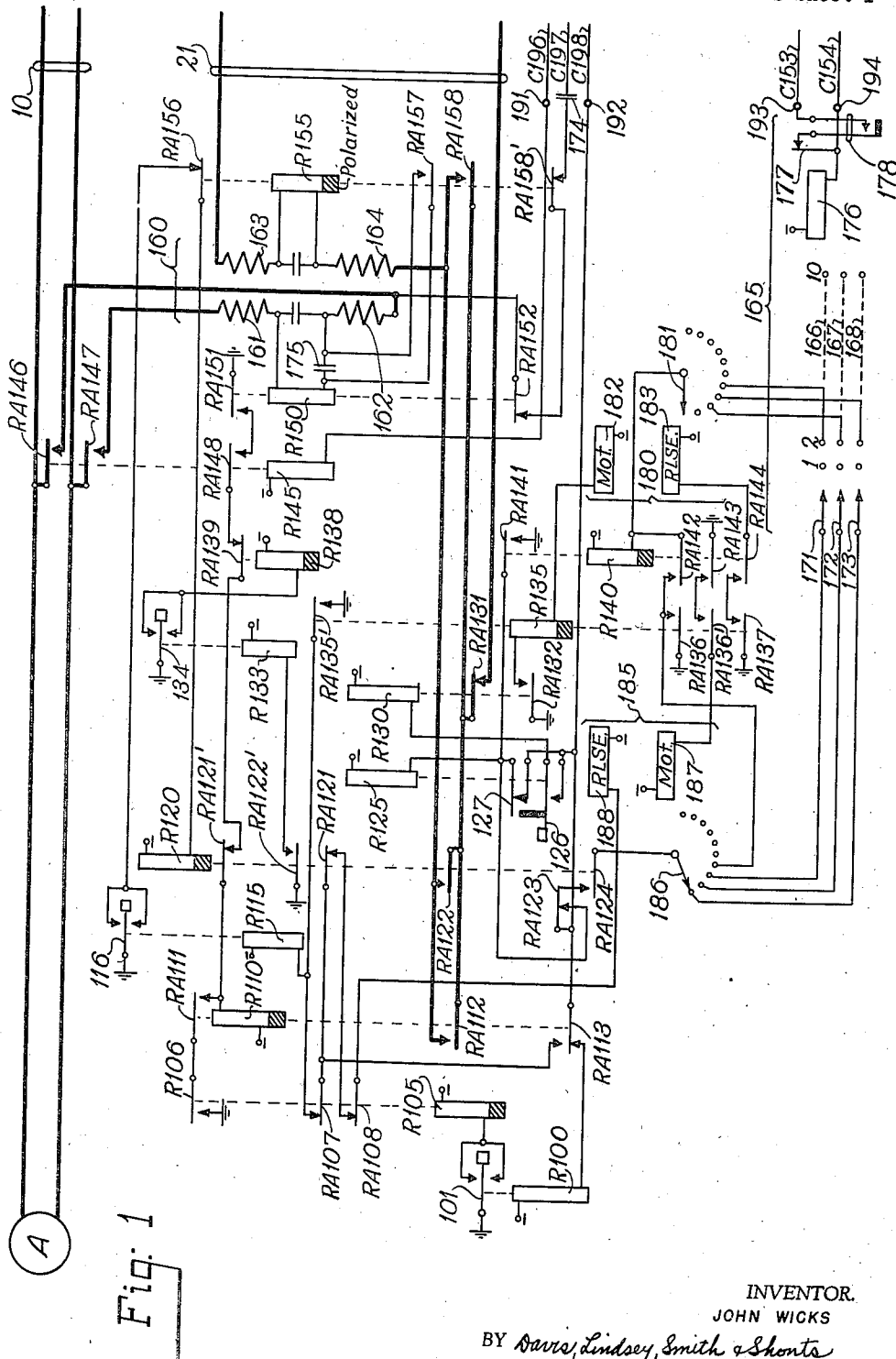
J. WICKS

2,274,760

TELEPHONE SYSTEM

Filed June 30, 1939

2 Sheets-Sheet 1



INVENTOR.

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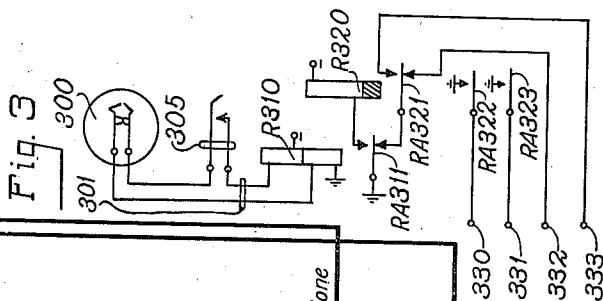
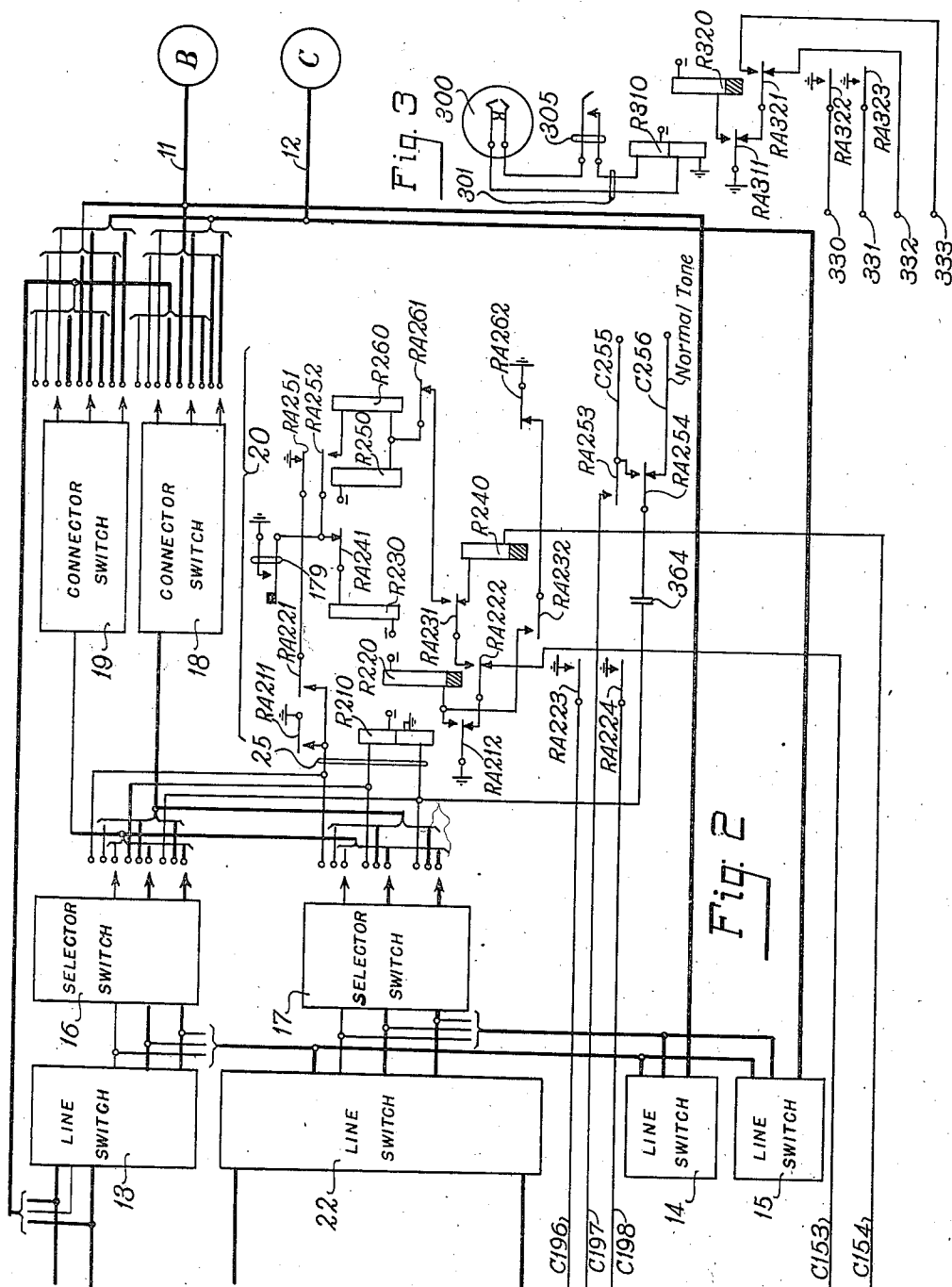
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UNITED STATES PATENT OFFICE

2,274,760

TELEPHONE SYSTEM

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23 Claims. (Cl. 179—18)

The present invention relates to automatic telephone systems and has for one of its objects the provision of improved call forwarding apparatus of the general character disclosed in Patent No. 1,760,823, granted May 27, 1930, to H. M. Friendly.

In the arrangement disclosed in this patent, call forwarding apparatus is provided in the central exchange of an automatic telephone system which may be operatively associated with a subscriber's line to provide call forwarding service and which, when conditioned for operation, functions to forward calls incoming to the line through the automatic switching apparatus embodied in the exchange to another line of the system. The call forwarding apparatus has embodied therein a register which may be set so that the call forwarding apparatus will function to forward the calls to any desired subscriber's line of the system. In order to set the register it is necessary to transmit thereto the impulses making up the directory number designating the substation to which the calls are to be forwarded. The particular arrangement disclosed requires a large amount of complicated equipment in order to obtain the desired end. Moreover, each substation for which call forwarding service is to be provided must be equipped with a special dial or calling device capable of transmitting twelve impulses therefrom. In addition, certain of the first selector switches of the system must be specially designed so that they are capable of operating twelve steps in a vertical direction. Further, the arrangement is such that the register embodied in the call forwarding apparatus can only be set from the particular substation which the apparatus is arranged to serve.

It is an object of the present invention, therefore, to provide in an automatic telephone system, improved call forwarding apparatus of the general character described which is simple in arrangement, is economical to manufacture and install, and is thoroughly reliable in operation.

It is another object of the invention to provide in an automatic telephone system, improved call forwarding apparatus of the character described which is so arranged that it may be conditioned for operation over any line of the system.

It is a further object of the invention to provide in an automatic telephone system, improved call forwarding apparatus of the character described wherein the apparatus may be set to forward calls incoming to the associated line to any

desired one of a number of substations by transmitting thereto a single digit of impulses.

It is a still further object of the invention to provide improved call forwarding apparatus of the character described which is adapted for use in an automatic telephone system employing practically any of the well-known types of automatic switching apparatus without in any way necessitating modification of the installed equipment.

The invention is illustrated in its embodiment in an automatic telephone system which comprises a plurality of subscribers' lines extending to a line terminating exchange and automatic switching equipment provided in the exchange for setting up connections between the lines. Briefly described, the call forwarding apparatus comprises a register, means controllable over any line of the system for variably setting the register in accordance with the directory designation of another of the subscribers' lines, and apparatus operative when a call is directed to the subscriber's line arranged for call forwarding service, under the condition of the register being set, for causing the call to be routed to the one of the other lines of the systems which corresponds to the setting of the register. More particularly, the call forwarding apparatus comprises an impulse sender for directly controlling the automatic switching apparatus to forward calls incoming to the associated line to a selected one of the other lines, and an impulse responsive switch for selecting the one of the other lines to which the calls are to be forwarded and to control the operation of the impulse sender in accordance with the line selected. The apparatus further comprises control means operative to initiate the operation of the impulse sender and a control circuit which is adapted to be seized over a connection routed through the automatic switching apparatus from any line of the system. This circuit includes means for repeating to the impulse responsive line selecting switch impulses transmitted over the connection extending to the circuit, thereby to cause the impulse responsive switch to select the one of the lines to which the calls are to be forwarded. The control circuit further comprises means for conditioning the above-mentioned control means to operate in response to a call routed to the line associated with the call forwarding apparatus. The arrangement is such that if a connection is routed to the control circuit after the call forwarding apparatus has been conditioned for operation and is then released, the impulse respon-

sive line selecting switch embodied in the apparatus is released and the control means for initiating the operation of the apparatus is rendered nonresponsive to calls routed to the associated line. There is further provided an arrangement, operative when the control circuit is seized, for transmitting a signal of one character back over the established connection extending to the control circuit in the event the call forwarding apparatus is conditioned to respond to calls incoming to the associated line and for transmitting a signal of different character over the established connection in the event the call forwarding apparatus is not conditioned to respond to calls incoming to the associated line.

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 and 2 illustrate an automatic telephone system having incorporated therein call forwarding apparatus and control apparatus constructed and arranged in accordance with the present invention, and Fig. 3 illustrates a modification of the apparatus which may be provided for controlling the call forwarding apparatus.

Briefly described, the system illustrated in the drawings comprises a plurality of substations A, B and C individually associated with the subscribers' lines 10, 11 and 12 in the order named; which lines all extend to the automatic switching apparatus provided in the line terminating exchange. This apparatus comprises line switches 13, 14 and 15 individually associated with the lines 10, 11 and 12, a plurality of impulse responsive selector switches including the two switches indicated at 16 and 17, and a plurality of impulse responsive connector switches, two of which are indicated at 18 and 19, respectively. The system further comprises call forwarding apparatus illustrated in detail in Fig. 1 which is individual to the substation A. In order to control this apparatus there is provided a control circuit 20 which is accessible to each of the first selector switches embodied in the line terminating exchange. The arrangement of the call forwarding apparatus as provided in conjunction with the substation A, is such that a repeating coil 160, a link line 21 and a line switch 22 individual to the line 10 are utilized in forwarding calls incoming to the line 10 to another line of the system, which other line is predetermined in accordance with the setting of the call forwarding apparatus.

The line switches 13, 14, 15 and 22 are commonly known as non-numerical switches for the reason that they perform no line selecting operations other than the selection of trunk lines extending to idle ones of the first selector switches. Preferably, these line switches are of the well-known rotary type of which several commercial embodiments are available. The selector and connector switches of the system are commonly known as numerical switches for the reason that they are directly controllable in accordance with impulses transmitted thereto to perform line group, subgroup and particular line selecting operations. Preferably, the last-mentioned

switches are of the well-known Strowger type, each having embodied therein a Strowger switching mechanism utilizing vertical and rotary motions in the operation thereof to select an outgoing line. Obviously, the control apparatus embodied in the selector and connector switches is different in each case depending upon the character of the switch. In this regard it is pointed out that the control circuit 20, through operation of which control of the call forwarding apparatus is effected, may be rendered accessible to the selector switches of the system by terminating the conductors of the link line extending thereto in the first set of contacts of a dead contact level, that is, the first set of contacts to be engaged by the wipers of the respective switches during rotary movement thereof when the wipers are vertically positioned opposite the level containing the inactive contacts.

Neglecting for the present the particular arrangement of the call forwarding apparatus and the control circuit therefor, the system as described above is entirely conventional in form and its mode of operation is well understood in the art. Briefly described, if a subscriber at the substation A, for example, initiates a call intended for the substation B, by removing the receiver provided at the substation A from its supporting hook or cradle, a calling loop circuit is completed by way of the line 10 for initiating the operation of the line switch 13. This line switch responds to the completion of the calling loop circuit by operating to select a trunk line extending to an idle one of the first selector switches. If the selector switch 13 is the first available idle selector switch accessible to the line switch 13, the last-mentioned switch, upon testing the condition of the trunk line extending to the selector switch 16 and finding this line to be idle, operates to extend the calling loop circuit to the indicated selector switch. In response to this operation, the control apparatus of the selector switch 16 functions in a well-known manner to transmit the usual dial tone signal over the calling line, thereby to inform the calling subscriber that the dialing operation may be started. The selector switch 16 responds to the impulses of the first digit dialed at the calling substation A by elevating its wipers to a position opposite the level of bank contacts terminating the trunk lines respectively extending to the connector switches of the group including the connector switch 18 having access to the called line 11. The control apparatus of the selector switch 16 also responds to the impulses of the first digit dialed at the calling substation by operating to terminate the dial tone signal. During the inter-digit pause between the first and second digits, the wipers of the selector switch 16 are rotated step by step in the usual manner successively to test the condition of the trunk lines respectively extending to the connector switches of the selected group. If the connector switch 18 is the first available idle switch of the selected group, the rotary movement of the wipers embodied in the selector switch 16 is arrested when these wipers engage the contacts terminating the conductors of the trunk line incoming to the indicated connector switch. Further, the control apparatus of the selector switch 16 functions to extend the calling loop circuit to the seized connector switch 18, whereby the control apparatus of the latter switch is conditioned to respond to the impulses of the second digit dialed at the calling substation. During the dialing of the

second digit, the wipers of the connector switch 18 are elevated step by step in a vertical direction to a position opposite the level of bank contacts terminating the group of ten lines including the called line 11. In response to the impulses of the third digit dialed at the calling substation, these wipers are rotated into engagement with the particular set of bank contacts at which the conductors of the line 11 are terminated. Following the selection of the called line in the manner just explained, the control apparatus embodied in the connector switch 18 functions to determine the idle or busy condition of the selected line and to transmit the usual busy signal over the calling loop circuit to the calling subscriber in the event the called line is busy. If the called line is found to be idle, the control equipment embodied in the connector switch 18 functions to transmit ringing current over the called line for the purpose of energizing the ringer or signal device conventionally provided at the called substation B. This equipment further operates to transmit a portion of the ringing current back over the calling loop circuit, whereby the usual ring-back tone signal is reproduced by the receiver provided at the calling substation. When the call is answered at the called substation, a direct current bridge is connected across the conductors of the line 11, thereby to complete, in the usual manner, a direct current circuit for energizing the ring cut-off relay conventionally embodied in the control equipment of the operated connector switch. This relay, upon operating, functions to terminate the ringing operation, to terminate the ring-back tone signal, to extend the loop circuit originating at the called substation through the windings of the back bridge or battery reversing relay embodied in the connector switch, and to complete the desired conversational circuit between the calling and called substations. The indicated back bridge relay, upon operating, functions to reverse the direction of current flow over the loop circuit extending to the calling substation in a manner well understood in the art. This reversal of current flow over the calling loop circuit may be utilized for control purposes, such, for example, as call metering, or the like. The manner in which the connection is released depends upon the particular arrangement of the control apparatus embodied in the connector switch 18. For example, this apparatus may be so arranged that the operated switch train is released only when the connection is cleared out at both the calling and called substations. Alternatively, the control apparatus of the connector switch 18 may be so arranged that the release of the switch train is entirely under the control of the calling subscriber. Assuming that the latter arrangement is employed, when the calling party replaces the receiver provided at the calling substation upon its supporting hook or cradle, the calling loop circuit is interrupted with the result that the connector switch 18, the selector switch 16 and the line switch 13 are released in the order named and in a manner well understood in the art. When these switches are all restored to normal, the calling and called lines 10 and 11, respectively, are marked as idle in the bank contacts of the connector switches having access thereto, and the apparatus utilized in completing the connection is rendered available for further use. In view of the foregoing brief description, it is believed that the manner in which connections may be established between

the other substations of the system will be clearly apparent without further explanation.

Referring now more particularly to the arrangement of the call forwarding apparatus illustrated in Fig. 1 and individually associated with the substation A, this apparatus comprises a register which includes an impulse responsive line selecting switch 165, an impulse counting or sending control switch 180, a digit sequence switch 185 and an impulse sender comprising a relay R125 having a weighted armature 126 which is adapted to vibrate at a rate of approximately ten vibrations per second. The apparatus further comprises a first timing device in the form of a vibratory relay R100 which is operative in conjunction with a slow-to-release relay R105 to delay the operation of the register for a predetermined time interval after a call is routed to the line 10. There is also provided a second timing device in the form of a vibratory relay R115 which, in combination with a second slow-to-release relay R120, functions to delay the release of a connection through which a call is forwarded for a predetermined time interval after the connection is set up. A third timing device in the form of a vibratory relay R133 is provided, which, in conjunction with a slow-to-release relay R138, functions to insure the complete release of a switch train through which a call is forwarded before a second cycle of operation of the register is started. The call forwarding apparatus further comprises a plurality of additional control relays including the relay R145 for operatively associating the apparatus to respond to calls incoming to the line 10, an alternating current relay R150 which is operative to initiate the operation of the apparatus in response to ringing current transmitted over the line 10, a slow-to-release relay R110 which is controlled by the two relays R145 and R150 and is operative to complete a calling loop circuit from the repeating coil 160 to the line switch 22, a pulsing relay R130, a slow-to-release impulse responsive relay R135, a control relay R140, and a slow-to-release back bridge relay R155 of the permanent magnet polarized type which only operates when a forwarded call is answered at the substation to which the call is routed. The impulse responsive line selecting switch 165 is of the well-known rotary type. Briefly described, this switch comprises three sets of contacts 166 to 168, inclusive, of ten points each; three wipers 171 to 173, inclusive, individually associated with the contact sets in the order of enumeration, means comprising an operating magnet 176 and a ratchet and pawl mechanism, not shown, for driving the enumerated wipers over the contacts of their respective associated contact sets and two sets of off-normal springs 178 and 179, which are provided for control purposes described hereinafter. The impulse counting or sending control switch 180 and the digit sequence switch 185 are of the well-known minor type. In brief, the switch 180 comprises a single set of contacts, a wiper 181 associated with the contact set, means comprising a motor magnet 182 and a ratchet and pawl mechanism, not shown, for driving the wiper 181 over the contacts of the associated contact set and a release magnet 183 which is operative to cause the wiper 181 to be returned to its normal or home position. The digit sequence switch 185 similarly comprises a single set of bank contacts, a wiper 186 associated with the contact set, means comprising a motor magnet 187 and a ratchet and pawl mechanism, not shown, for

driving the wiper 186 over the contacts of the associated contact set and a release magnet 188 which is operative to cause the wiper 186 to be returned to its home position.

As indicated previously, the call forwarding apparatus just described is arranged to be controlled by the apparatus embodied in the control circuit 20, which control circuit is accessible to each of the first selector switches of the system. Briefly described, the control circuit 20 comprises a line relay R210, a slow-to-release hold relay R220, a control relay R230, a slow-to-release impulse responsive relay R240 and a call sequence relay network comprising the two relays R250 and R260. This control circuit has associated therewith two sources of alternating currents having different signaling characteristics; the current of one source being utilized in signaling over an established connection extending to the control circuit 20, that the call forwarding apparatus is conditioned to respond to calls incoming to the line 10, and the current of the other source being utilized in signaling over an established connection extending to the control circuit 20 that the call forwarding apparatus is not operatively associated with the line 10.

Referring now more particularly to the operation of the control circuit 20 and the call forwarding apparatus illustrated in Fig. 1, it will be apparent that with the start relay R145 deenergized such that the repeating coil 160 is disconnected from the line 10, calls may be routed to and from the substation A without interference occasioned by the associated call forwarding apparatus and without in any way initiating the operation of this apparatus. Further, if the relay R145 is operated such that the call forwarding apparatus is conditioned for operation, calls originating at the substation A may successfully be completed without interference occasioned by the call forwarding apparatus and, in addition, calls incoming to this substation may be answered at the substation even though operation of the call forwarding apparatus is initiated.

As indicated in the introductory portion of the specification, the call forwarding apparatus may be conditioned to respond to calls incoming to the line 10 by controlling the circuit 20 over any line of the system. For example, if the subscriber for whose service the substation A is provided is temporarily located at the substation B and desires that calls routed to the substation A be forwarded at the substation B, he may condition the call forwarding apparatus to forward calls to the substation B by initiating a call at the substation B and dialing a directory number of two digits. When the call is initiated at the substation B, the line switch 14 operates to select an idle one of the selector switches to which it has access. Assuming that the selector switch 16 is seized and, further, that the link line 25 extending to the control circuit 20 is terminated in the first contact set of the tenth level in each of the first selector switches, the calling party upon initiating the call and receiving the usual dial tone signal dials a first digit of ten impulses, causing the wipers of the selector switch 16 to be operated to a position opposite the tenth level of contacts. During the interdigit pause between the first and second digits, these wipers are rotated to engage the contacts terminating the conductors of the link line 25. In response to this operation, the line relay R210 is energized over the calling loop circuit and operates to complete, at RA211, an

obvious circuit for impressing ground potential upon the control conductor of the link line 25; thereby to maintain the selector switch 16 operated in the usual manner. When the link line 25 is seized by the selector switch 16, a circuit is completed for transmitting over the calling loop circuit a signal current which, when reproduced, informs the calling party that the call forwarding apparatus is at normal. The path traversed by this current may be traced as extending from one terminal of the signal current source by way of C256, RA254, the condenser 364, one side of the calling loop circuit, the receiver at the calling substation, the other side of the calling loop circuit, the upper winding of R210 and the exchange battery to the opposite terminal of the signal current source. At RA212, the relay R210 completes an obvious circuit for energizing the slow-to-release hold relay R220. The relay R220, upon operating, completes, at RA221, a multiple path extending through RA251 for impressing ground potential upon the control conductor of the link line 25. At RA222, the relay R220 prepares a circuit for energizing the relay R240 in series with the operating magnet 176. At RA223, the relay R220 completes a circuit extending by way of C196 for energizing the start relay R145. At RA224, the relay R220 completes a circuit for energizing the impulse sending relay R125, this circuit extending from ground by way of RA224, C198, RA123 and the winding of R125 to battery. When energized over this circuit, the relay R125 attracts its weighted armature 126 thus conditioning this armature for vibration when the operating circuit just traced is subsequently interrupted. A branch of the last-mentioned circuit extends by way of RA113 and the winding of R100 to battery, thereby to energize the last-mentioned relay.

The relay R145, at its armatures RA146 and RA147, connects the line terminals of the repeater windings 161 and 162 to the conductors of the line 10, thereby to condition the alternating current relay R150 to respond to ringing current transmitted over the indicated line. At RA148, the relay R145 prepares a circuit traced hereinafter for energizing the slow-to-release relay R110. The relay R100, upon operating, attracts its weighted armature RA101 to complete an obvious circuit for energizing the slow-to-release relay R105. The relay R105, upon operating, opens, at RA108, a point in the circuit traced hereinafter for energizing the release magnet 188. At RA107, the relay R105 opens a point in the operating circuit for the relay R115. At RA106, the relay R105 prepares a holding circuit for the relay R110. Following the operation of the relays R210, R220, R145, R100, R105 and R125, the call forwarding apparatus and the control circuit 20 are conditioned to respond to the impulses of the second digit dialed at the substation B. The numerical value of this second digit determines the substation to which calls incoming to the line 10 will be forwarded. Thus, each vertical row of bank contacts embodied in the line selecting switch 165 corresponds to a particular one of the substations; the contact of each vertical row which is included in the contact set 168 determining, by its cross connection to one of the contacts of the impulse counting switch 190, the number of impulses of the first digit of the directory number designating the corresponding substation; the contact of the same vertical row and included in the contact set 167 determining, by its cross connection to one of

the contacts of the impulse counting switch 180, the number of impulses of the second digit; and the contact of the same vertical row included in the contact set 166 determining, by its cross connection to one of the contacts of the impulse counting switch 180, the number of impulses of the third digit. For example, if the second vertical row of contacts in the switch 165 corresponds to the substation B and the directory number of this substation is 324, the connections illustrated in Fig. 1 of the drawings may be used. More particularly, the second contact of the contact set 168 is connected to the third contact of the contact set embodied in the switch 180; the second contact of the contact set 167 is connected to the second contact of the contact set embodied in the switch 180; and the second contact of the set 166 is connected to the fourth contact of the contact set embodied in the switch 180. It will be clearly apparent that the other vertical rows of contacts embodied in the contact bank of the switch 165 and individually corresponding to other substations to which calls may be forwarded are cross connected to the bank contacts of the switch 180 in different manners depending upon the numerical values of the digits of the directory numbers designating the respective corresponding substations. It will also be apparent that by increasing the number of contact sets in the line selecting switch 165, the register may be arranged to transmit more than three trains of impulses during each call forwarding operation. In view of the immediate preceding explanation, it will be understood that in order to cause calls incoming to the line 10 to be forwarded to the substation B, the wipers 171 to 173, inclusive, of the switch 165 must be positioned upon their respective associated second contacts. To this end, a second digit of two impulses is dialed at the calling substation B. At the beginning of the open circuit period of the first impulse of this digit, the line relay R210 restores to open, at RA211, the initially completed path for impressing ground potential upon the control conductor of the link line 25. At RA212 and its associated working contact, the relay R210 opens the operating circuit for the relay R220. The latter relay, due to its slow-to-release characteristic, remains operated during impulsing. At RA212 and its associated resting contact, the relay R210 completes the previously mentioned circuit for energizing the slow-to-release relay R240 in series with the winding of the operating magnet 176, this circuit extending from ground by way of RA212, RA222, RA231, the winding of R240, C154 and the winding of the magnet 176 to battery. When energized over this circuit, the relay R240 immediately operates to open, at RA241, a point in the circuit traced hereinafter for energizing the control relay R230. Due to its slow-to-release characteristic, the relay R240 remains operated during the impulses of the impulse train transmitted to the control circuit 20 and only releases shortly following the end of this impulse train. At the end of the open circuit period of the first impulse, the relay R210 reoperates to recomplete the operating circuit for the hold relay R220, to recomplete, at RA211, the path for impressing ground potential upon the private conductor of the link line 25, and to interrupt the above-traced circuit for energizing the relay R240 and the operating magnet 176 in series. When energized and deenergized in this manner, the magnet 176, in cooperation with its associated ratchet and

pawl mechanism, functions to advance the wipers 171 to 173, inclusive, one step from normal and into engagement with their respective associated first contacts. When these wipers are stepped to the first off-normal position, the off-normal springs 178 are moved into engagement to prepare a circuit traced hereinafter for energizing the magnet 176 during the release of the apparatus. The off-normal springs 179 are also moved into engagement in response to operation of the wipers 171 to 173, inclusive, to the first off-normal position. When these latter off-normal springs are engaged, a circuit is prepared for energizing the control relay 230. The line relay R210 functions to repeat the additional impulses of the second digit to the operating magnet 176 of the switch 165 in the exact manner just described with reference to the first impulse of this digit. Since the wipers 171 to 173, inclusive, are stepped at the rate of one step for each impulse, it will be apparent that in the case under consideration wherein a second digit of only two impulses is dialed at the substation B these wipers are left standing in engagement with their respective associated second contacts, which contacts correspond to the substation B.

At the end of the second digit, the line relay is held energized over the calling loop circuit until the connection is released at the substation B. With this relay operated, the above-traced circuit serially including the winding of the relay R240 and the winding of the magnet 176 is opened. Accordingly, the relay R240 restores shortly following the end of the digit to complete the above-mentioned circuit for energizing the control relay R230, this circuit extending from ground by way of the off-normal springs 179, RA241 and the winding of R230 to battery. When energized over this circuit, the relay R230 operates to open, at RA231 and its associated resting contact, a further point in the circuit for energizing the relay R240 and the magnet 176 in series. At RA231 and its associated working contact, the relay R230 prepares a circuit for energizing the relay R250. At RA232, the relay R230 completes a holding circuit for the hold relay R220, this circuit extending from ground by way of RA262, RA232 and the winding of R220 to battery.

After dialing the two digits required to condition the call forwarding apparatus for operation and to select the substation to which calls incoming to the line 10 are to be forwarded, the calling party at the substation B may release the connection extending to the control circuit 20. To this end, the receiver provided at the substation B is restored to its supporting hook or cradle with the result that the calling loop circuit extending through the windings of the line relay R210 is interrupted. When deenergized in this manner, the relay R210 restores to open, at RA211, the initially completed path for impressing ground potential upon the control conductor of the link line 25. At RA212 and its associated working contact, the relay R210 interrupts the operating circuit for the relay R220. At RA212 and its associated resting contact, the relay R210 completes the above-mentioned circuit for energizing the relay R250, this circuit extending from ground by way of RA212, RA222, RA231, RA261 and the winding of R250 to battery. Upon operating, the relay R250 completes, at RA252, a path for short-circuiting the winding of R260, this path extending from ground by way of the off-normal springs 179,

RA252, the winding of R260, RA261, RA231, RA222 and RA12 back to ground. At RA251, the relay R250, upon operating, interrupts the previously traced alternative path over which ground potential is impressed upon the control conductor of the link line 25. In response to the last-mentioned operation, the selector switch 16 and the line switch 14 are released in the usual manner. Thus, the connection extending to the control circuit 20 is fully released and the automatic switches utilized in completing the connection are conditioned for further use. At RA254, the relay R250 opens a point in the above-traced circuit for transmitting normal tone signaling current by way of the link line 25 and prepares a circuit for transmitting over this link line to the calling substation signaling current which will indicate by its reproduction that the call forwarding apparatus is conditioned for operation. At RA253, the relay 20 250 prepares a circuit for transmitting to the substation A signaling current which, when reproduced, will serve to inform a calling party at the substation A that the call forwarding apparatus is conditioned to respond to calls incoming to the line 10.

With the apparatus in this condition, if the subscriber for whose services the substation A is provided returns to this substation and initiates a call thereat, the last-mentioned signaling circuit is completed, so that the subscriber is informed that the call forwarding apparatus is conditioned for operation and may take the necessary steps to release this apparatus in the manner pointed out hereinafter. More particularly, the last-mentioned signaling circuit is completed immediately the receiver provided at the substation A is removed from its supporting hook or cradle, this circuit extending from one terminal of the off-normal tone current source by way of C255, RA253, C197, the condenser 174, RA158', RA152, RA146, the upper side of the line 10, the receiver provided at the substation A, the lower side of the line 10, the winding of the line relay embodied in the line switch 13 and the exchange battery to the opposite terminal of the off-normal tone current source.

After the call forwarding apparatus has been conditioned for operation in the manner just explained, all calls incoming to the line 10 are forwarded to the substation B through operation of this apparatus and operation of the automatic switch apparatus embodied in the exchange. For example, if a call intended for the substation A is initiated at the substation C and is routed through the line switch 15, the selector switch 17 and the connector switch 19 to the line 10 at a time when the line 10 is idle, the control apparatus of the last-mentioned switch operates in the manner previously explained to transmit ringing current over the line 10 for the purpose of energizing the signal device provided at the called substation A. A portion of this ringing current is by-passed through the winding of the alternating current relay R150 over a circuit which may partially be traced as extending by way of the upper conductor of the line 10, RA146, the repeater winding 162, the condenser 175, the winding of R150, the repeater winding 161, RA147, and the lower line conductor of the line 10. When energized over this circuit, the line relay R150 operates to open, at RA152, the above-traced circuit for transmitting off-normal tone signaling current to the

substation A. At RA151, the relay R150 completes a circuit extending by way of RA148, RA139 and RA121' for energizing the slow-to-release relay R110. The relay R110, upon operating, completes, at RA111, an obvious holding circuit for itself. At RA112, the relay R110 completes a calling loop circuit including the link line 21 and extending to the line switch 22. This loop circuit may partially be traced as extending by way of the upper conductor of the line 21, the repeater winding 163, the winding of R155, the repeater winding 164, RA112, RA131 and the lower conductor of the link line 21. In response to the completion of this loop circuit, the line switch 22 operates to seize an idle one of the selector switches, such, for example, as the selector switch 16, to which it has access and to extend the loop circuit thereto. At RA113, the relay R110, upon operating, opens the previously traced operating circuit for the relay R100 and prepares a circuit for energizing the relay R115. When the winding of the relay R100 is deenergized, the weighted armature 101 is released and starts vibrating alternately to engage its two associated contacts. Due to its slow-to-release characteristic, the relay R105 is held in its operated position until the vibratory movement of the armature 101 is substantially ended. When the amplitude of movement of this armature is sufficiently reduced so that it no longer engages its two associated contacts, the relay R105 is deenergized and restores. Upon restoring, the relay R105 opens, at RA106, the above-traced holding circuit for the relay R110 causing the last-mentioned relay to restore after an interval; provided ringing current is not being transmitted over the line 10. At RA108, the relay R105 completes the above-mentioned circuit for energizing the release magnet 188, this circuit extending from ground at RA224 by way of C198, RA113, RA121, RA108, and the winding of the magnet 188 to battery. The resulting operation of the release magnet causes the wiper 186 of the digit sequence switch 185 to be returned to its normal position. At RA107, the relay R105, upon restoring, completes the previously mentioned circuit for energizing the relay R115, this circuit extending from ground at RA224 by way of C198, RA113, RA107 and the winding of R115 to battery. When energized over this circuit, the relay R115 attracts its weighted armature 116 to complete a circuit extending by way of RA156 for energizing the slow-to-release relay R120. The relay R120, upon operating, opens, at RA121, the above-traced circuit for energizing the release magnet 188. At RA122, the relay R120 short-circuits the operated armature RA112 of the relay R110, it being noted that the relay R120 operates prior to the release of the relay R110 in the manner described above. At RA121', the relay R120 opens a point in the above-traced operating circuit for the relay R110. At RA122', the relay R120 completes an obvious circuit for energizing the vibratory relay R133. The latter relay, in turn, attracts its weighted armature to complete an obvious circuit for energizing the slow-to-release relay R138. The relay R138, upon operating, opens, at RA139, a further point in the above-traced operating circuit for the relay R110. Thus, the relay R110 is prevented from reoperating in response to operation of the relay R150 during the interval when the call is being forwarded to the substation B and for a predetermined time interval thereafter. In this re-

gard, it will be understood that the relay R150 operates each time a splash of ringing current is transmitted over the line 10. During the interval when the relay R110 is operated, the successive operations of the relay R150 are without effect aside from the completion of a multiple circuit for energizing the first-mentioned relay. After the relay R110 is released, following operation of the relays R120 and R138, the operation of the relay R150 is obviously without effect. The relay R110, upon restoring, re completes, at RA113, the previously traced operating circuit for the relay R100 causing the latter relay to attract its weighted armature 101 and thereby complete the operating circuit for the relay R105. The relay R105, upon reoperating, reprepares, at RA106, the holding circuit for the relay R110, interrupts at RA107 the operating circuit for the relay R115 and opens, at RA108, a point in the previously traced circuit for energizing the release magnet 188. When the relay R115 is deenergized in this manner, the weighted armature 116 controlled thereby starts vibrating intermittently to complete the above-traced operating circuit for the relay R120. Due to its slow-to-release characteristic, however, the latter relay does not restore at this time.

The relay R120, upon operating in the manner described above, also functions to initiate the operation of the register to transmit over the established calling loop circuit the impulses of the directory number designating the station B to which the call is to be forwarded. More particularly, the relay R120 opens, at RA123 and its associated resting contact, a point in the above-traced operating circuit for the impulse sending relay R125. At RA123 and RA124, the relay R120 prepares a circuit, traced hereinafter, for energizing the slow-to-release relay R140. When the relay R125 is deenergized, the weighted armature 126 controlled thereby is released and swings through its retracted position to engage its associated back contact and to release the armature 127 so that this latter armature also engages its back contact. In response to the latter operation, an alternative circuit is completed for energizing the winding of the relay R125, this circuit extending from ground at RA224 by way of C198, the armature 127 and the winding of R125 to battery. In response to the completion of this circuit the weighted armature 126 is again attracted so that this armature is moved to its operated position to disengage its associated back contact and to move the armature 127 out of engagement with its associated resting contact. Thus, the alternative circuit for energizing the relay R125 is interrupted. By virtue of the completion of this alternative circuit, upon each back stroke of the weighted armature 126, this armature and the armature 127 are vibrated between two positions until a holding circuit for the relay R125 is subsequently completed. Each time the armature 126 engages its associated back contact, a circuit is completed for energizing the pulsing relay R130, this circuit extending from ground at RA224 by way of C198, the armature 126 and the winding of R130 to battery. This circuit is obviously interrupted to cause the release of the pulsing relay R130 each time the weighted armature 126 is attracted to its operated position. Thus, the relay R130 functions to transmit impulses by way of the loop circuit extending by way of the link line 21 to the line switch 22. Each time the relay R130 operates, it also functions to complete an

obvious circuit for energizing the relay R135 in series with the operating magnet 182. The relay R135 operates at the beginning of the first impulse transmitted through operation of the pulsing relay R130 and, due to its slow-to-release characteristic, remains operated until the digit of impulses is ended. Upon operating, the relay R135 prepares, at RA136, a holding circuit for the relay R140; prepares, at RA136', a circuit for energizing the operating magnet 187 and prepares, at RA137, a circuit for energizing the release magnet 183. At RA135', the relay R135 completes an obvious alternative circuit for energizing the relay R115, which latter relay is still vibrating intermittently to complete the operating circuit for the relay R120. When this alternative circuit is completed the relay R115 holds its weighted armature 116 in the attracted position so that the operating circuit for the relay R120 is not interrupted during impulsing. Each time the operating magnet 182 is energized by a current pulse transmitted thereto through operation of the pulsing relay R130, it operates to advance the wiper 181 one step. Thus, the switch 180 functions as an impulse counting switch for the purpose of determining the number of impulses transmitted during each digit. More particularly, when the wiper 181 is, during its first cycle of operation, operated into engagement with its associated third contact, the above-mentioned circuit is completed for energizing the relay R140, this circuit extending from ground at RA224 by way of C198, RA123, RA124, the wiper 186, the wiper 173 and its associated second contact, the third contact of the set associated with the wiper 181, the wiper 181 and the winding of R140 to battery. When energized over this circuit, the relay R140 operates to complete, at RA141, an obvious circuit for maintaining the relay R125 energized. Thus, the relay R125 is held in its operated position so that the pulsing relay R130 remains in its restored position and the impulses of the first digit are terminated. At RA142, the relay R140, upon operating, completes a holding circuit for itself, this holding circuit extending from ground by way of RA136, RA142 and the winding of R140 to battery. At RA144, the relay R140 completes a circuit for energizing the release magnet 183, this circuit extending from ground at RA137 by way of RA144 and the winding of the magnet 183 to battery. When energized over this circuit, the magnet 183 operates to cause the wiper 181 to be returned to its normal position, thus interrupting the above-traced operating circuit for the relay R140. At RA143, the relay R140 completes a circuit extending by way of RA136' for energizing the operating magnet 187 of the digit sequence switch 185. When energized over this circuit, the magnet 187 operates to advance the wiper 186 one step so that it is moved out of engagement with its associated first contact and into engagement with its associated second contact. Shortly following the operation of the relay R140, the slow-to-release relay R135 restores to open, at RA136, the holding circuit for the relay R140; to interrupt, at RA136', the operating circuit for the motor magnet 187; and to open, at RA137, the circuit for energizing the release magnet 183. At RA135', the relay R135, upon restoring, also interrupts the above-mentioned alternative circuit for energizing the relay R115 with the result that this relay is deenergized and vibration of the weighted armature 116 controlled thereby is again initiated. Short-

ly following the release of the relay R135, the relay R140 restores to open further points in its holding circuit and the operating circuits for the magnet 187 and the release magnet 183. At RA141, the relay R140 opens the holding circuit for the relay R125, whereby the periodic movement of the weighted armature 126 carried by the latter relay is again initiated. Thus, the operation of the pulsing relay R130 to transmit to the operated switch train the impulses of the second digit is started. At the beginning of the first impulse of this second digit when the circuit for energizing the magnet 182 in series with the relay R135 is again completed, the relay R135 reoperates to again complete, at RA135', the alternative circuit for energizing the relay R115. Accordingly, the weighted armature 116 controlled by the relay R115 is held in its attracted position to maintain the operating circuit for the relay R120 completed. When the wiper 181 has been stepped two steps so that it stands in engagement with its associated second contact, an alternative circuit is completed for energizing the relay R140, this circuit extending by way of the grounded conductor C198, RA123, RA124, the wiper 186 and its associated second contact, the wiper 172 and its associated second contact, the second contact of the set associated with the wiper 181, the wiper 181 and the winding of R140 to battery. The relay R140, upon operating, again completes the holding circuit for the relay R125, thereby to arrest the operation of this relay and the pulsing relay R130, and completes the previously traced operating circuits for the operating magnet 187 and the release magnet 183. As a result, the wiper 181 is returned to its normal position and the wiper 186 is advanced into engagement with its associated third contact. Shortly thereafter, the relays R135 and R140 sequentially restore in the manner explained above, the latter relay functioning to open, at RA141, the holding circuit for the relay R125 so that vibratory movement of the weighted armature 126 is again initiated. Thus, the operation of the pulsing relay R130 to transmit the impulses of the third digit of the directory number designating the substation B is started. During operation of the pulsing relay to transmit these impulses, the wiper 181 is again advanced step by step at the rate of one step for each impulse; it being understood that the relay R130 reoperates at the beginning of the first impulse of the digit to perform the functions previously described. When the wiper 181 is moved into engagement with its associated fourth contact, corresponding to a digit of four impulses, a second alternative circuit is completed for energizing the relay R140, this circuit extending by way of the grounded conductor C198, RA123, RA124, the wiper 186 and its associated third contact, the wiper 171 and its associated second contact, the fourth contact of the set associated with the wiper 181, the wiper 181 and the winding of R140 to battery. When energized over this circuit, the relay R140 again operates to complete, at RA141, the holding circuit for the relay R125; thus terminating the vibratory movement of this latter relay and the operation of the pulsing relay R130. The relay R140 also completes the previously traced circuits for energizing the release magnet 183 and the operating magnet 187, thus causing the wiper 181 to be returned to its home position and the wiper 186 to be advanced into engagement with its associated fourth contact. When

the wiper 186 is stepped into engagement with its associated fourth contact, an alternative holding circuit is completed for the relay R140, this circuit extending by way of the grounded conductor C198, RA123, RA124, the wiper 183 and its associated fourth contact, RA142 and the winding of R140 to battery. Thus, the relay R140 is prevented from releasing in response to restoration of the relay R135 which occurs shortly following the operation of the relay R140 at the end of the third series of impulses. With the relay R140 held in its operated position the impulse sending relay R125 is also energized so that the pulsing relay R130 is maintained in its restored position. Thus, the transmission of impulses from the register equipment is terminated.

When the relay R135 restores shortly following the end of the third series of impulses transmitted from the register equipment it opens, at RA135', the above-traced alternative circuit for energizing the relay R115. Accordingly, vibration of the weighted armature 116 controlled by the relay R115 is again initiated. As explained above, the relay R120, due to its slow-to-release characteristic, does not restore until the amplitude of movement of the armature 116 is sufficiently reduced so that this armature no longer engages either of its two associated contacts. The purpose of this arrangement is to provide an interval during which the called substation, as selected by the automatic switching apparatus in response to the impulses transmitted thereto from the register equipment, may be signaled and the call answered. In this regard, it will be apparent from the preceding description that the selector switch 16 seized by the line switch 22 responds to the impulses of the first digit transmitted thereto from the register equipment by operating to select the group of connector switches having access to the called line 11. During the interdigit pause between the first and second digit, this selector switch operates to select an idle one of the selected group of switches, such, for example, as the connector switch 18, and to extend the calling loop circuit to the last-mentioned switch. The connector switch 18, in turn, responds to the impulses of the second and third digits by operating in the manner previously explained to select the line 11 to which the call is to be routed. If this line is busy at the time it is thus selected, busy tone current is returned over the calling loop circuit extending to the repeater 160 and a portion thereof is repeated by induction to the loop circuit extending through the connector switch 19, the selector switch 17 and the line switch 15 to the calling substation C. This signal is intermixed with the ring-back tone signal being transmitted to the calling subscriber, but may be sufficiently discernible to inform the calling party that the called line is busy. In the event the line 11 to which the call is forwarded is idle at the time it is selected by the connector switch 18, the control apparatus of this connector switch functions in the manner previously explained to transmit ringing current over the line 11 for the purpose of energizing the signal device provided at the substation B. The desired conversational circuit between the substations B and C is completed when the call is answered at the substation B. More particularly, when the receiver provided at the last-mentioned substation is removed from its supporting hook or cradle, the usual direct current

bridge is connected across the conductors of the line 11 so that the ring cut-off and back bridge relays embodied in the connector switch 18 sequentially operate. The back bridge relay, upon operating, functions to reverse the direction of current flow over the loop circuit extending to the repeater 160 with the result that the polarized relay R155 operates. Upon operating, the relay R155 completes, at RA158, an obvious path shunting the operated armature RA122, thereby to maintain intact the loop circuit extending through the line switch 22 when the relay R120 is subsequently released. At RA157, the relay R155 completes an obvious path for short-circuiting the condenser 175, thus establishing a direct current bridge across the conductors of the line 10. In response to this operation, the ring cut-off and back bridge relays embodied in the connector switch 19 are caused to operate in the usual manner. The ring cut-off relay of this connector switch, upon operating, arrests the ringing operation being performed by the switch, terminates the ring-back signal being transmitted to the calling substation C, and completes the desired conversational circuit between the substations B and C. When the ringing operation of the connector switch 19 is ended, the intermittent operation of the relay R150 is terminated and this relay remains in its restored position.

The back bridge relay R155, upon operating, also functions to interrupt, at RA156, the previously traced operating circuit for the slow-to-release relay R120. At RA158', the relay R155, upon operating, opens a point in the previously traced circuit for transmitting off-normal tone signal current over the line 10. When the relay R120 restores its functions to reprepare, at RA121', the operating circuit for the relay R110 and to reprepare, at RA121, the above-traced operating circuit for the release magnet 188. At RA122', the relay R120 opens the operating circuit for the relay R133, thereby to cause the sequential restoration of the last-mentioned relay and the relay R138. At RA122, the relay R120 opens the path shunting the operated armature RA158. At RA123 and its associated resting contact, the relay R120 re completes the previously traced multiple holding circuit for the impulse sending relay R125. At RA123 and RA124, the relay R120 interrupts the above-traced alternative holding circuit for the relay R140, causing the latter relay to restore after an interval. Upon restoring, the relay R140 opens, at RA141, the multiple holding circuit for the impulse sending relay R125. Following the release of the relays R150, R120, R133, R140 and R138, in the manner just explained, no further operation of the call forwarding apparatus occurs until the connection is released.

The manner in which the operated switches 15, 17 and 19 are released when the connection is cleared out at the calling substation C is exactly the same as described previously with reference to the call originating at the substation A. When the connection is cleared out at the substation B, the back bridge relay embodied in the connector switch 18 functions to again reverse the direction of current flow over the loop circuit extending to the repeater 160. Accordingly, the polarized back bridge relay R155 restores to interrupt, at RA158, the loop circuit extending through the switches 22 and 16 to the connector switch 18. When this loop circuit is interrupted the operated switches 18, 16 and 22

are released in the order named and in the exact manner described previously with reference to the call originating at the substation A. At RA157, the relay R155, upon restoring, interrupts the path short-circuiting the condenser 175. At RA156, the relay R155 reprepares the operating circuit for the relay R120. At RA158', the relay R155 reprepares the circuit for transmitting off-normal tone signal current over the line 10. Following the release of the relay R155, the call forwarding apparatus is fully restored to normal and is conditioned to respond to another call routed to the line 10. In this regard, it will be noted that the relays R145, R125, R100 and R105 are maintained in their respective operated positions after the connection as routed to the substation B through operation of the call forwarding apparatus is released. It will further be noted that the digit sequence switch 185 is not restored to normal during the release of the call forwarding apparatus. When, however, another call is routed to the line 10 to cause the sequential operation of the relays R150 and R110, in the manner explained above, the previously traced circuit for energizing the release magnet 188 is completed immediately the relay R110 operates. Thus, the digit sequence switch 185 is released during the initial response of the call forwarding apparatus in its operation to perform a call forwarding operation.

If the above-described call, initiated at the substation C and intended for the substation A, is abandoned during the interval when the call forwarding apparatus is operating to route a connection from the line 10 to the substation B, this apparatus continues its operation even though the connection as set up between the substation C and the line 10 is released. Under such conditions, if the call is answered at the substation B during the interval which elapses between the release of the relay R115 and the release of the relay R120, the back bridge relay R155 is caused to operate and a connection is fully completed between the repeating coil 160 and the telephone provided at the substation B. When the answering party challenges the connection and fails to obtain a response from the calling party, he is informed that the call has been abandoned and may initiate the release of the switch train through which the connection is routed from the repeating coil 160 to the line 11 by hanging up, thereby to cause the release of the back bridge relay R155 in the manner pointed out above. When this relay restores, the calling loop circuit extending from the repeating coil 160 to the operated connector switch of the train is interrupted and the switches included in the train are restored to normal in the above-described manner.

As indicated previously, the call as routed from the substation C to the substation A may be answered at the last-mentioned substation even though the call forwarding apparatus is conditioned for operation. In such case, when the receiver provided at the substation A is removed from its supporting hook or cradle, a direct current bridge is connected across the conductors of the line 10 to arrest the ringing operation being performed by the connector switch through which the connection extends and thus prevents further operation of the alternating current relay R150. When the call is answered in this manner, the previously traced circuit is completed for conducting the off-normal tone signal current through the receiver provided at the substation

A, so that the answering party is informed that the call forwarding apparatus is conditioned for operation. In the case under consideration, operation of this apparatus is initiated when ringing current is first transmitted over the line 10 and this apparatus operates to forward the connection to the substation B, or to another substation designated by the setting of the line selecting switch 165. Assuming that the call is answered at the last-mentioned substation, a three-way talking circuit is established between the substations A and C and the third substation to which the call is forwarded. The completion of this three-way talking circuit in no way prevents the release of the two operated switch trains when the conversation is terminated and the three parties hang up.

The arrangement is such that if the above-described call initiated at the substation C is not abandoned by the calling party and the call as forwarded through operation of the call forwarding apparatus to the substation B is not answered during the interval which elapses between the release of the relay R115 and the release of the relay R120, the connection through which the call is forwarded to the substation B is released and a second cycle of operation of the call forwarding apparatus is initiated so that a second connection is routed to the line 11. Thus, when the transmission of impulses to the automatic switching apparatus of the exchange is ended, the relay R115 is deenergized in the manner previously described so that vibration of its associated armature 116 is initiated. When the amplitude of vibration of this armature is sufficiently reduced so that it no longer engages either of its two associated contacts, the operating circuit for the relay R120 is interrupted. Upon restoring, the relay R120 reprepares, at RA121', the operating circuit for the relay R110 and, at RA121, the operating circuit for the release magnet 188. At RA122, the relay R120 interrupts the loop circuit, extending by way of the link line 21 and through the line switch 22 and the selector switch 16 to the connector switch 18, thereby to initiate the release of these three switches. At RA123 and RA124, the relay R120 opens the previously traced alternative holding circuit for the relay R140, causing the last-mentioned relay to restore. At RA123 and its associated resting contact, the relay R120 completes the previously traced holding circuit for the relay R125. At RA122', the relay R120 opens the operating circuit for the relay R133. When the relay R133 is deenergized, its weighted armature 134 is released and starts vibrating alternately to engage its two associated contacts. Due to its slow-to-release characteristic, the relay R138 does not restore until the amplitude of vibration of the weighted armature 134 is sufficiently reduced so that it no longer engages either of its two associated contacts. The period during which the armature 134 vibrates to hold the relay R135 operated is sufficient to insure the full release of the switch train through which the connection is forwarded to the substation B. When the relay R138 finally restores it further prepares, at RA139, the operating circuit for the relay R110. Thereafter and during the next period when ringing current is transmitted over the line 10 to cause the operation of the relay R150, the operating circuit for the relay R110 is again completed. The relay R110, upon operating, re completes its holding circuit, re completes the loop circuit extending to the line switch 22 and interrupts the operating circuit for the relay R100. At

RA113, the relay R110 completes the previously traced circuit for energizing the release magnet 188, whereby the wiper 186 of the switch 185 is returned to its home position. From this point on, the manner in which the call forwarding apparatus operates to again route a connection to the line 11 is exactly the same as described previously. From the foregoing explanation it will be apparent that the call forwarding apparatus functions repeatedly to forward a call through the automatic switching apparatus of the exchange to the substation designated by the setting of the line selecting switch 165 until the call is answered at the last-mentioned substation or is abandoned at the calling substation. In this regard, it will be apparent that if a call as forwarded to the substation B, for example, is not answered at this substation and the call is abandoned at the calling substation, the call forwarding apparatus will be released and conditioned for further operation in response to the operation of the relay R115 to interrupt the operating circuit for the relay R120 and, thus, cause the sequential release of the relays R120, R133, R140 and R138 in the manner described above.

In order to render the call forwarding apparatus nonresponsive to calls routed to the line 10, it is necessary that a second connection be routed to the control circuit 20 and then released. For example, if the subscriber for whose service the substation A is provided returns to this substation and attempts to initiate a call, he is informed by the off-normal tone signal reproduced by the receiver provided at this substation and transmitted to the substation over the circuit previously traced that the call for forwarding apparatus is conditioned for operation. Upon receipt of the off-normal tone signal, the subscriber may cause a connection to be forwarded to the control circuit 20 by dialing the single digit required to cause one of the selector switches to seize this circuit. Assuming, for example, that the connection is routed through the line switch 13 and the selector switch 16, when the selector switch operates to seize the link line 25 and extends the calling loop circuit by way of this link line through the windings of the line relay R210, the indicated line relay operates to complete, at RA211, the path for connecting the control conductor of the link line to ground, thereby to maintain the selector switch 16 operated. When the control circuit 20 is seized the above-traced circuit is completed for transmitting signal current to the calling substation. In the present case, with the relay R250 operated, this circuit is energized by the off-normal tone current, thereby to indicate that the call forwarding apparatus is conditioned for operation. At RA212, the relay R210 re completes the operating circuit for the slow-to-release hold relay R220 and interrupts the previously traced path short-circuiting the winding of the relay R260. When this path is interrupted, the two relays R250 and R260 are energized in series over a circuit extending from ground by way of the off-normal springs 179, RA252, the winding of R260 and the winding of R250 to battery. The relay R250 remains operated so long as it is energized over this circuit. When this circuit is completed, the relay R260 operates to open, at RA261, a point in the operating circuit for the relay R250 and a point in the above-traced short-circuiting path. At RA262, the relay R260 opens a point in the previously traced holding circuit for the relay R220.

When the connection as routed from the substation A to the control circuit 20 is released, the

line relay R210 restores to disconnect the control conductor of the link line 25 from ground and thus initiate the release of the selector switch 16 and line switch 13. At RA212, the relay R210 interrupts the operating circuit for the hold relay R220, causing the last-mentioned relay to restore after an interval. Upon restoring, the relay R220 interrupts, at RA223, the previously traced operating circuit for the relay R145, causing the latter relay to restore and disconnect the repeater 160 from the conductors of the line 10. At RA224, the relay R220 disconnects the release conductor C198 from ground, thereby to deenergize the relays R100 and R125 and to open a point in the operating circuit for the pulsing relay R130. The relay R100, at its armature 101, interrupts, after an interval, the operating circuit for the relay R105. Thus, all of the relays illustrated in Fig. 1 are restored to normal. At RA222, the relay R220, upon restoring, completes an alternative circuit for energizing the operating magnet 176 of the line selecting switch 165. This circuit extends from ground at RA212 by way of RA222, C153, the off-normal springs 178, the armature 177 and the winding of the magnet 176 to battery. Due to the circuit interrupting action of the contacts associated with the armature 177, the magnet 176 operates buzzer fashion and in cooperation with its associated ratchet and pawl mechanism functions to drive the wipers 171 to 173, inclusive, back to the normal position. When these wipers are returned to normal, the off-normal springs 178 are disengaged to open the above-traced alternative circuit for energizing the magnet 176, thereby to arrest the stepping operation of the wipers. When the indicated wipers are returned to normal, the off-normal springs 179 are also moved out of engagement to interrupt the previously traced operating circuit for the relay R230 and the above-traced circuit serially including the windings of the two relays R250 and R260. Thus, all of the relays included in the control circuit 20 are released and this circuit is conditioned for seizure in response to another connection routed thereto. After the wipers of the switch 165 have been returned to normal, the call forwarding apparatus is fully released and, since the repeater 160 is no longer connected to the conductors of the line 10, is nonresponsive to calls incoming to this line.

The apparatus illustrated in Fig. 3 of the drawings is adapted to be used in lieu of the control circuit 20 for the purpose of controlling the call forwarding apparatus illustrated in Fig. 1. More particularly, this apparatus comprises an auxiliary line 301 which is adapted to extend between a substation, such, for example, as the substation A, arranged for call forwarding service, and the call forwarding apparatus provided in the central exchange in association with the line extending to the substation arranged for call forwarding service. The apparatus further comprises an auxiliary impulsing device 300 and a start key 305 both of which are provided at the substation. In the central exchange the auxiliary line 301 terminates at the windings of the line relay R310 which is arranged to control a slow-acting hold relay R320. In order to adapt the apparatus shown in Fig. 3 for use in conjunction with the call forwarding apparatus illustrated in Fig. 1, when the latter apparatus is connected to serve the substation A, the auxiliary impulsing device 300 and the start key 305 are conveniently installed at the substation A

in any desired manner. The line 301 is connected between this substation and the call forwarding apparatus, and the relays R310 and R320 are conveniently assembled with the other elements of the call forwarding apparatus located in the central exchange. In the central exchange the terminals 191 to 194, respectively, are connected to the terminals 330 to 333. The control circuit 20, including the off-normal springs 179 forming a part of the line selecting switch 165, may thus be dispensed with. Further, the above-described signaling circuit, provided for the transmission of off-normal tone signal current over the line 10, is no longer required and may be omitted from the apparatus since the position of the key 305, which is of the locking type, serves visually to indicate whether or not the call forwarding apparatus is conditioned for operation.

With the apparatus illustrated in Fig. 3 substituted for the control circuit 20 in the manner described in the preceding paragraph, if the subscriber for whose service the substation A is provided desires to condition the call forwarding apparatus to respond to calls incoming to the line 10, he may do so by operating the key 305 to its off-normal position and operating the calling device 300 in accordance with the numerical value of the digit designating the substation to which the calls incoming to the line 10 are to be forwarded. When the springs of the key 305 are moved into engagement, through operation of this key to its off-normal position, an obvious circuit including the conductors of the line 301 and extending by way of the pulsing springs embodied in the calling device 300 is completed for energizing the line relay R310. The relay R310, upon operating, opens, at RA311 and its associated resting contact, a point in the circuit traced hereinafter for energizing the magnet 176 during the release of the call forwarding apparatus. At RA311 and its associated working contact, the relay R310 completes an obvious circuit for energizing the slow-to-release hold relay R320. The relay R320, upon operating, opens, at RA321 and its associated resting contact, a further point in the circuit for energizing the magnet 176 during the release of the apparatus. At RA321 and its associated working contact, the relay R320 prepares a circuit for transmitting impulses to this magnet for the purpose of operating the switch 165 to the position corresponding to the substation to which calls are to be forwarded. At RA322, the relay R320 completes a circuit extending by way of the terminals 330 and 191 for energizing the relay R145, causing the latter relay to operate and prepare the previously traced circuit for energizing the relay R110 and connect the repeater 160 to the conductors of the line 10. At RA323, the relay R320 completes circuits commonly extending by way of the terminals 331 and 192, and substantially coincident with those previously traced, for energizing the relays R100 and R125, whereby these two relays and the relay R105 are caused to operate. Following the operation of the relays R310, R320, R145, R100, R105 and R125, in the manner just explained and during operation of the calling device 300, the relay R310 is caused alternately to restore and operate a number of times determined by the numerical value of the digit dialed. Each time the relay R310 restores it opens, at RA311, the operating circuit for the relay R320 and completes the above-mentioned circuit for energizing the magnet 176, this circuit extending from

ground by way of RA311, RA321, the terminals 333 and 194 and the winding of the magnet 176 to battery. Obviously, this circuit is interrupted and the operating circuit for the relay R320 is recompleted each time the relay R310 reoperates at the end of the open circuit period of an impulse transmitted thereto. Due to its slow-to-release characteristic, the relay R320 remains operated during impulsing. Each time the magnet 176 is energized and deenergized it functions in cooperation with its associated ratchet and pawl mechanism to advance the wipers 171 to 173, inclusive, one step. At the end of the digit, therefore, these wipers are left standing in engagement with the contacts corresponding to the numerical value of the digit and also to the substation to which calls are to be forwarded. At the end of the digit the line relay R310 is held energized over the loop circuit including the line 301 so that this relay and the relay R320 are held in their respective operated positions until the key 305 is returned to its normal position.

After the wipers of the switch 165 have been positioned in engagement with the contacts corresponding to the substation to which calls are to be forwarded, this apparatus responds to calls incoming to the line 10 by operating to cause the calls to be forwarded to the desired substation in the exact manner described previously with reference to the arrangement including the control circuit 20. In order to render the call forwarding apparatus nonresponsive to calls routed to the line 10, it is only necessary to restore the key 305 to its normal position. When the springs of this key are disengaged, the loop circuit including the windings of the line relay R310 is interrupted and this relay restores to open the operating circuit for the hold relay R320. The last-mentioned relay, upon restoring, completes, at RA321, the above-traced circuit for causing the wipers of the switch 165 to be returned to normal. This circuit extends from ground at RA311 by way of RA321, the terminals 332 and 193, the off-normal springs 178, the armature 177 and the winding of the magnet 176 to battery. Due to the circuit interrupting action of the contacts associated with the armature 177, the magnet 176 in cooperation with its associated ratchet and pawl mechanism, operates to return the wipers 171 to 173, inclusive, to normal at which time the springs 178 are disengaged to interrupt the above-traced release circuit and thus arrest the stepping operation of the wipers. Upon restoring, the relay R320 also opens, at RA322, the above-traced circuit for energizing the relay R145, causing the latter relay to restore and disconnect the windings of the repeater 160 from across the conductors of the line 10. At RA323, the relay R320 opens the above-traced operating circuits for the relays R180 and R125, causing both of these relays to restore. The relay R100, after an interval, opens the operating circuit for the relay R105, causing the last-mentioned relay to restore. Thus, the call forwarding apparatus is fully restored to normal and is rendered nonresponsive to calls routed through the automatic switching apparatus of the exchange to the line 10.

While there has 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 contemplated to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In an automatic telephone system, an exchange, a plurality of subscribers' lines extending to said exchange, said exchange comprising automatic switching apparatus for setting up connections between said lines, call forwarding apparatus in said exchange, said call forwarding apparatus being operative to forward calls incoming to one of said lines through said automatic switching apparatus to any one of several other lines of the system, a relay adapted to be connected to said one line to respond to ringing current transmitted over said one line and operative to initiate the operation of said call forwarding apparatus, and means controllable over said one line for connecting said relay to said line.

2. In an automatic telephone system, an exchange, a plurality of subscribers' lines extending to said exchange, said exchange comprising automatic switching apparatus for setting up connections between said lines, call forwarding apparatus in said exchange, said call forwarding apparatus including a register operative directly to control said automatic switching apparatus to extend a connection from one of said lines to any selected one of a number of the other lines, a relay adapted to be connected to said one line to respond to ringing current transmitted over said one line and operative to initiate the operation of said call forwarding apparatus, and means controllable over said one line for controlling said register to select the one of said other lines to which calls are to be forwarded and for connecting said relay to said one line.

3. In a telephone system, a subscriber's line, other lines, a register, automatic means controllable over any line of the system for variably setting said register in accordance with the directory designation of another of said lines, and means operative when a call is directed to said subscriber's line under the condition of the register being set, for causing said call to be routed to the one of said other lines corresponding to the setting of said register.

4. In a telephone system, a subscriber's line, other lines, a register, automatic means controllable over said subscriber's line and operative in response to a single digit of impulses transmitted thereto for variably setting said register in accordance with the directory designation of any one of a plurality of said other lines, and means operative when a call is directed to said subscriber's line under the condition of the register being set, for causing said call to be routed to the one of said other lines corresponding to the setting of said register.

5. In a telephone system, a subscriber's line, other lines, a register, automatic means controllable over any line of the system and operative in response to a single digit of impulses transmitted thereto for variably setting said register in accordance with the directory designation of another of said lines, and means operative when a call is directed to said subscriber's line under the condition of the register being set, for causing said call to be routed to the one of said other lines corresponding to the setting of said register.

6. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus associated with one of said lines, said call forwarding apparatus being operative to forward calls incoming to said one line through said automatic switching apparatus to any one of several other

lines of the system, means for initiating the operation of said call forwarding apparatus, and means controllable over any line of the system for conditioning said last-named means to operate in response to a call routed to said one line.

7. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus associated with one of said lines, said call forwarding apparatus including a register operative directly to control said automatic switching apparatus to extend a connection from said one line through said automatic switching apparatus to any selected one of a number of the other lines, means for initiating the operation of said call forwarding apparatus, and means controllable over any line of the system for controlling said register to select the one of said other lines to which calls are to be forwarded and for conditioning said last-named means to operate in response to a call routed to said one line.

8. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus individual to one of said lines and operative to forward calls incoming to said one line to another of said lines, a circuit for controlling said call forwarding apparatus, said automatic switching apparatus including a selector switch having access to said circuit through its outlet contacts, whereby said circuit is controllable over any line of the system, and means included in said circuit and controllable over a connection including any one of said lines and extending through said selector switch for conditioning said call forwarding apparatus to operate in response to a call routed to said one line.

9. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus individual to one of said lines and operative to forward calls incoming to said one line to another of said lines, a circuit for controlling said call forwarding apparatus, said automatic switching apparatus including a selector switch having access to said circuit, whereby said circuit is controllable over any line of the system, said circuit comprising means controllable over a connection including one of said lines and extending through said selector switch for conditioning said call forwarding apparatus to operate in response to a call routed to said one line, and means responsive to seizure of said circuit by said switch for transmitting a signal over said connection to the calling end thereof.

10. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus associated with one of said lines and operative to forward calls incoming to said one line to another of said lines, a circuit for controlling said call forwarding apparatus, said automatic switching apparatus including a selector switch having access to said circuit, whereby said circuit is controllable over any line of the system, said circuit comprising means controllable over a connection including one of said lines and extending through said selector switch for conditioning said call forwarding apparatus to operate in response to a call routed to said one line, and means operative

in response to the release of a connection routed through said switch to said circuit following the release of said last-mentioned connection for rendering said call forwarding apparatus nonresponsive to calls routed to said one line.

11. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus associated with one of said lines and operative to forward calls incoming to said one line to another of said lines, a circuit for controlling said call forwarding apparatus, said automatic switching apparatus including a selector switch having access to said circuit, whereby said circuit is controllable over any line of the system, said circuit comprising means controllable over a connection including one of said lines and extending through said selector switch for conditioning said call forwarding apparatus to operate in response to a call routed to said one line, means operative in response to the release of a connection routed through said switch to said circuit following the release of said last-mentioned connection for rendering said call forwarding apparatus nonresponsive to calls routed to said one line, and means responsive to seizure of said circuit by said switch for transmitting one signal over the connection routed through said switch in the event said call forwarding apparatus is conditioned to respond to calls routed to said one line and for transmitting a different signal over said last-mentioned connection in the event said call forwarding apparatus is not conditioned to respond to calls routed to said one line.

12. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus associated with one of said lines and operative to forward calls incoming to said one line to another of said lines, a circuit for controlling said call forwarding apparatus, said automatic switching apparatus including a selector switch having access to said circuit, whereby said circuit is controllable over any line of the system, said circuit comprising means controllable over a connection including one of said lines and extending through said selector switch for conditioning said call forwarding apparatus to operate in response to a call routed to said one line, means operative in response to the seizure of said circuit by said switch in setting up a second connection to said circuit following the release of said last-mentioned connection for transmitting a signal over said second connection, and means operative in response to the release of said second connection for rendering said call forwarding apparatus nonresponsive to calls routed to said one line.

13. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, and call forwarding apparatus including a circuit accessible to certain of the automatic switches included in said automatic switching apparatus through the outlet contacts of said switches, said circuit including means operative in response to seizure thereof over a first connection routed thereto from any one of said lines for conditioning said call forwarding apparatus to forward calls incoming to a predetermined one of said lines to another of said lines, and means operative in response to the release of a second connection routed to said circuit from any one of said lines for rendering said call for-

warding apparatus nonresponsive to calls incoming to said predetermined line.

14. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, and call forwarding apparatus including a circuit accessible to certain of the automatic switches included in said automatic switching apparatus, said circuit including means operative in response to seizure thereof over a first connection routed thereto for conditioning said call forwarding apparatus to forward calls incoming to one of said lines to another of said lines, means operative in response to the release of a second connection routed to said circuit for rendering said call forwarding apparatus non-responsive to calls incoming to said one line, and means responsive to seizure of said circuit for transmitting one signal over the connection routed to said circuit in the event said call forwarding apparatus is conditioned to respond to calls incoming to said one line and for transmitting a different signal over said last-named connection in the event said call forwarding apparatus is not conditioned to respond to calls incoming to said one line.

15. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus individual to one of said lines and including an impulse sender for directly controlling said automatic switching apparatus to forward calls incoming to said one line to a selected one of the other lines and an impulse responsive switch for selecting any one of said other lines and for controlling the operation of said impulse sender in accordance with the line selected, control means operative to initiate the operation of said impulse sender, a circuit for controlling said call forwarding apparatus, said automatic switching apparatus including means operative to establish a connection between said circuit and any line of the system, said circuit including means for repeating to said impulse responsive switch impulses transmitted over said connection, thereby to cause said switch to select the one of said other lines to which calls routed to said one line are to be forwarded, and means for conditioning said control means to operate in response to a call routed to said one line.

16. In an automatic telephone system, a plurality of subscribers' lines, automatic switching apparatus for setting up connections between said lines, call forwarding apparatus individual to one of said lines and including an impulse sender for directly controlling said automatic switching apparatus to forward calls incoming to said one line to a selected one of the other lines and an impulse responsive switch for selecting any one of said other lines and for controlling the operation of said impulse sender in accordance with the line selected, control means operative to initiate the operation of said impulse sender, a circuit for controlling said call forwarding apparatus, said automatic switching apparatus including means operative to establish a connection between said circuit and any line of the system, said circuit including means for repeating to said impulse responsive switch impulses transmitted over said connection, thereby to cause said switch to select the one of said other lines to which calls routed to said one line are to be forwarded, means for conditioning said control means to operate in response to a call routed to

said one line, and means operative in response to the release of a second connection routed to said circuit for releasing said impulse responsive switch and for rendering said control means non-responsive to calls routed to said one line.

17. In an automatic telephone system comprising a plurality of subscribers' lines and automatic switching apparatus for setting up connections between said lines, call forwarding apparatus individual to one of said lines and operative to forward calls incoming to said one line to another selected line, said call forwarding apparatus comprising a switch controlled in accordance with impulses transmitted thereto over any line of the system for selecting the line to which said calls are to be forwarded, an impulse sender controlled in accordance with the setting of said switch for transmitting to said automatic switching apparatus the impulses of the directory number designating the selected line, means operative in response to a call routed to said one line for initiating the operation of said sender, and means controllable over any line of the system for releasing said switch and for rendering said last-named means nonresponsive to calls routed to said one line.

18. In an automatic telephone system comprising a plurality of subscribers' lines and automatic switching apparatus for setting up connections between said lines, call forwarding apparatus individual to one of said lines and operative to forward calls incoming to said one line to another selected line, said call forwarding apparatus comprising a line selecting switch including a plurality of sets of contacts individually corresponding to the impulse digits of directory numbers designating said other lines, wipers operative to engage corresponding contacts of said contact sets thereby to select the digits of the directory numbers designating said other lines, and means adapted to be controlled in accordance with impulses transmitted over any line of the system for operating said wipers to engage the contacts corresponding to a line to which calls are to be forwarded, an impulse sender for transmitting impulses to said automatic switching apparatus, a sending control switch operative in response to operation of said impulse sender, a digit sequence switch, means controlled by apparatus including said sending control switch for controlling said sequence switch to cause the operation thereof at the end of each digit of impulses transmitted by said impulse sender, means including said sending control switch and said sequence switch for causing said sender to transmit to said automatic switching apparatus the impulses making up the digits of the directory number of the line to which calls are to be forwarded, and means operative in response to a call routed to said one line for initiating the operation of said impulse sender.

19. In an automatic telephone system comprising a plurality of subscribers' lines and automatic switching apparatus for setting up connections between said lines, call forwarding apparatus individual to one of said lines and operative to forward calls incoming to said one line to another selected line, said call forwarding apparatus comprising a line selecting switch including a plurality of sets of contacts individually corresponding to the impulse digits of directory numbers designating said other lines, wipers operative to engage corresponding contacts of said contact sets thereby to select the digits of the directory numbers designating said other lines, and means adapted to be controlled in accord-

ance with impulses transmitted over any line of the system for operating said wipers to engage the contacts corresponding to a line to which calls are to be forwarded, an impulse sender for transmitting impulses to said automatic switching apparatus, a sending control switch operative in response to operation of said impulse sender, a digit sequence switch, means controlled by apparatus including said sending control switch for controlling said sequence switch to cause the operation thereof at the end of each digit of impulses transmitted by said impulse sender, means including said sending control switch and said sequence switch for causing said sender to transmit to said automatic switching apparatus the impulses making up the digits of the directory number of the line to which calls are to be forwarded, a timing device, means operative in response to a call routed to said one line for initiating the operation of said timing device, and means controlled by said timing device for initiating the operation of said impulse sender a predetermined time interval after said call is routed to said one line.

20. In an automatic telephone system comprising a plurality of subscribers' lines and automatic switching apparatus for setting up connections between said lines, a repeater including a first winding adapted to be connected across the conductors of one of said lines and a second winding adapted to be included in a calling loop circuit extending to said automatic switching apparatus, call forwarding apparatus individual to said one line and operative to forward calls incoming to said one line to another selected line, a switch adapted to be controlled in accordance with impulses transmitted thereto over any line of the system for selecting the line to which said calls are to be forwarded, means operative in response to said impulses for connecting said first winding across the conductors of said one line, an impulse sender controlled in accordance with the setting of said switch for transmitting over said calling loop circuit the impulses of the directory number designating the selected line, and means operative in response to a call routed to said one line for completing said calling loop circuit and for initiating the operation of said sender.

21. In an automatic telephone system comprising a plurality of subscribers' lines and automatic switching apparatus for setting up connections between said lines, a repeater including a first winding adapted to be connected across the conductors of one of said lines and a second winding adapted to be included in a calling loop circuit extending to said automatic switching apparatus, call forwarding apparatus individual to said one line and operative to forward calls incoming to said one line to another selected line, a switch adapted to be controlled in accordance with impulses transmitted thereto over any line of the system for selecting the line to which said calls are to be forwarded, a timing device, means operative in response to said impulses for connecting said first winding across the conductors of said one line and for conditioning said timing device for operation, an impulse sender controlled in accordance with the setting of said switch for transmitting over said calling loop circuit the impulses of the directory number designating the selected line, means operative in response to a call routed to said one line for completing said calling loop circuit and for initiating the operation of said timing device, and means controlled by said timing device for initiating the operation of said

sender a predetermined time interval after said loop circuit is completed.

22. In automatic telephone system comprising a plurality of subscribers' lines and automatic switching apparatus for setting up connections between said lines, a repeater including a first winding adapted to be connected across the conductors of one of said lines and a second winding adapted to be included in a calling loop circuit extending to said automatic switching apparatus, call forwarding apparatus individual to said one line and operative to forward calls incoming to said one line to another selected line, a line selecting switch including a plurality of sets of contacts individually corresponding to the impulse digits of directory numbers designating said other lines, wipers operative to engage corresponding contacts of said contact sets, thereby to select the digits of the directory numbers designating said other lines, and means adapted to be controlled in accordance with impulses transmitted over any line of the system for operating said wipers to engage the contacts corresponding to the line to which calls are to be forwarded, means operative in response to said impulses for connecting said first winding across the conductors of said one line, an impulse sender for transmitting impulses over said calling loop circuit to said automatic switching apparatus, a sending control switch operative in response to operation of said impulse sender, a digit sequence switch, means controlled by said sender control switch for controlling said sequence switch to cause the operation thereof at the end of each digit of impulses transmitted by said sender, means including said sending control switch and said sequence switch for causing said sender to transmit over said calling loop circuit the impulses making up the digits of the directory number designating the line to which calls are to be forwarded, and means operative in response to a call routed to said one line for completing said calling loop circuit and for initiating the operation of said sender.

23. In an automatic telephone system comprising a plurality of subscribers' lines and automatic switching apparatus for setting up connections between said lines, a repeater including a first winding adapted to be connected across the conductors of one of said lines and a second winding adapted to be included in a calling loop circuit extending to said automatic switching apparatus, call forwarding apparatus individual to said one line and operative to forward calls incoming to said one line to another selected line, a line selecting switch including a plurality of sets of contacts individually corresponding to the impulse digits of directory numbers designating said other lines, wipers operative to engage corresponding contacts of said contact sets, thereby to select the digits of the directory numbers designating said other lines, and means adapted to be controlled in accordance with impulses transmitted over any line of the system for operating said wipers to engage the contacts corresponding to the line to which calls are to be forwarded, a timing device, means operative in response to said impulses for connecting said first winding across the conductors of said one line and for conditioning said timing device for operation, an impulse sender for transmitting impulses over said calling loop circuit to said automatic switching apparatus, a sending control switch operative in response to operation of said impulse sender, a digit sequence switch, means controlled by said

sender control switch for controlling said sequence switch to cause the operation thereof at the end of each digit of impulses transmitted by said sender, means including said sending control switch and said sequence switch for causing 5 said sender to transmit over said calling loop circuit the impulses making up the digits of the directory number designating the line to which calls

are to be forwarded, means operative in response to a call routed to said one line for completing said calling loop circuit and for initiating the operation of said timing device, and means controlled by said timing device for initiating the operation of said sender a predetermined time interval after said loop circuit is completed.

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