

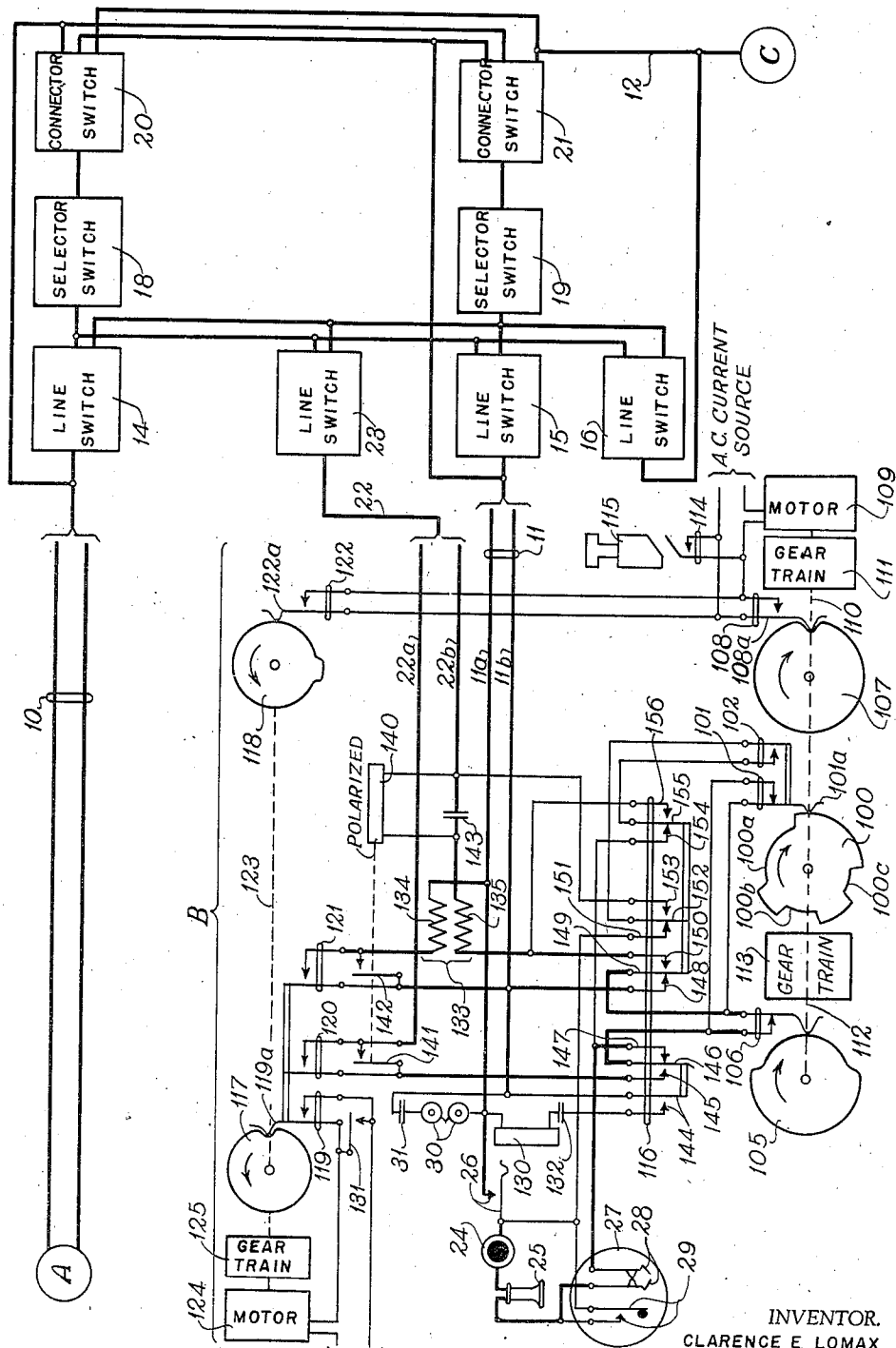
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CALLING APPARATUS

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CALLING APPARATUS

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The present invention relates to calling apparatus adapted for use in automatic telephone systems and has for one of its objects the provision of improved calling apparatus which may be provided at one of the substations of an automatic telephone system and is operative automatically to forward calls incoming to the substation to another substation of the system, and also to route calls originating at the substation to other substations of the system.

It is another object of the invention to provide apparatus of the character described which is arranged in an improved manner such that the same impulse sender may be used both as a call initiating and as a call forwarding instrumentality.

It is a further object of the invention to provide in an automatic telephone system improved apparatus of the character described which is economical to manufacture and install, is adapted for use in conjunction with automatic switching apparatus of substantially all types, and is thoroughly reliable in operation.

The invention is illustrated in its embodiment in an automatic telephone system which comprises a plurality of substations and automatic switching apparatus including non-numerical and impulse responsive numerical switches for setting up connections between the lines extending to the substations. One of the substations of the system is illustrated as being equipped for call forwarding service; two lines extending between this substation and the automatic switching apparatus of the line terminating exchange being provided for handling calls involving this substation. The calling apparatus provided at the substation comprises a plural digit impulse sender and means for selectively connecting the sender to transmit switch control impulses over either of the two associated lines. When operatively associated with one of the two lines the impulse sender is manually controllable to operate as a plural digit calling device. There is also provided apparatus which is operative in response to a call routed to the substation for initiating the operation of the impulse sender only when the sender is connected to transmit impulses over a particular one of the two associated lines. The last-mentioned apparatus comprises a cyclically operative control device, the operation of which is initiated in response to a call routed to the indicated substation. This control device is arranged to control means for initiating the operation of the impulse sender a predetermined time interval after operation of

the control device is initiated. By virtue of this arrangement, transmission of impulses from the impulse sender to the automatic switching apparatus of the line terminating exchange is delayed for a time interval during which a seized one of the non-numerical switches provided in the exchange may operate to select an idle one of the first numerical switches to which it has access. The arrangement is such that the switches through which the call is forwarded are held operated for a substantial time interval, determined by operation of the above-mentioned control device, after the impulse transmission is completed. By virtue of this arrangement, a period is provided during which the substation to which the call is forwarded may be signaled and the call answered.

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 drawing in which the single figure illustrates an automatic telephone system having incorporated therein improved calling apparatus of the character briefly described above.

Briefly described, the system illustrated in the drawing comprises a plurality of substations A, B and C individually associated with the 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 14, 15 and 16 individually associated with the lines 10, 11 and 12, a plurality of impulse responsive selector switches including the two switches indicated at 18 and 19 and a plurality of impulse responsive connector switches, two of which are indicated at 20 and 21 respectively. The system further comprises call forwarding apparatus connected and arranged in accordance with the present invention and individually associated with the substation B. The arrangement of this apparatus is such that an auxiliary call forwarding line 22 extending from the substation B to the automatic switching apparatus of the line terminating exchange and a line switch 23 for serving the line 22, are required.

The line switches 14, 15, 16 and 23 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, sub-group and particular line selecting functions. Preferably, these switches are of the well-known Strowger type each having embodied therein a Strowger switching mechanism utilizing vertical and rotary motions in its operation to select an outgoing line. Obviously, the control apparatus embodied in the selector and connector switches is different in each instance depending upon the particular character of the switch.

In brief, the apparatus provided at the substation B comprises a transmitter 24, a receiver 25, a hook switch including the contact springs 26, and a calling device 27 which is of the well-known dial operated type and includes a pair of pulsing springs 28 and a pair of shunt springs 29. The apparatus further comprises a ringer 30 having its windings bridged across the conductors of the line 11 in series with a condenser 31 so that it is energized and operates in response to ringing current transmitted over the line 11.

Neglecting for the present the arrangement of the call forwarding apparatus provided at the substation B, 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 B, for example, initiates a call intended for the substation A, by removing the receiver 25 from its supporting hook, the hook-switch springs 26 are engaged and a calling loop circuit is completed by way of the line 11 for initiating the operation of the line switch 15. 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 18 is the first available idle selector switch accessible to the line switch 15, the last-mentioned switch, upon testing the condition of the trunk line extending to the selector switch 18 and finding this line to be idle, operates to extend the calling loop circuit to the indicated selector switch. The control apparatus of the seized selector switch 18 now operates to return the usual dial tone signal to the calling subscriber. In order directly to control the automatic switching apparatus provided in the exchange so that the call will be forwarded to the desired substation, the calling party, after removing the receiver 25 from its supporting hook, operates the dial of the calling device 27 in accordance with the digits of the directory number designating the desired substation. Each time the dial of the calling device 27 is moved off-normal, the shunt springs 29 are closed to complete an obvious path for short circuiting the transmitter 24 and the receiver 25. During each return movement of the dial, the pulsing springs 28 are opened one or more times, determined by the numerical value of the digit dialed, to transmit one or more impulses over the established calling loop circuit to the automatic switching apparatus provided in the exchange. The seized

selector switch 18 responds to the impulses of the first digit dialed at the substation B by elevating its wipers to a position opposite the level of bank contacts terminating the trunk lines extending to the connector switches having access to the called line 10. Further, the control apparatus of the seized selector switch 18 operates to terminate the dial tone signal in response to the impulses of this digit. During the interdigit pause between the first and second digits, the wipers of the selector switch 18 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 20 is the first available idle switch of the selected group, the rotary movement of the wipers embodied in the selector switch 18 is arrested when these wipers engage the contacts terminating the conductors of the trunk line incoming to this connector switch. Further, the control apparatus of the selector switch 18 functions to extend the calling loop circuit to the selected connector switch 20. The connector switch 20 responds to the impulses of the second digit dialed at the calling substation by elevating its wipers to a position opposite the level of bank contacts terminating the group of lines including the called line 10. 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 10 are terminated. Following the selection of the called line, in the manner just explained, the control apparatus embodied in the connector switch 20 functions to determine the idle or busy condition of the selected line and to transmit the usual busy tone 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 functions to transmit ringing current over the called line for the purpose of energizing the ringer conventionally provided at the called substation A and over the calling line to signal the calling party that the called substation is being rung. When the call is answered at the called substation, a direct current bridge is connected across the conductors of the line 10, thereby to complete a 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 arrest the ring-back tone signal and to complete the desired conversational circuit between the calling and called substation. When the ring cut-off relay operates, a loop circuit including the line 11 is established between the connector switch 20 and the substation A, which loop circuit extends through the windings of the back bridge or battery reversing relay conventionally embodied in the connector switch 20. The resulting operation of this back bridge relay causes the direction of current flow over the calling loop circuit to be reversed in the usual manner. This current reversal may be utilized for various control functions such 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 20. For example, this apparatus may be so arranged that the operated switch train is not released until the connection is cleared out at both the calling and called substations. Alter-

natively, the control apparatus of the connector switch 20 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 25 upon its supporting hook, the calling loop circuit is interrupted at the switchhook springs 26 with the result that the connector switch 20, the selector switch 18 and the line switch 15 are successively 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 11 and 10 are marked as idle in 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 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 provided at the substation B, this apparatus comprises a cyclically operative impulse sender which includes a plurality of control elements or cams individually corresponding to the substations to which calls are to be routed. One such cam is indicated at 100, this cam individually corresponding to the substation C associated with the subscriber's line 12. Each of the control elements or cams is notched around its periphery to provide a camming surface for controlling a pair of impulse shunting springs 101 and a pair of additional shunt springs 102. These two sets of springs are manually movable transversely with respect to the control cams to be controlled by any selected one of the cams. The impulse sender further comprises an impulsing cam 105 which is arranged to operate a pair of pulsing springs 106. An additional control element or cam 107 is provided which is arranged to control a pair of contact springs 108. For the purpose of driving the enumerated control cams there is provided a small synchronous motor 109 of the self-starting type which is arranged to be energized from the usual 110-volt commercial frequency current source. More particularly, this motor is arranged to drive a shaft 110, upon which the station selecting control elements including the element 100 and the control cam 107 are mounted, through a speed reducing gear train 111. The shaft 110 is, in turn, geared to drive a shaft 112, upon which the pulsing cam 105 is mounted, through a speed increasing gear train 113. Preferably, the gear ratio of the train 111 is such that the station selecting cams and the control cam 107, carried by the shaft 110, are rotated at a speed of approximately five revolutions per minute. The gear ratio of the train 113 is such that the impulsing cam is driven at a speed of approximately 600 revolutions per minute corresponding to an impulsing rate or approximately ten impulses per second. If desired, the mechanical construction of the impulsing device may be substantially similar to that disclosed in the copending application of Hans Sengebusch, Serial No. 147,831, filed June 12, 1937, now Patent No. 2,209,615, granted July 30, 1940. The impulse sender, just described, is normally connected to transmit impulses over the line 11. In order to initiate the operation of the impulse sender there is provided a manually operable switch of the push button type. This switch comprises a pair of contact springs

114 and an operating button 115 for moving the springs 114 into engagement. Preferably, this switch is of the non-locking type such that, when operated to its off-normal position and released, it immediately assumes its normal position.

In order operatively to associate the impulse sender with the call forwarding line 22 there is provided a manually operable transfer switch 116 of the locking type. When thus operatively associated with the line 22, operation of the impulse sender is initiated in response to calls routed to the substation B under the control of a control device which comprises a pair of motor driven control cams 117 and 118 mounted upon a shaft 123 which is arranged to be driven by a motor 124 through a speed reducing gear train 125. The control cam 117 is arranged to operate three pairs of contact springs 119, 120 and 121. The cam 118 is arranged to control a pair of contact springs 122 which are included in the operating circuit for the impulse sender driving motor 109. The motor 124 is of the self-starting synchronous type and may be energized from the usual commercial frequency alternating current source. In order to initiate the operation of the control device, just described, there is provided an alternating current relay 130 which is arranged to be bridged across the conductors of the line 11 in series with a condenser 132 when the transfer switch 116 is operated to its off-normal position.

The line connecting equipment of the call forwarding apparatus includes a repeating coil 133 having a winding 134 adapted to be connected across the conductors of the line 11, and a winding 135 which is adapted to be serially connected in a calling loop circuit including the auxiliary line 22 and extending to the line switch 23. The completion of a talking circuit between the lines 11 and 22 is under the control of a polarized back bridge relay 140 which is preferably of the permanent magnet type. This relay includes an operating winding which is adapted to be connected in series with the winding 135 of the repeating coil 133 across the conductors of the auxiliary line 22. A condenser 143, shunting the relay 140, is provided for the purpose of bypassing voice frequency currents around the winding of this relay.

Referring now more particularly to the operation of the calling apparatus provided at the substation B, it is pointed out that the transfer switch 116 normally occupies the position illustrated in the drawing. With the transfer switch in this position, if it is desired to utilize the impulse sender in initiating a call at the substation B, the contact springs 101 and 102 are positioned to be controlled by the cam, such, for example, as the cam 100, corresponding to the desired substation, following which, the receiver 25 is removed from its supporting hook and the button 115 is depressed to complete the operating circuit for the motor 109. When the receiver 25 is removed from its supporting hook the switch springs 26 are engaged to complete a loop circuit to the line switch 15. This loop circuit extends by way of the line conductor 11a, the switch springs 26, the transmitter 24, the receiver 25, the pulsing springs 28, the contact springs 146 and 147, the pulsing springs 106, as shunted by the springs 101, the contact springs 149 and 148 and the line conductor 11b. When this loop circuit is completed, the line switch 15 operates in the manner pointed out above to select an idle one of the first selector switches, such, for ex-

ample, as the switch 18, to which it has access. When the operating button 115 is depressed, the contact springs 114 are moved into engagement to complete an obvious circuit for energizing the motor 109. During the initial operation of the motor, the cam 107 is moved off-normal to operate the contact springs 108 into engagement and thus complete a circuit for maintaining the motor 109 energized until a cycle of operation of the impulse sender is completed. From the above it will be apparent that momentary operation of the button 115 is sufficient to initiate the operation of the motor 109. Shortly following operation of the springs 108, the cam follower portion of the spring 101a drops into the notch 100a provided in the peripheral surface of the cam 100. As a result, the shunt springs 101 are disengaged and the springs 102 are moved into engagement. When the springs 101 are disengaged, the pulsing springs 106 are operatively included in the above-traced calling loop circuit so that the impulses of the first digit designating the called substation C are transmitted over the loop circuit to the seized first selector switch 18. In this regard, it will be apparent that the number of impulses transmitted during the digit is determined by the circumferential length of the notch 100a formed in the peripheral surface of the cam 100. For example, if the directory number designating the substation C is 844, the length of the notch 100a will be so proportioned relative to the pulsing rate and the speed of rotation of the cam 100 that eight impulses will be transmitted over the calling loop circuit during the interval when the cam follower portion of the spring 101a is engaging the peripheral surface of the cam 100 defined by this notch. In a similar manner, the length of the second notch 100b corresponding to the second digit of the directory number designating the substation C is formed of a length such that four impulses will be transmitted over the calling loop circuit while the cam follower portion of the spring 101a is engaging the peripheral surface defined by this second notch. Also, the length of the notch 100c, which determines the number of impulses of the third digit, is such that four impulses are transmitted over the calling loop circuit by the pulsing springs 106 during the interval when the cam follower portion of the spring 101a is engaging the peripheral surface of the cam 100 defined by this third notch. When the springs 102 are moved into engagement, in the manner pointed out above, a path is completed for short circuiting the transmitter 24 and the receiver 25, this path extending from the line terminal of the transmitter 24 by way of the contact springs 151 and 152, the springs 102, the springs 155 and 154, and the pulsing springs 28 to the line terminal of the receiver 25. The completion of this path serves to lower the resistance of the calling loop circuit so that the impulses may be more effectively transmitted thereover to the automatic switching apparatus provided in the line terminating exchange.

The selector switch 18 responds to the impulses of the first digit by elevating its wipers to a position opposite the level of bank contacts terminating the conductors of the trunk lines respectively extending to the connector switches having access to the called line 12. When the cam follower portion of the shunt spring 101a engages the projection separating the notches 100a and 100b of the cam 100, the shunt springs 101 are moved into engagement to complete an obvious path in shunt with the pulsing springs 106

so that the latter springs are no longer actively included in the calling loop circuit. Simultaneously, the springs 102 are disengaged to open the above-traced path short circuiting the transmitter 24 and the receiver 25. The circumferential length of the projection separating the two notches 100a and 100b determines the duration of the interdigit pause between the first and second digits of the directory number designating the substation C. During this pause, the wipers of the selector switch 18 are rotated step by step until a trunk line extending to an idle one of the connector switches of the selected group is found. Assuming, for example, that the connector switch 20 is the first available idle switch of the selected group, the selector switch 18 seizes this connector switch and extends the calling loop circuit thereto. Thereafter, and when the cam follower portion of the shunt spring 101a drops into the notch 100b of the cam 100, the pulsing springs 106 are again actively included in the circuit so that the impulses of the second digit are transmitted to the connector switch 20. The connector switch 20 responds to the impulses of this digit by elevating its wipers to a position opposite the level of bank contacts terminating the group of ten subscribers' lines including the line 12. When the cam follower portion of the spring 101a engages the projection separating the notches 100b and 100c, the shunt springs 101 are again moved into engagement to short circuit the pulsing springs 106, thereby to terminate the impulses of the second digit and to provide an interdigit pause during which the control apparatus of the connector switch 20 is conditioned to respond to the impulses making up the third digit of the directory number designating the substation C. The impulses of the third digit are started when the cam follower portion of the spring 101a drops into the notch 100c to again actively include the pulsing springs 106 in the calling loop circuit. The connector switch 20 responds to the impulses of the third digit by operating to select the line 12 from the selected subgroup of lines. The impulses of the third and final digit are terminated when the cam follower portion of the spring 101a is moved out of the notch 100c and into engagement with its associated contact spring. Shortly following the end of the third digit the cams 100 and 107 are rotated to a position such that the cam follower portion of the spring 103a drops into the notch formed in the peripheral surface of the cam 107. In response to this operation, the circuit for energizing the motor 109 is interrupted, thus arresting the operation of the impulse sender. From this point on, the manner in which the desired conversational circuit is established between the calling and called substation when the call is answered at the called substation is exactly the same as set forth above with reference to the call routed to the substation A. The release of the connection is effected when the receiver 25 is replaced upon its supporting hook to interrupt, at the springs 26, the established calling loop circuit.

In order to condition the impulse sender to operate as a call forwarding instrumentality, the transfer switch 116 is operated to its off-normal position. In response to this operation, the contact springs 144 are moved into engagement to connect the alternating current relay 130 across the conductors of the line 11. At the contact springs 146 to 149, inclusive, the telephone instrument provided at the substation B is discon-

connected from the line 11. At the contact springs 145, 146, 149 and 150, a calling loop circuit including the line 22 and extending to the line switch 23 is prepared. At the contact springs 151 and 152, a point is opened in the above-traced path for short circuiting the transmitter 24 and the receiver 25. At the springs 152, 153, 155 and 156, a path is prepared for short circuiting the winding of the relay 140 and the winding 135 of the repeating coil 133.

With the transfer switch 116 occupying its off-normal position and the contact springs 101 and 102 positioned to be controlled by the cam 100, if a call is routed from the substation A, for example, through the line switch 14, the selector switch 19 and the connector switch 21 to the line 11, at a time when this line is idle, ringing current is projected over the line, thereby to energize the alternating current relay 130 in parallel with the ringer 30. The path traversed by this current extends by way of the line conductor 11a, the winding of the relay 130, the condenser 132, the contact springs 144 and the opposite line conductor 11b. When energized by current traversing this path, the relay 130 operates to complete, at its armature 131, an obvious circuit for energizing the motor 124. During the initial movement of the cam 117, resulting from the operation of the motor 124, the contact springs 119 are moved into engagement to complete an obvious multiple circuit for energizing the motor 124 so that this motor is not deenergized until the initiated cycle of operation of the control device is fully completed. At the contact springs 121, also controlled by the cam 117, a loop circuit including the winding 134 is completed by way of the line 11 to the operated connector switch 21, thereby to cause the operation of the ring cut-off and battery reversing relays embodied in this connector switch in the manner explained above with reference to the operation of the connector switch 20. At the contact springs 120, also controlled by the cam 117, the above-mentioned calling loop circuit extending by way of the line 22 to the line switch 23 is completed. This loop circuit extends by way of the line conductor 22a, the contact springs 120, 145 and 146, the pulsing springs 106, the contact springs 149 and 150, the repeater winding 135, the winding of the relay 140 and the line conductor 22b. The direction of current flow over this loop circuit is such that the polarized relay 140 does not operate. The line switch 23 responds to the completion of the above-traced loop circuit by operating to select an idle one of the selector switches, such, for example, as the switch 18 to which it has access. A predetermined time interval after rotation of the cams 117 and 118 is started the projection carried by the cam 118 is moved into engagement with the cam follower portion of the contact spring 122a. As a result, the contact springs 122 are moved into engagement to complete an operating circuit for the impulse sender driving motor 109. The interval which elapses between the initial operation of the control device and the completion of the operating circuit for the motor 109 is provided in order to give the line switch 23 an opportunity to select an idle one of the selector switches accessible thereto before operation of the impulse sender is initiated. When the motor 109 is energized by way of the above-mentioned circuit, including the contact springs 122, rotation of the shafts 110 and 112 is initiated. During the initial movement of the cam 107, the contact

springs 108 are moved into engagement to complete an obvious multiple circuit for energizing the motor 109. Shortly thereafter, the projection carried by the cam 118 is moved out of engagement with the cam follower portion of the contact springs 122a so that the initially completed circuit for energizing the motor 109 is interrupted. From this point on, the manner in which the impulse sender operates to transmit to the automatic switching apparatus the impulses of the directory number designating the substation C is exactly the same as described above with reference to the call routed over the line 11 and through the switches 15, 18 and 20 to the substation C. In this regard it is pointed out that each time the cam follower portion of the spring 101a drops into one of the notches formed in the peripheral surface of the cam 109, the springs 102 are moved into engagement to complete the above-mentioned path for short circuiting the winding 135 and the winding of the relay 140. This path extends from the left terminal of the winding 135 by way of the springs 156, 155, 102, 152 and 153 to the line conductor 22b. When this path is completed, the resistance of the calling loop circuit extending to the line switch 23 is lowered so that the switch control impulses are more effectively transmitted thereover. The arrangement is such that the cycle of operation of the impulse sender is completed a substantial time interval before the control device, including the cams 117 and 118, completes its cycle of operation. Shortly following the transmission of the impulses making up the last digit of the directory number designating the substation C, the cam 107 is rotated to its normal position such that the cam follower portion of the spring 108a drops into the notch formed in the peripheral surface of the cam 107 and the springs 108 are disengaged to open an operating circuit for the motor 109. Accordingly, operation of the impulse sender is arrested. Assuming that the switches 18 and 20 are utilized in forwarding the call to the line 12, the connector switch 20 operates to test the called line for the purpose of determining the idle or busy condition thereof during the interval required for the control device to complete its cycle of operation. If the called line is found to be busy, busy tone current is returned over the loop circuit extending to the repeater 133 and is transmitted by induction through this repeater to the established talking circuit extending to the calling substation A, whereby the calling party is informed that the connection cannot be obtained. In the event the called line 12 is idle at the time it is selected, ringing current is projected over this line for the purpose of energizing the signal device provided at the called substation. A portion of ringing current is by-passed over the calling loop circuit extending to the repeater 133 and is transmitted through this repeater to the established talking circuit extending to the calling substation A. Thus, the calling subscriber is informed that the called substation is being rung. In the event the call is answered at the called substation during the interval required for the control device to complete its cycle of operation, the desired conversational circuit between the substations A and C is established. When the call is answered at the called substation, the ring cut-off and back bridge relays embodied in the connector switch 20 are caused to operate in the manner previously explained. When the indicated back bridge relay operates it

functions to reverse the direction of current flow over the loop circuit extending to the repeating coil 133. As a result, the polarized relay 140 operates to complete, at its armature 141, a path in shunt with the contact springs 120. At its armature 142, the relay 140 completes a path in shunt with the springs 121. Due to the completion of these shunt paths, the established talking circuit extending between the substations A and C is not interrupted when the control device completes its cycle of operation. When the cams 117 and 118, embodied in the control device, are rotated back to normal, the cam follower portion of the spring 119a drops into the notch formed in the peripheral surface of the cam 117 so that the springs 119, 120 and 121 are respectively disengaged. At the springs 119, the circuit for energizing the motor 124 is interrupted. Thus, the motor 124 is deenergized and further operation of the control device is prevented. The manner in which the switch train, comprising the line switch 14, the selector switch 19 and the connector switch 21, is released when the connection is cleared out at the calling substation A is substantially similar to the release of the connection described above and established between the substations B and A. When the connection is cleared out at the called substation C, the back bridge relay embodied in the connector switch 20 restores to again reverse the direction of current flow over the loop circuit extending through the selector switch 18 and the line switch 23 to the repeating coil 133. In response to this operation, the polarized relay 140 restores to open, at its armature 142, a point in the established loop circuit extending from the repeating coil 133 to the connector switch 21. At its armature 141, the relay 140 interrupts the loop circuit extending by way of the line 22, the line switch 23 and the selector switch 18 to the operated connector switch 20. In response to this operation, the enumerated switches are released in the order named and in the manner previously explained.

In the event the call as forwarded to the substation C is not answered within the time interval required for the control device provided at the substation B to complete its cycle of operation, the switch train through which the call is forwarded is released. More particularly, when the cams 117 and 118 are returned to normal, the contact springs 119, 120 and 121 are respectively disengaged in the manner pointed out above. At the contact springs 120, the loop circuit extending by way of the line 22 and through the line switch 23 and the selector switch 18 to the operated connector switch 20 is interrupted causing these switches to restore to normal. At the contact springs 121, the loop circuit including the winding 134 and extending to the operated connector switch 21 is also interrupted. Thus, the busy tone signal or the ring-back tone signal being transmitted to the calling subscriber is terminated, thereby to inform the calling subscriber that the call has failed. After the control device has been restored to normal in the manner just explained, further operation thereof can only be initiated by releasing the switch train through which the connection is routed to the line 11, and by routing a second connection to the line 11 so that the alternating current relay 130 is again energized.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that vari-

ous 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, a substation, a pair of lines extending to said substation, an impulse sender, means for selectively connecting said impulse sender to transmit switch control impulses over either of said lines, and means operative in response to a call routed to said substation for initiating the operation of said impulse sender only when said impulse sender is connected to transmit impulses over a predetermined one of said lines.

2. In an automatic telephone system, a substation, a pair of lines extending to said substation, an impulse sender normally operative to transmit switch control impulses over one of said lines, means for initiating the operation of said sender, means for connecting said impulse sender to transmit switch control impulses over the other of said lines, and means adapted to operate in response to a call routed to said one line for initiating the operation of said impulse sender to transmit switch control impulses over said other line.

3. In an automatic telephone system, a substation, a pair of lines extending to said substation, an impulse sender including a driving motor, a circuit for energizing said motor, means for completing said circuit, circuits normally arranged so that said impulse sender is operative to transmit switch control impulses over one of said lines, switching means operative to rearrange said circuits so that said impulse sender is connected to transmit impulses over the other of said lines, means adapted to operate in response to a call routed to said one line to complete the operating circuit for said motor, and means controlled by said switching means for conditioning said last-named means to operate in response to calls routed to said one line.

4. In an automatic telephone system, a substation, a pair of lines extending to said substation, an impulse sender normally operative to transmit switch control impulses over one of said lines, manually operable means for initiating the operation of said sender, a cyclically operative control device, means for initiating the operation of said control device, means for connecting said impulse sender to transmit impulses over the other of said lines and for conditioning said last-named means to operate in response to a call routed to said one line, and means controlled by said device for initiating the operation of said impulse sender a predetermined time interval after operation of said device is initiated.

5. In an automatic telephone system, a substation, a pair of lines extending to said substation, an impulse sender normally operative to transmit switch control impulses over one of said lines, a first motor for driving said impulse sender, a first operating circuit for said first motor, a manually operable switch for completing said first operating circuit, a cyclically operative control device, a second motor for driving said control device, a second operating circuit for said second motor, a relay and means controlled thereby for completing said second operating circuit, means for connecting said impulse sender to transmit impulses over the other of said lines and for connecting said relay to respond to ringing current transmitted over said

one line, and means controlled by said device for completing said first circuit a predetermined time interval after operation of said control device is initiated.

6. In an automatic telephone system, a sub- station, a pair of lines extending to said sub- station, a cyclically operative impulse sender nor- mally connected to transmit over one of said lines the switch control impulses comprising the directory number designating another substa- tion of the system, a first motor for driving said impulse sender, a first operating circuit for said first motor, a manually operable switch for com- pleting said first operating circuit, a cyclically operative control device, a second motor for driv- ing said control device, a second operating cir- cuit for said second motor, a relay and means controlled thereby for completing said second operating circuit, means for connecting said im- pulse sender to transmit impulses over the other of said lines and for connecting said relay to respond to ringing current transmitted over said one line, means controlled by said device for completing, for a short time interval, said first circuit a predetermined time interval after oper- ation of said control device is initiated, means controlled by said control device for holding said second operating circuit completed independently of said relay until an initiated cycle of operation of said control device is completed, and means controlled by said impulse sender for holding said first operating circuit completed inde- pendently of said switch or said control device until an initiated cycle of operation of said im- pulse sender is completed.

7. In an automatic telephone system includ- ing a plurality of substations and means compris- ing automatic switching apparatus for setting up connections between said substations, call for- warding apparatus including an impulse sender for transmitting to said automatic switching apparatus the impulses of the directory number designating another of said substations, said automatic switching apparatus including non- numerical and impulse responsive numerical switches operative in the order named to extend a connection to said other substation, a control device, means responsive to a call routed to said one substation for initiating the operation of said control device, means controlled by said device for completing a calling loop circuit to said non- numerical switch and for initiating the opera- tion of said impulse sender a predetermined time interval thereafter, and means controlled by said device for interrupting said calling loop circuit a predetermined time interval after operation of said impulse sender to transmit said impulses is ended.

8. In an automatic telephone system including a plurality of substations and means comprising impulse responsive automatic switches for setting up connections between said substations, call forwarding apparatus comprising a cyclically operative impulse sender associated with one of said substations and operative to transmit to said automatic switching apparatus the impulses of the directory number designating another of said substations during each cycle of operation thereof, a motor for driving said impulse sender, first and second circuits for energizing said motor, means responsive to a call routed to said one substation for measuring a predetermined time interval and for completing said first circuit at the end of said time interval, and means con- trolled by said impulse sender for completing

said second circuit during the initial operation of said impulse sender and for interrupting said second circuit after said impulse sender has com- pleted a cycle of operation.

9. In an automatic telephone system including a plurality of substations and means comprising impulse responsive automatic switching appa- ratus for setting up connections between said substations, a line extending to one of said sub- stations, a relay adapted to be bridged across the conductors of said line to respond to ringing cur- rent transmitted to said one substation on calls incoming thereto, call forwarding apparatus comprising a cyclically operative impulse sender associated with said line and operative to trans- mit to said automatic switching apparatus the impulses of the directory number designating another of said substations, a motor for driving said impulse sender, a first circuit for energizing said motor, means operative in response to operation of said relay for measuring a predeter- mined time interval and for completing said first circuit at the end of said time interval, a second circuit for energizing said motor, said second circuit being completed in response to the initial operation of said impulse sender, said automatic switching apparatus including automatic switches operative to extend a connection from said one line to said other substation in response to the impulses transmitted thereto from said impulse sender, and means controlled by said impulse sender for interrupting said second circuit after said impulse sender has completed a cycle of operation.

10. In an automatic telephone system includ- ing a plurality of substations and means compris- ing impulse responsive automatic switching apparatus for setting up connections between said substations, call forwarding apparatus compris- ing means provided at one of said substations for transmitting to said automatic switching appa- ratus the impulses of the directory number designating another of said substations, a motor for driving said impulse sender, means responsive to a call routed to said one substation for initiat- ing the operation of said motor, said automatic switching apparatus including automatic switches operative to extend a connection to said other substation in response to the impulses transmitted thereto from said impulse sender, means included in said call forwarding apparatus for holding said switches operated for an interval after said impulse transmission is ended and for then initiating the release of said switches, and means operative in the event the call as for- warding to said other substation over said last- mentioned connection is answered during said in- terval for holding said switches operated inde- pendently of said last-named means.

11. In an automatic telephone system including a plurality of substations and means comprising impulse responsive automatic switching appa- ratus for setting up connections between said substations, call forwarding apparatus provided at one of said substations and including means for transmitting to said automatic switching appa- ratus the impulses of the directory number designating another of said substations, and means responsive to a call routed to said one substation for initiating the operation of said call forwarding apparatus, said automatic switch- ing apparatus including non-numerical and im- pulse responsive numerical switches operative in the order named to extend a connection to said other substation in response to operation of said

call forwarding apparatus, said call forwarding apparatus including control means so connected and arranged that the transmission of impulses from said call forwarding apparatus is delayed for a predetermined time interval after operation of said call forwarding apparatus is initiated, whereby said non-numerical switch is operated to extend said connection to one of said numerical switches; and said switches are held operated for an interval after impulse transmission is ended, whereby said other substation may be signaled and the forwarded call answered.

12. In an automatic telephone system including a plurality of substations and means comprising impulse responsive automatic switching apparatus for setting up connections between said substations, a line extending from said automatic switching apparatus to one of said substations, a repeater including a first winding adapted to be connected to said line and a second winding included in an incomplete calling loop circuit extending to said automatic switching apparatus; and call forwarding apparatus including means operative in response to a call routed to said line for completing said loop circuit and for transmitting over said loop circuit to said automatic switching apparatus the impulses of the directory number designating another of said substations to which said call is to be forwarded, a polarized relay having an operating winding included in said calling loop circuit and operative in response to the reversal of the direction of current flow over said loop circuit which occurs when the forwarded call is answered at said other substation, and means controlled by said relay for connecting said one winding to said line and for holding said loop circuit completed, thereby to establish a connection including said repeater and extending between said line and said other substation.

13. Call forwarding apparatus adapted to be associated with a substation of an automatic telephone system and comprising, in combination, an impulse sender, a first motor for driving said impulse sender, a first operating circuit for said first motor, a cyclically operative control device, a second motor for driving said control device, a second operating circuit for said second motor, a relay operative to complete said second operating circuit in response to a call routed to said substation, and means controlled by said device for completing said first operating circuit a predetermined time interval after operation of said control device is initiated.

14. Call forwarding apparatus adapted to be associated with a substation of an automatic telephone system and comprising, in combination, a cyclically operative impulse sender, a motor for driving said impulse sender, a first operating circuit for said first motor, a cyclically operative control device, a second motor for driving said control device, a second operating circuit for said second motor, a relay operative to complete said second operating circuit in response to a call routed to said substation, means controlled by said device for completing, for a short time interval, said first circuit a predetermined time interval after operation of said control device is initiated, means controlled by said control device for holding said second operating circuit completed independently of said relay until an initiated cycle of operation of said control device is completed, and means controlled by said impulse sender for holding said first operating circuit completed independently of said control device until an initiated cycle of operation of said impulse sender is completed.

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