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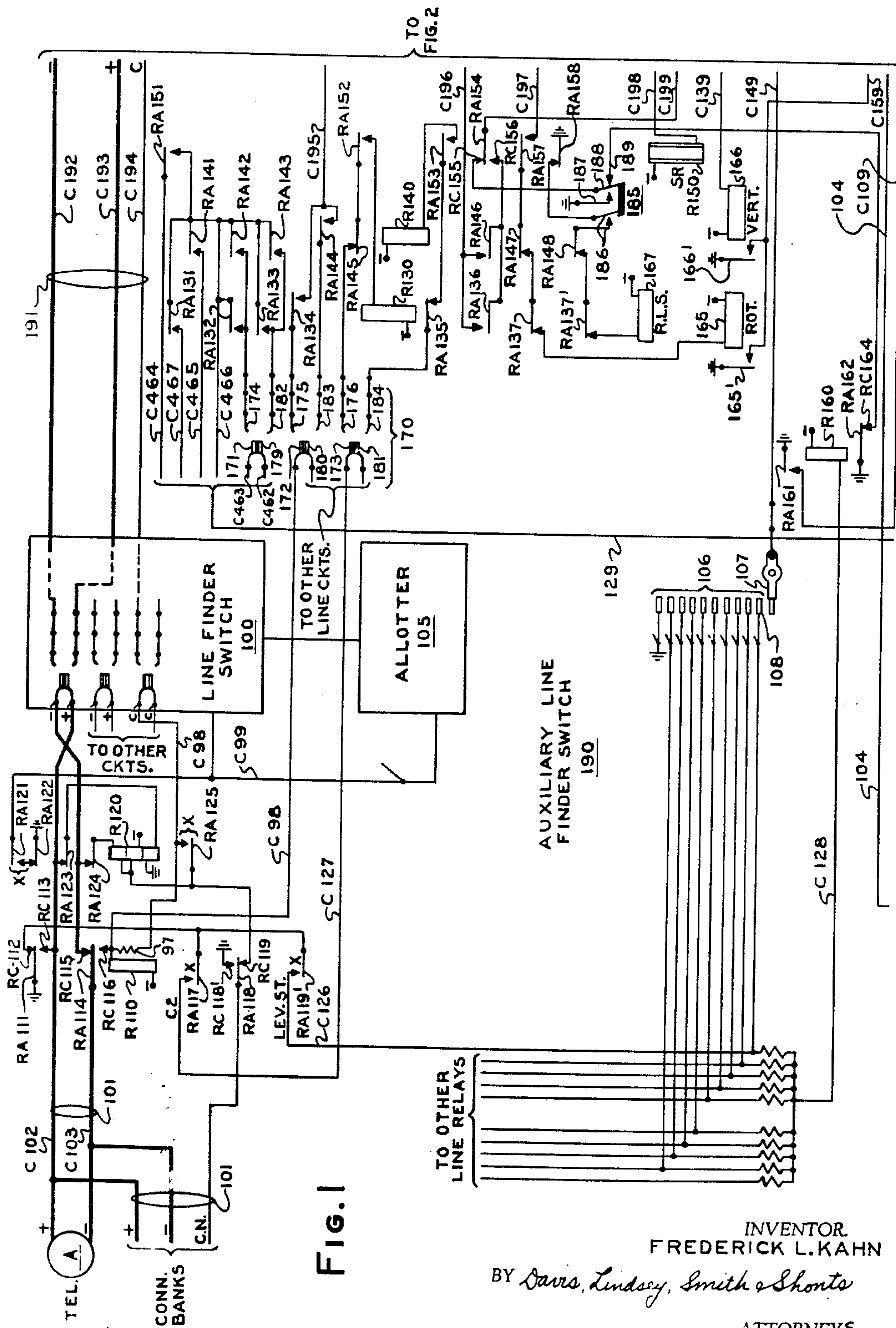
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AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 8, 1938

4 Sheets-Sheet 1



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4 Sheets-Sheet 2



TO
FIG. 1

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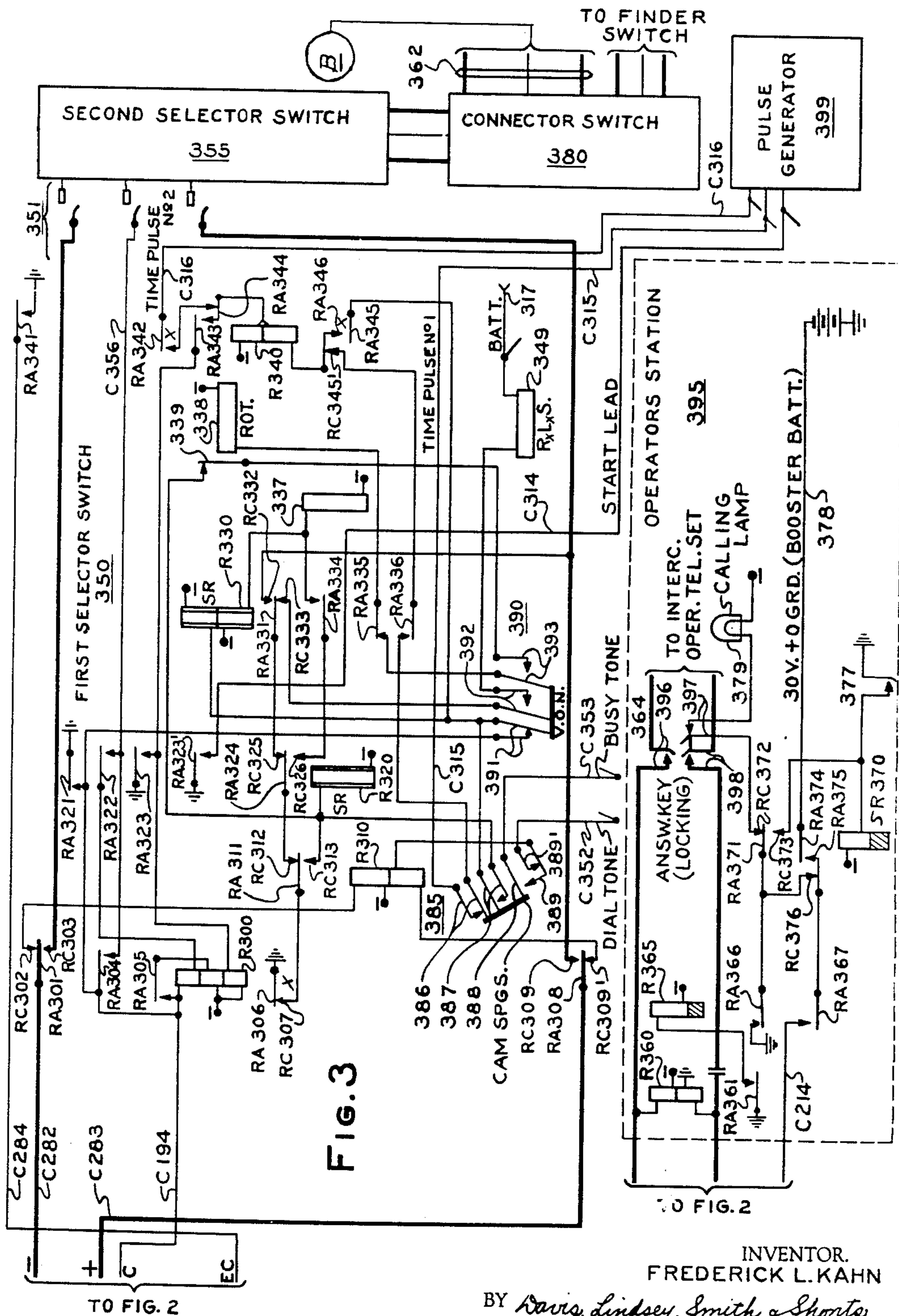
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4 Sheets-Sheet 3



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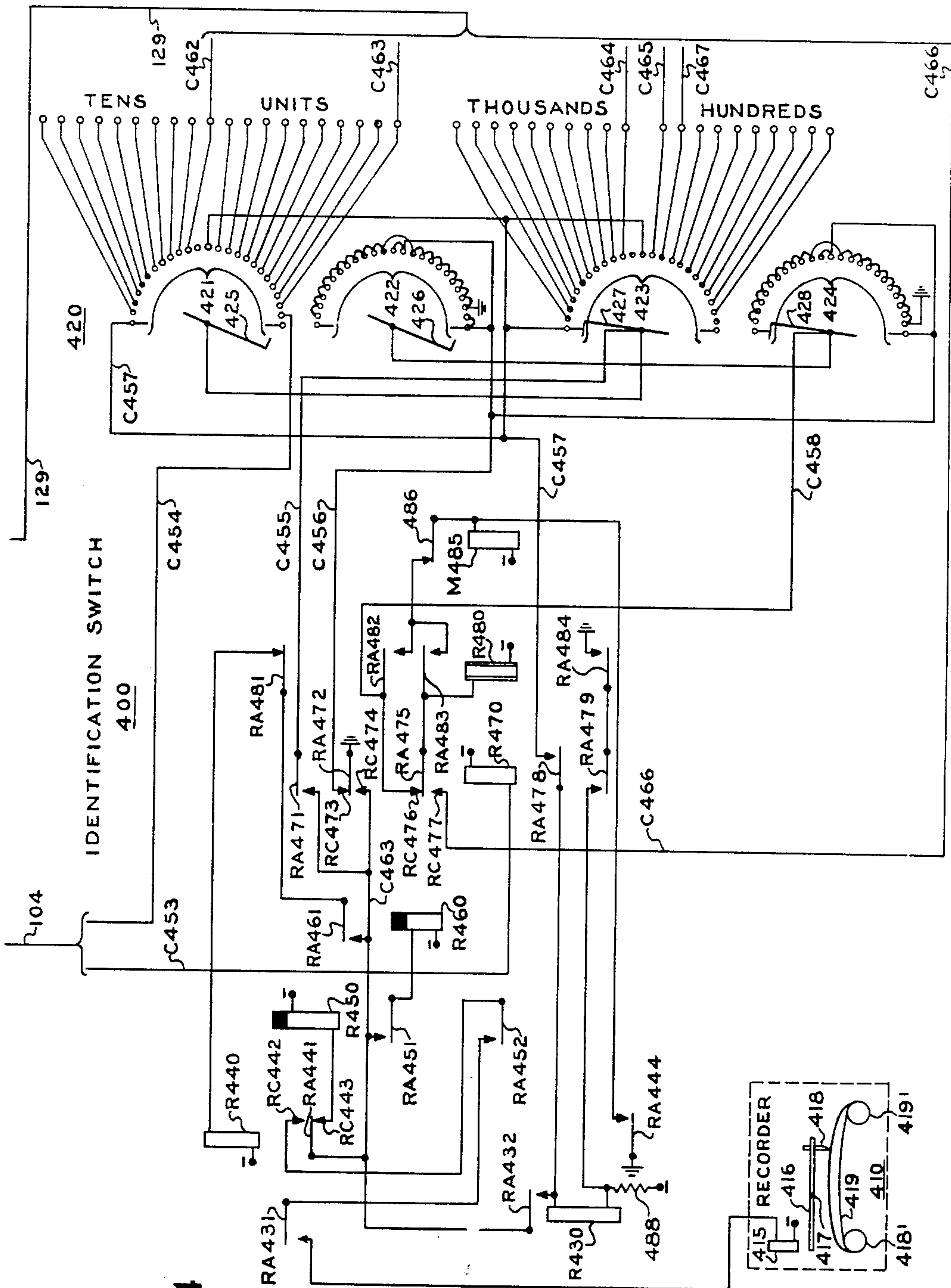


FIG. 4

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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SYSTEM

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Application January 8, 1938, Serial No. 184,043

28 Claims. (Cl. 179—27)

The present invention relates to automatic telephone systems and more particularly to improved apparatus for providing, under certain operating conditions, operator supervision of subscribers' lines terminating in an automatic telephone exchange.

In existing installed automatic telephone systems, if a subscriber's line has a calling condition maintained thereon for a prolonged time interval, due to a faulty condition of the line or to the failure of a calling party to dial a desired number, only one of two results can follow. Thus, if the switching equipment in the exchange includes line lockout apparatus, as is sometimes the case, the calling condition created on the line will cause the line to be locked out of service until the receiver at the calling substation is replaced on its hook. If, on the other hand, no such line lockout equipment is employed in the exchange, certain of the automatic switches embodied therein will be assigned to the use of the calling line and held operated until the calling condition of the line is terminated. Line lockout apparatus of the form mentioned above, when provided, is primarily for the purpose of preventing the automatic switches of the exchange from being appropriated for long time intervals by lines which, due to a faulty condition thereof, have a calling condition created thereon. While perfectly satisfactory for this purpose, such apparatus does not function to give any indication to the exchange maintenance staff of the line on which the fault is present.

It is an object of the present invention to provide in an automatic telephone system improved apparatus for performing one or more of the following functions: automatically routing a connection to an operator's station from a line on which a calling condition is maintained for a prolonged time interval; assisting an operator to determine the line on which the calling condition is maintained for a prolonged time interval; and locking the line out of service and releasing the operated switching equipment in the event it is found the call results from a faulty condition of the line circuit or from the failure of a party to restore his receiver to its hook.

The invention as described in detail hereinafter is illustrated in its embodiment in an automatic telephone system comprising a plurality of subscribers' lines, each of which is identified by a particular number or character, and a plurality of subscriber-controlled automatic switches, including at least one group of impulse responsive selector switches, for setting up connections be-

tween the lines. In conformance with the usual arrangement, certain of the automatic switches other than the selector switches are operative to establish a link connection between any one of the subscribers' lines and an idle one of the selector switches when a calling condition is created on the said one line. In general, the objects as set forth above are attained in accordance with the present invention by providing in the exchange an emergency operator's station, together with means for establishing a connection between any calling one of the subscribers' lines and the operator's station in response to the continuation of a calling condition on the said one line for a given time interval. Specifically, this last-mentioned means comprises a link finder switch which is only operative in the event no control impulses are transmitted to a selected one of the selector switches within a given time interval after a link connection has been established thereto from a calling line. It is pointed out here that the term "calling condition" as used hereinafter is a generic descriptive term denoting any condition which results in the usual response of automatic switches in the exchange, whether this response be caused in the conventional manner by a subscriber lifting his receiver from its hook, by a fault in the circuit of the calling line, or by any other means. Each subscriber's line has associated therewith line lockout means in the form of a two-step lockout relay, and the plurality of lines have commonly associated therewith recording means in the form of a tape type of pen recorder. For the purpose of controlling these elements there is provided means controllable from the operator's station for causing the operation of the lockout relay associated with any calling line and for causing the recording means to record the character or number identifying the calling line. This last-mentioned means specifically comprises an auxiliary line finder switch, having a plurality of operating positions individually corresponding to the individual lines of a group of lines including a calling line, and an identification switch controlled in accordance with any particular operating position assumed by the auxiliary line finder switch. More particularly, the operation of the auxiliary line finder switch is initiated in response to the partial operation of the line lockout relay associated with the calling line, which partial operation results from the operator actuating a key switch provided at the operator's station to apply booster battery potential to the control conductor which extends through the operated

switch train between the line circuit of the calling line and the operator's station. This booster battery potential serves partially to energize the lockout relay associated with the calling line and results in the partial operation of this relay to initiate the operation of an auxiliary line finder switch and the associated identification switch.

Further features of the invention pertain to the particular arrangement and operation of the circuit elements whereby the various service features as outlined above are attained.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings in which Figures 1, 2, 3 and 4 illustrate an automatic telephone system having incorporated therein apparatus constructed and arranged in accordance with the present invention.

Referring now to the drawings, the system there illustrated comprises, in general, a plurality of subscribers' lines, two of which are indicated at 101 and 362, and a plurality of subscriber-controlled automatic switches, including a line finder switch 100, a first selector switch 350, a second selector switch 355 and a connector switch 380, for setting up connections between the various subscribers' lines. It will be understood that a plurality of switches of each type, namely, a plurality of line finder switches, a plurality of first selector switches, a plurality of second selector switches, and a plurality of connector switches, are provided in the system for performing the usual line switching functions. The switches of each type are respectively arranged in groups, and, in accordance with universally followed practice, the number of switches in each group is determined in accordance with the maximum volume of traffic the particular switch group is required to handle. Specifically, the exchange is designed to serve ten thousand subscribers' lines, these lines being divided into one hundred-line groups with the conductors of the lines of each group terminating in the bank contacts of a group of finder switches and a group of connector switches. In accordance with conventional practice, each line is multiplied between the corresponding bank contacts of a group of finder switches and the corresponding bank contacts of a group of connector switches, whereby a plurality of such switches are available for setting up connections between each line and every other line of the system. Thus, the conductors of the line 101 terminate in the bank contacts of the finder switch 100, which is one of a group of switches for serving the group of one hundred lines including the line 101. This line, in addition to being multiplied in the bank contacts of the switches in the finder switch group noted, is also multiplied in the bank contacts of a group of connector switches. Similarly, the line 362, which is indicated as terminating in the bank contacts of the connector switch 380, is multiplied to the corresponding contacts of other connector switches of the group including this switch and in the bank contacts of the switches in a finder switch group.

The end of each subscriber's line remote from the exchange housing the switching apparatus illustrated terminates in a subscriber's substation which may be of any desired arrangement. Two

such substations are diagrammatically illustrated at A and B in association with the lines 101 and 362, respectively. In brief, each of the substations may comprise the usual hand set type of transmitter and receiver, a hook switch, a ringer, and an impulsing device for transmitting the switch control impulses by way of the associated line to the automatic switching equipment embodied in the terminating exchange. Also associated with each subscriber's line is a line circuit, that for the line 101 being illustrated as comprising a combined line and cut-off relay R120 and line lockout means comprising a two-step relay R110.

As indicated above, each subscriber's line has associated therewith a group of line finder switches, any one of which is capable of establishing a link connection between the line and an associated first selector switch. In order, therefore, to assign the finder switches constituting a particular group to successive calling ones of the lines included in the associated line group, there are provided allotters, that associated with the group of finder switches including the switch 100 being indicated generally at 105. Since this allotter may be of any conventional arrangement, it has been only diagrammatically illustrated in the drawings.

Each of the line finder, first selector, second selector and connector switches is preferably of the well-known Strowger type having embodied therein a wiper carriage structure adapted to be translated vertically to bring the wipers thereof opposite a particular level of bank contacts and then rotated to bring the wipers into engagement with a particular set of contacts in a selected level; vertical, rotary and release magnets; and control relays suitably connected and arranged to control the energization of the various magnets and the line switching in accordance with particular functions of the switch. Obviously, the particular arrangement of the control apparatus as embodied in the switches of different type is different in each instance, depending upon the character of the switch. Since only the first selector switches represent a departure from conventional and well understood prior art arrangements, the remaining switches have been diagrammatically illustrated.

Each of the first selector switches included in the system may be identical with that indicated generally at 350 in Fig. 3. In brief, this switch comprises a switching mechanism, indicated at 351, of the well-known Strowger type including a plurality of bank contacts arranged in levels; wipers for engaging the bank contacts; means comprising a vertical magnet 337 for stepping the wiper carriage structure vertically to position the wipers opposite a particular selected level; means comprising a rotary magnet 338 for imparting rotary motion to the wiper carriage structure, thereby to move the wipers into engagement with a selected contact set in the selected level; and means comprising a release magnet 349 for restoring the wiper carriage structure to its normal position during the release of the switch. Also incorporated in the selector switch 350 are the usual line, hold and impulse circuit control relays R310, R320 and R330, respectively, a line switching relay R300 and rotary and vertical off-normal springs indicated respectively at 385 and 390. In addition to the conventional elements as identified above, there is provided in this selector switch a time pulse controlled relay R340 which enters into the operation of the apparatus in its performance of

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the novel functions outlined above. For the purpose of controlling this and the other similar relays, there is provided a pulse generator schematically illustrated at 399 which is commonly associated with all of the first selector switches. This generator may be of any well-known construction which includes means for alternately applying ground pulses to the time pulse leads C315 and C316 at spaced intervals. If desired, it may comprise a commutator driven by a synchronous motor through a gear reduction box and including grounded commutator segments suitably arranged to engage brushes respectively terminating the leads C315 and C316.

Neglecting for the present the remaining apparatus illustrated in the drawings, the system as described above is, in general, entirely conventional in form and its operation is well understood in the art. In brief, when a subscriber, such, for example, as the subscriber at the telephone A, initiates a call over the line 101 to a second subscriber's telephone, such, for example as the telephone B, by lifting his receiver from its hook, a circuit is completed for energizing the three windings of R120 in series, this circuit extending from ground at the upper terminal of the lower winding of R120 by way of RA123, C102, the bridge across C102 and C103 at the substation A, C103, RA114, RC115, RA124 and through the upper and intermediate windings of R120 in series to battery. Due to the high series resistance of this circuit, R120 only partially operates to close the "X" contacts associated respectively with RA121 and RA125. At RA121, ground from RA122 is applied to the start conductor C99, thereby to cause the allotter means 105 to initiate the operation of one of the finder switches to search for the calling line 101. At RA125, a path is prepared for applying ground to the control conductor of the line 101, thereby to mark the line as busy in the bank contacts of the connector switches at which this line terminates. At RA125, battery from the upper terminal of the intermediate winding of R120 is extended to the control conductor C98 terminated in the bank contacts of the finder switches, thereby to mark the line 101 as the calling line. It is noted that the allotter 105 functions in a manner such that an idle line finder switch is conditioned immediately to start operating in search of a calling line upon the application of ground potential to the start conductor C99. Assuming, for example, that the finder switch 100 is the switch assigned by the allotter 105 to the use of the calling line 101, the wipers of this switch are first operated to a position opposite the level in which the calling line is terminated, this level being identified through the application of marking or ground potential to C99. When this level is found, the wipers are automatically stepped into the bank contact field to test the individual lines terminating at the selected bank contact level. When the calling line, as marked by the application of battery to the control conductor thereof, is found, the hunting operation is automatically discontinued and the control apparatus embodied therein functions automatically to switch the calling line through and establish a link line between this line and the trunk line 191 incoming to the first selector switch 350. Following this operation, the line finder switch 100 is marked as busy in the allotter means 105 and the allotter means is started in operation to a position corresponding to the next available idle finder switch. Also in the course of these operations,

direct ground is applied to the control conductor C98, thereby to mark the calling line as busy through the application of ground to the control conductor of the line 101 and to cause the full energization of the intermediate winding of R120. As a result, R120 now fully operates to remove, at RA121, ground from the start conductor C99 and to disconnect its windings from the line conductors C102 and C103 of the line 101. Thus, the calling line is cleared of any impedance elements which might interfere with the transmission of impulsing and voice frequency currents.

Immediately the link connection is established to the first selector switch 350, a circuit is completed for energizing the line relay R310 embodied in this switch. This circuit extends from ground on the dial tone conductor C352 by way of the off-normal springs 389' and 389, the lower winding of R310, RC309', RA308, C283, RA292, C193, C102, the bridge across C102 and C103 at the substation A, C103, RA114, C192, RA291, C282, RA301, RC302 and through the upper winding of R310 to battery. Dial tone current is conducted over a path similar to that just traced and through the receiver at the substation A, thereby to indicate to the calling party that the dialing operations may be performed. At RA311 and RC313, the relay R310, upon operating, completes an obvious circuit for energizing the hold relay R320. The last-mentioned relay, in turn, operates to complete a circuit for energizing the pulse circuit transfer relay R330, this latter circuit extending from ground at RA321 by way of the off-normal springs 391 and through the upper winding of R330 to battery. At RA323', the relay R320 applies ground to the start conductor C314, thereby to initiate the operation of the pulse generator 399. At RA321, the relay R320 completes an obvious path for applying ground potential to the control conductor C194 of the trunk line 191, thereby to hold the preceding finder switch 100 operated. At RA323, the relay R320 completes an obvious circuit for energizing the lower winding of the polarized relay R300, thereby to render this relay exceedingly fast to operate when its upper winding is subsequently energized. At RA322, the relay R320 prepares a test circuit, traced hereinafter, for energizing the upper winding of R300, following the operation of the switching mechanism embodied in the selector switch 350 to a position corresponding to an idle trunk in a selected trunk group. At RA324 and RC326, the relay R320 prepares an impulsing circuit for energizing the vertical operating magnet 337 in accordance with the impulses comprising the first digit dialed at the calling substation A.

The last-mentioned circuit is completed at the beginning of the first impulse of the first series of impulses dialed at the calling substation and extends from ground at RA306 by way of RC307, RA311, RC312, RA324, RC326, RA334 and through the winding of the magnet 337 to battery. When energized over the above-traced circuit, the vertical magnet 337 lifts the wipers of the mechanism 351 one step or to a position opposite the first level of bank contacts. Simultaneously with this operation, the off-normal springs 390 are operated to the off-normal position, whereby the above-traced operating circuit for R330 is interrupted at the springs 391, and circuits, traced hereinafter, are prepared at the springs 392 and 393, respectively, for energizing the release and rotary magnets 349 and 338, respectively. During each impulse of the

first series of impulses, the vertical magnet 337 is energized in the above-described manner so that, at the conclusion of the first digit dialed, the wipers of the mechanism 351 stand in a position opposite the level of bank contacts terminating the group of trunks outgoing to the second selector switches having access to the connector switches at which the called line 362 terminates. Each time this magnet is energized, the lower winding of R330 is energized in parallel therewith over the impulsing circuit as traced above and, due to the slow-to-release characteristic of this relay, it remains operated until the first series of impulses is terminated. For the same reason, the hold relay R320 is held operated during impulsing.

With the wipers of the mechanism 351 standing opposite the level of bank contacts terminating the group of trunks leading to the respective selector switches of the group including the switch 355, the first selector switch 350 is automatically conditioned to search for an idle one of these trunks. Thus, shortly following the end of the first series of impulses, R330 restores to open, at RA334, the impulsing circuit for the vertical magnet 337 and to complete, at RA335, a circuit for energizing the rotary magnet 338. This last-mentioned circuit extends from ground at RA306 by way of RC307, RA311, RC313, the armature 339, the springs 393, RA335 and through the winding of the magnet 338 to battery. Upon being energized over the above-traced circuit, the rotary magnet steps the wipers of the mechanism 351 into engagement with the first set of contacts in the selected level and simultaneously interrupts its operating circuit at the armature 339. Obviously, with this circuit open, the magnet noted restores its armature 339, to recomplete the circuit. Hence, the rotary magnet 338 operates in the manner of a buzzer to drive the wipers of the mechanism 351 over the contacts of the selected level until they are moved into engagement with a set of contacts terminating a trunk leading to an idle second selector switch. In this connection, it is noted that, if any one of the second selector switches is idle, this condition is indicated by the presence of battery potential on the control conductor of the trunk incoming thereto. In the case of a busy second selector switch on the other hand, ground potential is present on the control conductor of the trunk incoming thereto. Assuming that the switch 355 is the first switch of the selected group found idle, the wipers of the mechanism 351 are rotated until they encounter the bank contacts terminating the conductors of the trunk leading to this switch. Since battery potential is present on the control conductor of this trunk, the upper winding of R300 is energized over a circuit extending from ground at RA321 and through the upper winding noted, RA322, to battery on C356 immediately the contacts terminating the conductors of the trunk are engaged by the wipers of the mechanism 351. This relay immediately operates to interrupt, at RA306, the above-traced circuit for the rotary magnet 338 thereby to arrest the rotary movement of the switch wipers.

When R300 operates, it switches the partially completed connection through to the trunk line extending to the switch 355, through the operation of its armatures RA301 and RA308 into engagement with their associated contacts RC303 and RC309, respectively. There is thereby completed a loop circuit for energizing the line relay conventionally included in the switch 355,

which relay, upon operating, causes the operation of an associated hold relay. The last-mentioned relay functions to apply ground to the control conductor of the trunk incoming to the switch 355, which ground is extended by way of the switch mechanism 351 to the control conductor C356. Since R300 is now in its fully operated position, this ground is further extended by way of RA304 to the control conductor C194 and, hence, serves to hold the finder switch 100 in its operated position. At RA305, the relay R300, upon operating, completes an obvious circuit extending from ground on C194 for energizing its intermediate winding, thereby to hold itself operated independently of the condition of the line and hold relays R310 and R320.

At RA301 and RA308 and their respective associated contacts RC302 and RC309', the relay R300, upon operating, opens two points in the above-traced operating circuit for R310, causing this relay to restore. When R310 falls back, it opens, at RA311 and RC313, a further point in the operating circuit for R320, this latter relay having been previously deenergized in response to the operation of R300. With R310, R320 and R330 deenergized and the off-normal springs 390 operated to their respective off-normal positions, a circuit, traced hereinafter, is prepared for energizing the release magnet 349. The selector switch 350 remains in this condition until the connection is cleared out.

In the event all of the trunks terminated at the selected level of bank contacts lead to busy second selector switches, the rotary magnet 338 will cause the wipers of the mechanism 351 to be stepped to their respective eleventh off-normal positions, at which time the springs 385 are moved to the off-normal position. When this occurs, an alternative circuit is completed for energizing the upper winding of R330, this circuit extending from ground at RA306 by way of RC307, RA311, RC313, the switch springs 387, and through the upper winding of R330 to battery. The relay R330, upon operating, interrupts, at RA335, a point in the above-traced operating circuit for the rotary magnet 338, thereby to arrest the movement of the wipers embodied in the mechanism 351. At the off-normal springs 389 and 389', a point is opened in the above-mentioned circuit for conducting dial tone current to the receiver at the calling substation, and, at the springs 388 and 389, a circuit including the busy tone conductor C353 is completed for conducting busy tone current by way of the subscriber's loop circuit to the receiver at the calling substation. The resulting busy tone indicates to the calling subscriber that the desired connection cannot immediately be completed.

The calling subscriber, upon receiving busy tone, may initiate the release of the operated switch train by restoring his receiver to its hook to open the loop circuit over which the line relay R310 is held operated. This relay, upon restoring, opens, at RA311 and RC313, points in the above-traced operating circuits for the relays R320 and R330. These two relays restore, after an interval, to complete a circuit for energizing the release magnet 349, this circuit extending from ground at RA306 by way of RC307, RA311, RC312, RA324, RC325, RA331, RC333, the switch springs 392, and through the winding of the magnet 349 to battery. In response to the energization of the release magnet, the wipers of the mechanism 351 are restored to normal, at

which time the off-normal springs 385 and 390 are returned to normal. When the hold relay R320 restores, ground is removed at RA321 from the control conductor C194 of the trunk incoming to the selector switch 350, thereby to release the line finder switch 100 and cause the restoration of the combined cutoff and line relay R120. Thus, the switch train involved in the partially completed connection is cleared out and the switches included therein are released for further use.

Continuing now with the operation of the apparatus to establish a connection to the called line 362 and assuming that the second selector switch 355 is selected by the first selector switch 350 to forward the connection, immediately the loop circuit is extended to the switch 355, this switch is conditioned to respond to the impulses of the second digit dialed at the calling substation. Since this second selector switch may in all essentials be identical with the switch 350, it will be understood that the second dialed digit results in the elevation of the wipers of the switch 355 to a position opposite the level of the bank contacts terminating the trunks leading to the connector switches having access to the called line. Following this operation, the wipers of the switch 355 are automatically stepped over the contacts of the selected level until a trunk leading to an idle connector switch of the selected group is found. Assuming that the connector switch 380 is the first idle connector switch in the selected group, when the wipers of the switch 355 are stepped into engagement with the contacts terminating the trunk extending to this connector switch, the subscriber's loop circuit is extended thereto to cause the operation of the line and hold relays conventionally provided therein, whereby ground is returned over the control conductor of the selected trunk to hold operated the switches 355, 350 and 100. With the apparatus in this condition, the connector switch 380 is conditioned to respond to the impulses comprising the third digit dialed at the substation A. In response to the dialing of this digit, the wipers of the connector switch 380 are stepped vertically opposite the level of bank contacts at which are terminated the lines of the ten line group including the called line 362. Following this series of impulses the connector switch is conditioned to rotate the wipers step by step in accordance with the impulses making up the fourth and final digit dialed at the calling substation. When the last digit is dialed, the wipers of the switch 380 are stepped into engagement with the set of bank contacts terminating the called line 362. In accordance with conventional practice, suitable provisions are made for testing this called line to determine its idle or busy condition; for returning busy tone over the established loop to the calling subscriber in case the line is busy; and for applying ringing current to the called line in the event this line is idle at the time it is selected. Assuming that the called line is idle, the desired conversational connection is established when the called substation B is answered.

Any desired arrangement of the connector switches may be used for insuring the release of the switch train following the completion of a talking connection by way thereof between two subscribers' lines. Thus, the control apparatus embodied in the switch 380 may be arranged so that the release of the connection is under the control of the calling party or, alternatively,

under the control of the last party to hang up. In either case the release of the switch train is initiated upon the restoration of the hold relay conventionally provided in the connector switch 380, this operation serving to remove holding ground from the control conductors of the various operated switches, thereby to cause the energization of the release magnets respectively provided therein in a manner similar to that described above with reference to the release of the selector switch 350. During the release of the switch train and when ground is removed from C98, the holding circuit for R120 is opened causing this relay to restore. When this occurs, ground is removed from the control conductor of the line 101, thus identifying this line as idle in the bank contacts of the connector switches at which the line terminates.

Referring now more particularly to the apparatus provided in the system for rendering the various services discussed briefly in the introductory portion of the specification, it is pointed out that this apparatus comprises an operator's station 395 and means comprising a link finder switch 210 and certain of the apparatus embodied in the selector switch 350 for establishing a connection between a subscriber's line and the operator's station in the event a calling condition is maintained on the line for a predetermined time interval. More generally considered, a group of link finder switches including the switch 210 are provided, each switch having associated therewith an operator's station or board corresponding to that indicated generally at 395 in association with the switch 210. Each of the link finder switches is arranged to have access through its bank contacts to the respective trunk lines which extend to the first selector switches of the exchange. For the purpose of assigning the link finder switches for use in a definite order, there is provided a link finder switch allotter 215. The link finder allotter 215 functions in a manner such that an idle link finder switch is always immediately available for use. Since the link finder switches may be of any conventional arrangement and in all respects identical with the line finder switch 100, and the allotter 215 may be similar to the allotter 105, the elements 210 and 215 are only schematically illustrated in the drawings. The operation of an assigned link finder switch to set up a connection between the calling line and the operator's station associated with the assigned link finder switch may be initiated through the provision of a time pulse controlled relay in each of the first selector switches. To this end, R340 is included in the selector switch 350.

The apparatus embodied in the operator's station 395 comprises a line relay R360, a hold relay R365, a control relay R370, an operator's telephone set, a key switch 364 for connecting the operator's telephone set to the trunk 211 leading to the finder switch 210, and a key switch 377 for initiating certain control operations pointed out in detail hereinafter.

For the purpose of locking out any one of the subscriber's lines and determining the number identifying the line under the conditions discussed above, there is associated with the plurality of subscribers' lines terminating in the exchange a plurality of auxiliary finder switches, such, for example, as the switch 190 associated with the group of subscribers' lines including the line 101. These auxiliary line finder switches are arranged in groups with the individual

switches of each group each having a plurality of operating positions individually corresponding to the subscribers' lines included in a particular associated group of lines. Each of the auxiliary finder switches may be identical in construction and arrangement with the finder switches corresponding to and including the switches 100 and 210. More specifically, the switch 190 is indicated as being of the well-known Strowger type and comprises a switching mechanism 170 which includes a plurality of bank contacts arranged in levels and a set of wipers 174, 175, 176, 182, 183 and 184 adapted to be translated vertically opposite a selected contact level by means comprising a vertical operating magnet 166 and thereafter to be rotated into engagement with a selected set of contacts in the selected level by means comprising a rotary operating magnet 165. For the purpose of selecting a desired level of contacts, there is also included in the switching mechanism a set of test contacts 106, individual ones of which are oppositely disposed with respect to the various contact levels, and a test wiper 107 for successively engaging the contacts of the set 106 as the wiper carriage mechanism is translated vertically through the operation of the magnet 166. In order to release the wiper carriage mechanism following its operation to a particular position, there is provided a release magnet 167. Also included in the finder switch are three control relays R130, R140 and R150 and off-normal springs 185.

For the purpose of determining the auxiliary finder switch associated with a particular group of lines including a calling line, there is provided, in common association with the plurality of auxiliary switches an auxiliary line finder switch distributor. This distributor includes a rotary switch of conventional construction indicated at 205, through the operation of which the auxiliary finder switches are selected for use and the control relays R250, R260 and R270 are selectively associated with the control apparatus of the selected auxiliary finder switch. Operation of the distributor switch 200 to select and initiate the operation of an auxiliary line finder switch is started through the provision therein of a common start relay R280 under the control of each of the start relays respectively associated with the auxiliary finder switches such, for example, as R160, associated with the finder switch 190. Also included in the distributor 200 are three control relays R220, R230, and R240 which function to control the operation of a line identification switch 400 in accordance with the operating position assumed by the wiper carriage mechanism embodied in a selected operated one of the auxiliary line finder switches.

The identification switch 400 is commonly associated with all of the subscribers' lines terminating in the exchange, and functions to control indicating means in the form of a pen type of recorder 410. Specifically, this identification switch comprises a rotary switch 420 which may be of any standard commercial construction comprising four sets of bank contacts 421, 422, 423 and 424 of twenty-five points each, wipers 425, 426, 427 and 428 respectively associated with the bank contact sets in the order of their enumeration, and means comprising an operating magnet M485 and a ratchet and pawl mechanism, not shown, for driving the enumerated wipers over the contacts of their respective associated contact sets. As indicated by the cable 129, the bank contacts of the switch 420 are wired to the bank contacts

and certain of the relay armature springs embodied in the respective auxiliary line finder switches. This wiring is such that, through the repeated operation of the switch 420, it is possible successively to determine the one thousand-line group including a particular calling line, the one hundred-line group of the selected one thousand-line group which includes the calling line, the ten-line subgroup of the selected one hundred-line group which includes the calling line, and the particular calling line in the selected ten-line subgroup. The repeated operation of the switch 420 to perform its line identification function is under the control of a plurality of relays R430, R440, R450, R460, R470 and R480, which relays are connected and arranged to operate in the manner pointed out in detail immediately hereinafter.

Operation of the apparatus to extend a connection to the operator's station

Referring now more particularly to the operation of the apparatus automatically to extend a connection to the operator's station 395, attention is again directed to the first selector switch 350 in its operation to extend a connection from the calling line 101 to the called line 362. Immediately a link connection is established to this selector switch from the calling line and when R330 operates, a circuit is prepared for energizing the two windings of R340 in series. If the calling condition on the line 101 is occasioned by a fault on this line or by an emergency at the substation A, such that the calling subscriber is unable to operate the dialing device located at this substation, no control impulses will be transmitted by way of the calling line and the established link connection to the selector switch 350. Hence, only the relays R310, R320 and R330 of this switch are operated. After this condition has prevailed for a given time interval, a ground pulse is applied to the conductor C315 by the pulse generator 399. This pulse serves to energize R340 over a circuit which extends from ground on the conductor C315 by way of the switch springs 386, RA336, RC345', RA346 and through the two windings of R340 in series to battery. Due to the high series resistance of its windings, the relay R340 only partially operates in response to its energization over the above-traced circuit, to close the "X" contacts associated with RA342 and RA345. At RA346 and RC345', the above-traced operating circuit for R340 is interrupted, but not before a substitute circuit is completed, at RA346 and RA345, for holding R340 energized, this latter circuit extending from ground at RA321 by way of the off-normal springs 391, RA345, RA346 and through the two windings of R340 in series to battery.

If, with R340 in this condition, a first digit is dialed at the calling substation, such that the wipers of the mechanism 351 are translated vertically to move the springs 390 to their respective off-normal positions, the above-traced holding circuit for R340 is interrupted at the springs 391. Following this first series of impulses, the original operating circuit for R340, as traced above, is interrupted at RA346. Hence, R340 is caused to restore and the connection may be extended to the desired called line in the manner described previously. Assuming, however, that no impulses are transmitted to the selector switch 350 following the partial energization of R340 in the manner just described, there is completed, after a given time interval, a circuit for causing R340 com-

pletely to operate. Thus, a given time interval after the ground pulse is applied to C315, a ground pulse is applied to C316 by the pulse generator 399, this pulse serving to energize the upper winding of R340 over a circuit extending by way of C316, RA342 and RA344. With its upper winding alone energized, R340 fully operates to complete, at RA343, a holding circuit for itself, which circuit extends from ground at RA323 by way of RA343, RA344 and the upper winding of R340 to battery.

Upon fully operating, R340 completes, at RA341, a circuit for partially energizing R290, this circuit extending from ground at RA341 by way of C284 and through the two windings of R290 in series to battery. Due to the high resistance of its upper winding, R290 only partially operates, when energized over the above-traced circuit, to close only the "X" contacts associated with RA295 and RA296, respectively. With these "X" contacts closed, ground from RA293 is applied to the link line marking conductor C217 and the start conductor C216 thereby to cause an idle one of the link finder switches to be started in operation to search for the link connection established to the selector switch 350. Assuming that the link finder switch 210 is the switch assigned by the allotter 215 for use, this switch operates in a conventional manner to a position corresponding to the link connection noted, as determined by the ground marking on C217. When the switch 210 has completed its operation, the link conductors C192 and C193 are connected through to the trunk conductors C212 and C213, respectively, and ground is directly applied to the control conductor C218. As a result, the upper winding of R290 is short-circuited and the lower winding thereof is fully energized to cause this relay to assume its fully operated position.

When the subscriber's loop circuit is extended by way of the link finder switch 210 to the line conductors C212 and C213, a circuit is completed for energizing the line relay R360 at the operator's station, this circuit extending from ground at the upper terminal of the lower winding of R360, through this winding, over one side of the loop circuit to the calling substation, through the bridge across the line conductors at this substation, over the other side of the loop circuit and through the upper winding of R360 to battery. The relay R360 operates, when energized over the above-indicated circuit, and completes, at RA361, an obvious circuit for energizing the slow-to-release hold relay R365. The relay R365 in turn completes, at RA366 and RA367, a path extending by way of RC376 and RA375, for applying ground to C214, thereby to maintain the link finder switch 210 operated independently of R290. Ground on C214 is extended by way of the switch 210, C218 and RA294 to the control conductor C194, whereby the line finder switch 100 and the relay R120 are also held operated.

At RA366 the relay R365 completes a circuit for energizing the indicating lamp 379, this circuit extending from ground at RA366 by way of RA371, RC372, the switch springs 397 and through the filament of the lamp 379 to battery. With the lamp 379 energized, the operator on duty at the station 395 is informed that an emergency call awaits attention. By operating the key switch 364 to its off-normal position, she may connect her telephone set to the line conductors C212 and C213 of the trunk 211, thereby to establish a talking connection which extends by way of the operated finder switches 100 and

210 to the calling line 101. It will be noticed that this operation results in closure of the switch springs 396 and 398 to complete the talking connection, and in the opening of the springs 397 to interrupt the above-traced operating circuit for the calling lamp 379.

When the relay R290 assumes its fully operated position following the operation of the link finder switch 210 to extend the connection to the operator's station, the loop circuit extending to the selector switch 350 is interrupted at the two armatures RA291 and RA292, causing R310 to restore. When R310 falls back, it causes the sequential restoration of the two relays R320 and R330. With the three enumerated relays restored, a circuit, traced previously, is completed for energizing the release magnet 349, thereby to cause the selector switch 350 to be restored to normal in the manner described above.

The operator at the station 395, upon completing the talking connection in the manner described above, may challenge the connection to determine whether the call was occasioned by a faulty condition of the line 101 or was the result of a call initiated at the substation A. If the call results from the first of these causes, obviously no response will be received when the connection is challenged. If, on the other hand, the connection to the operator's station was actually initiated at the substation A, the operator may, by conversing with the calling party, determine the nature of the call, that is, whether the failure to dial a number was due to ignorance on the part of the calling party or due to an emergency requiring the assistance of the operator. Assuming that the call was originated by a party unfamiliar with the mode of operating a dialing device as conventionally employed in automatic systems, the operator may either advise this party as to the operations required for obtaining the desired connection or she may extend the connection to the desired line in the manner conventionally employed in manual exchanges or exchanges of semi-automatic character.

In many cases of emergency, such, for example, as those occasioned by sudden illness, the party who initiates the call may have only sufficient strength to indicate that help is needed without giving any information concerning the point from which the call is originated. In these cases, as in these instances where the connection to the operator's station results from a faulty line condition, it is extremely desirable that the operator be able to determine the number identifying the calling line without assistance and with a minimum loss of time.

Operation of the apparatus to determine the number identifying the calling line and to lock the calling line out of service

The number or character identifying the calling line 101 may automatically be determined through the operation of the auxiliary line finder switch 190, the auxiliary line finder switch distributor 200, the identification switch 400, and the recording means 410. As indicated previously, each of the auxiliary line finder switches is controllable from the operator's station. Thus, if the operator, upon challenging the connection extending to the line 101, deems it necessary to determine the number identifying this line, she may initiate the operation of the distributor 200 to find the finder switch 190 associated with the group of lines including the line

101, by momentarily actuating the key switch 377 to its off-normal position. When this operation is performed, an obvious circuit is completed for energizing the slow-to-release relay R370. This relay, upon operating, completes a holding circuit for itself, which circuit extends from ground at RA366 by way of RA371, RC373 and through the winding of R370 to battery. At RA375 and RA376, ground is removed from the control conductor C214. Simultaneously with the last-mentioned operation, there is completed, at RA374 and RA375, a path for applying booster battery potential, which is present on the conductor 378, by way of RA367 to the control conductor C214. It will be understood that this operation in no way affects those operated relays which depend for energization upon the presence of ground to C214 or the control conductors C218 and C194 connected to C214. This is true for the reason that the booster battery voltage is connected in series with the exchange battery in aiding phase relation so that it serves further to energize those relays having windings connected to the control conductors noted. The application of booster battery voltage to C214 obviously results in an increase in the positive potential on the control conductor C98, which increase in potential results in the substantial energization of the line lockout relay R110 over a circuit extending from the positive side of the booster battery, as extended to C98, by way of the resistor 97 and the winding of R110 to the negative terminal of the regular exchange battery.

When energized over the above-traced circuit, the relay R110 partially operates to close only the "X" contacts associated with RA117 and RA119'. This operation serves to mark the calling line in the test contacts of the auxiliary finder switch 190 as being included in a particular ten-line subgroup and also to mark the particular line of the marked subgroup. Thus, the relay R110 applies, at RA119', ground from RA111 to the start conductor C126 and by way of this conductor to the first contact 108 of the test contact set 106. Hence, the calling line is identified as being included in the subgroup of ten lines corresponding to the first level of bank contacts embodied in the switch mechanism 170 of the auxiliary finder switch 190. At RA117, ground is likewise applied to C127, thereby to mark the calling line in the first level of bank contacts. The partial operation of R110 further results in the completion of a circuit for energizing the start relay R160, this circuit extending from ground at RA111 by way of RC112, RA119', C126, C128 and through the winding of R160 to battery.

The relay R160, upon operating, completes, at RA161, a circuit extending by way of C109 for energizing R280, which latter relay, in turn, operates to complete a circuit for energizing R260. The last-mentioned circuit extends from ground at RA254 by way of RA281, the winding of R260, the armature 207 and through the winding of M206 to battery. Due to the resistance of the winding of R260, M206 is not energized over the above-traced circuit and remains inactive. The relay R260, however, is energized and operates to complete, at RA265 and RA266, an obvious locking circuit for itself. The relay R260 upon operating also initiates the operation of the distributor 200 to select the particular auxiliary line finder switch associated with the group of two hundred lines including the calling line. This finder switch selecting operation is under the control of the start relays corresponding to R160

and respectively associated with each of the other auxiliary finder switches. Each of these relays includes armature springs for applying ground to the guard conductor of its associated finder switch. For example, the relay R160, in its restored position, applies ground to C199 terminating at the bank contact 235 over a path starting at RA162 and extending by way of RC164, the off-normal springs 188 and 189, RC155 and RA154. When R160 is energized this path is interrupted at RA162 and RC164. It will be understood, therefore, that if the wipers of the rotary switch 205 are standing in a position which does not correspond to the auxiliary finder switch 190, the contact of the set including the contact 235 and corresponding to the position of the switch wipers will have ground present thereon. More generally stated, all of the contacts of this set, other than the contact 235, will have ground potential thereon, assuming that only the lockout relay R110 associated with the line 101 is in its partially operated position. From the foregoing it will be seen that the relay R260, upon operating, completes, at RA262 and RC264, a circuit for energizing M206 of the rotary switch 205 in the event the position of the wipers of this switch does not correspond to the particular auxiliary line finder switch 190 associated with the group of two hundred lines including the calling line. This circuit extends from ground on the wiper 223 by way of RA262, RC264 and the winding of M206 to battery. When energized over the above-traced circuit, M206 attracts its armature 207 to interrupt a point in the above-traced circuit for R260, causing this relay to restore. Upon restoring, the relay R260, in turn, interrupts the above-traced circuit for energizing M206, and thus the wipers of the rotary switch 205 are caused to be stepped one step or into engagement with a set of bank contacts at which are terminated the control conductors for controlling a different auxiliary line finder switch associated with a different group of two hundred lines. When M206 restores its armature 207, the above-traced operating circuit for R260 is again completed. Assuming that the second selected auxiliary line finder switch, corresponding to the operating position of the wipers of the switch 205 at the end of the first step, does not include the calling line, M206 is again energized over a circuit similar to that traced above but extending by way of a different contact of the set including the contact 235. Hence, the wipers of the rotary switch 205 are moved a second step. This stepping operation of the switch 205 continues until such time as the auxiliary line finder switch 190 is found by the distributor 200. Since R160 is in its operated position, it will be seen that, when the wipers of the rotary switch 205 have been operated to a position corresponding to the auxiliary line finder switch 190, no circuit is available for thereafter energizing M206. Hence, the operation of the rotary switch 205 is arrested with the wipers of the switch occupying a position such that the control apparatus in the distributor 200 is connected by way of the various control conductors shown to control the operation of the line finder switch 190. Immediately the wiper 222 is stepped into engagement with the bank contact 234, a circuit is completed for energizing the slow-to-release relay R150, this circuit extending from ground at RA261 by way of the switch wiper 222, the bank contact 234, C198 and through the winding of R150 to battery. The relay R150, upon operating, prepares, at RA152 and RA153, respec-

tively, test circuits for energizing the test relays R130 and R140. At RA157, the relay R150 prepares a circuit, traced hereinafter, for energizing the rotary magnet 165. Simultaneously with the energization of R150, a circuit is completed for energizing the vertical magnet 166, this circuit extending from ground at RA266 by way of RA272, RC273, RA251, RC252, the switch wiper 224, the bank contact 236, C139 and through the winding of the magnet 166 to battery. This magnet, upon being energized, steps the wipers of the switching mechanism 170 one step in a vertical direction, or to a position opposite the first level of bank contacts, and attracts its armature 166' to complete a circuit for energizing R270; this last-mentioned circuit extending from ground at the armature 166' by way of C159 and through the winding of R270 to battery. The relay R270, upon operating, attracts its armature RA271, thereby to interrupt, at RA272 and RC273, the above-traced operating circuit for the vertical magnet 166. This magnet, upon being de-energized, restores its armature 166' to open the operating circuit for R270, which relay restores in turn to again complete the circuit for the magnet 166. Due to the interrelated operation of R270 and the vertical magnet 166, the wipers of the switching mechanism 170 are operated step by step until they reach a position opposite the level of bank contacts including the set of contacts corresponding to the calling line. In the present case, this set of contacts, which corresponds to the line 101, is included in the first bank contact level and, hence, the wipers are only translated one step vertically. Immediately the first step is taken by the wipers of the mechanism 170, a circuit is completed for energizing the lower winding of R250, this circuit extending from ground at RA111 by way of RC112, RA119', C126, the test contact 108, the test wiper 107, C149, the bank contact 237, the wiper 225, RA256, the lower winding of R250, RA266' and the resistor 274 to battery. The relay R250 now operates to complete, at RA255, an obvious holding circuit for itself including its upper winding; to interrupt, at RA254, a point in the original energizing circuit for R260; to interrupt, at RA251 and RC252 a point in the operating circuit for the vertical magnet 166; and to complete, at RA251 and RC253, a circuit for energizing the rotary magnet 165. The last-named circuit extends from ground at RA266 by way of RA272, RC273, RA251, RC253, C197, RA157, RA147, RA137 and the winding of the magnet 165 to battery. This magnet, when energized over the above-traced circuit, rotates the wipers of the mechanism 170 into engagement with the first set of contacts in the selected level and completes, at its armature 165', a circuit for energizing R270, this circuit being identical with that traced above with the exception that ground is applied to C159 at the armature 165' rather than at the armature 166'. When R270 operates, it interrupts, at RA272 and RC273, the above-traced circuit for energizing the rotary magnet 165 causing this magnet to restore its armature 165' and open the operating circuit for R270. Due to the interrelated operation of R270 and the magnet 165, the wipers of the mechanism 170 are successively stepped into engagement with their associated contacts included in the selected level until such time as the particular contact set corresponding to the calling line 101 is encountered. In the present case, this set of contacts comprises the contacts 171, 172 and 173 and when the wipers

174, 175 and 176 are stepped into engagement with these contacts, a circuit is completed for energizing R130, this circuit extending from ground at RA111 by way of RC112, RA117, C127, the contact 173, the wiper 176, RA145, RA152 and through the winding of R130 to battery. The relay R130, upon operating, interrupts, at RA137, a point in the above-traced operating circuit for the magnet 165, thereby to arrest the interrelated operation of this magnet and R270 while the wipers of the mechanism 170 are standing in engagement with the contacts of the set corresponding to the calling line 101. At RA135, the relay R130 opens a point in the operating circuit for the test relay R140 and, at RA137', it opens a point in the operating circuit for the release magnet 167. At its armatures RA131, RA132 and RA133, the relay R130 marks with battery potential the bank contacts of the identification switch 403 which determine the particular number identifying the line 101. At RA134, the relay R130 prepares a circuit, traced hereinafter, for fully energizing the line lockout relay R110.

As indicated above the auxiliary finder switch 190 is associated with a group of two hundred lines and has an operating position corresponding to each of the lines of the associated group. More generally considered, the switch has one hundred operating positions, but is of the type wherein two lines, one in each of two one hundred line groups, are simultaneously tested when the wipers are operated to any particular off-normal position. Thus, with the wipers operated to the position corresponding to the line 101, a test circuit is prepared for energizing the test relay R140 as well as R130, this circuit extending by way of a conductor, corresponding to C127 and leading to the armature springs of a lockout relay other than R110, the contact 181, the wiper 184, RA135, RA153 and through the winding of R140 to battery. Since, however, the line lockout relay R110 is energized rather than the lockout relay corresponding to the contact 181, the test relay R140 is not energized. It will be noted that with either of the two test relays operated, the operating circuit for the other is opened, thereby to prevent inadvertent energization of both of these relays at the same time. Also, with either relay operated a circuit is completed for energizing the relay R220.

Thus, the relay R130, upon operating, completes a circuit for energizing R220, this circuit extending from ground at the upper terminal of the winding of R220 by way of this winding, RA231, C196, RA136, RC156, RA154, C199, the bank contact 235, the wiper 223, RA262, RC264 and through the winding of M206 to battery. Due to the high resistance of the winding of R220, the magnet M206 is not sufficiently energized to cause further operation of the switch 205 or to attract its armature 207. The relay R220 is, however, sufficiently energized to operate and, upon operating, initiates the operation of the identification switch 400 to transmit to the recorder 410 coded impulses corresponding to the number identifying the line 101. Thus, R220, upon operating, completes, at RA221, a circuit for energizing R470, this circuit extending from ground at RA221 by way of C453, embodied in the cable 104, and through the winding of R470 to battery.

The relay R470, upon operating, completes, at RA471 and RA472, circuits for energizing R450 and R430. The first-mentioned circuit, namely, that for energizing R450, extends from ground at RA472 by way of RC474, C463, RA441, RC443,

and through the winding of R450 to battery. The operating circuit for R430 extends from ground at RA472 by way of RC474, RA471, C455, the switch wiper 427, the first contact of the set 423, C457, RA478, the winding of R430, and the resistor 488 to battery. The relay R430, upon operating, completes a holding circuit for itself, which circuit extends from ground, at RA472, by way of RC474, C463, RA432, the winding of R430 and the resistor 488 to battery. At RA431, the relay RA430 prepares a circuit, traced hereinafter, for energizing the pen operating magnet 415 embodied in the recorder 410.

When R450 operates, it completes, at RA451, a circuit extending from ground at RA472 for energizing the slow-to-operate relay R460 and prepares, at RA452, a further point in the operating circuit for the magnet 415 embodied in the recorder 410. The relay R460 operates, after an interval, to complete, at RA461, a circuit for energizing R440, which circuit extends from ground at RA472 by way of RC474, C463, RA461, RA481 and the winding of R440 to battery. The relay R440, upon operating, interrupts, at RA441, the above-traced operating circuit for R450 causing this latter relay to restore. Obviously, when R450 restores, it interrupts the previously prepared point in the operating circuit for the magnet 415 and opens the operating circuit for R460. The relay R460, in turn, restores to open, at RA461, the operating circuit, as traced above, for R440. When R440 restores, it again completes, at RA441 and RC443, the operating circuit for R450. In view of the above description, it will be apparent that the three relays R440, R450 and R460 operate and restore continuously and in a definite sequence for so long as R470 is operated and R480 is deenergized. It will further be observed that, during each cycle of operation of these relays, the operating circuit for the magnet 415 is completed.

Thus, the relay R430 is maintained energized continuously so long as R470 is held operated and R480 is deenergized. With R430 operated, the operating circuit for the magnet 415 is prepared at RA431. This circuit is further prepared at RA452, when R450 operates simultaneously with the operation of R430, and is completed upon the operation of R440 following the operation of R460. Specifically, this circuit extends from ground at RA472 by way of RC474, C463, RA441, RC442, RA452, RA431 and through the winding of the magnet 415 to battery. This circuit is only momentarily completed during each operating cycle of the three relays noted since, when R440 operates to complete this circuit, it also interrupts the operating circuit for R450. Hence, R450 restores shortly following the completion of the circuit to interrupt the same at RA452. Each time the magnet 415 is energized, it attracts its pivoted armature 416 to bring the pen 418 into engagement with the continuously driven tape 419 which extends between the two rollers 418' and 419'. Through this operation, each operating cycle of the three relays R440, R450 and R460 is recorded in the form of a dash on the tape 419.

During each cycle of operation of the three relays R440, R450 and R460, a circuit is completed for energizing M485, which magnet functions to drive the wipers 425 to 428, inclusive, over the contacts of their respective associated sets. More specifically, this circuit is completed upon the

operation of R440 during each cycle of operation of the three relays noted and extends from ground at RA444 through the winding of M485 to battery. Hence, so long as the cyclic operation of the three relays noted continues, M485 functions to drive the wipers of the switch 420 at the rate of one step for each operating cycle of the relays.

The first function of the identification switch 400 is to transmit to the operating magnet 415 of the recorder 410 a series of impulses identifying the particular one thousand-line group which includes the line 101. The method by which this is accomplished will more readily be apparent by again considering the auxiliary line finder switch 190. As pointed out above, this switch is associated with and has an operating position corresponding to each line of a particular group of two hundred lines. This particular group of two hundred lines forms a part of a particular one thousand-line group and the fact that the auxiliary finder switch 190 is selected by the distributor switch 200 indicates in which one of the one thousand-line groups the two hundred-line group is included. More specifically, when R150, associated with the auxiliary line finder switch 190, operates, it prepares a path for marking, in the bank contacts of the switch 420, the particular group of one thousand lines which includes the line 101. Thus, this relay, upon operating, prepares, at RA151, a path for applying battery to one of the ten contacts numbered from two to eleven, inclusive, of the contact set 423 embodied in the switch 420. This path, which is completed when R470 operates, extends from the battery at the lower terminal of the winding of R480 by way of this winding, RA475, RC477, C466, RA151 and C464 to the eleventh contact of the set 423. This marking identifies the calling line as being in the zero group of one thousand lines. Obviously, if the calling line had been one of the lines numbered from 2000 to 2999, inclusive, this marking battery would have been extended through the operation of the selected finder switch to the third contact of the contact set 423. Similarly, if the line 101 had been included in the group of lines numbered from 3000 to 3999, inclusive, this marking battery would have been applied to the fourth contact of the contact set 423. By this method of marking the contacts of the set 423 there may be identified the particular group of one thousand lines which includes any one of the subscribers' lines terminating at the exchange.

Continuing now with the operation of the identification switch 400, each time M485 is energized, in response to the cyclic operation of the three relays R440, R450 and R460, it causes the wipers of the switch 420 to be stepped one step. Normally, these wipers are in their respective home positions, as shown in the drawings and, hence, ten steps are required to operate the wipers to the position corresponding to the zero group of one thousand lines. As explained above, during each step, a dash is recorded on the tape 419 through the operation of the pen 418. Hence, at the conclusion of the stepping operation, ten dashes will be recorded on this tape.

When the wiper 427 is stepped to its tenth off-normal position or into engagement with the eleventh contact of its associated set, a circuit is completed for energizing the slow-to-release relay R450, this circuit extending from ground at RA472 by way of RC474, RA471, C455, the switch wiper 427, the eleventh contact of the set 423, C464, RA151, C466, RC477, RA475 and the wind-

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ing of R480 to battery. The relay R480, upon operating, opens, at RA481, a point in the operating circuit for R440, thereby to arrest the cyclic operation of the three relays R440, R450 and R460. At RA484, the relay R480 completes a path for short-circuiting the winding of R430, this path starting from ground at RA484 and extending by way of RA479, the winding of R430, RA432, C463 and RC474 back to ground at RA472. When R430 is short-circuited over the above-traced path, it restores, to interrupt, at RA432, a point in its holding circuit and to interrupt, at RA431, a point in the operating circuit for the magnet 415.

At RA482 and RA483, the relay R480 completes a temporary circuit for maintaining itself operated and for energizing M485 by way of the self-interrupting contacts associated with the armature 486. This circuit extends from ground as applied to the multiplied contacts of the set 424 by way of the switch wiper 428 and C458 to RA482 where it divides, one branch extending by way of RA483 and the winding of R480 to battery and the other branch extending by way of the armature 486 and the winding of M485 to battery. Due to the action of the self-interrupting contacts associated with the armature 486, the magnet M485 now operates buzzer fashion, to drive the wipers of the switch 420 to the starting position for the second cycle of operation of this switch. As pointed out below, this second operating cycle is for the purpose of determining the particular group of one hundred lines which includes the calling line and the starting position therefor is attained by the switch 420 when the wiper 428 is operated to its eleventh off-normal position or into engagement with the twelfth contact of the set 424. When the wiper 428 arrives in this position, the above-traced alternative operating circuit for M485 is interrupted and the stepping operation of the switch 420 is discontinued. Simultaneously, the branch of this circuit over which R480 held energized, is opened, causing this relay to restore, to re-complete, at RA481, the operating circuit for R440 and to open, at RA484, the path shunting the exchange battery and the resistor 488 in series. At RA482 and RA485, the relay R480, upon restoring, opens additional points in the above-traced circuit for energizing M485 and for holding itself operated.

When R440 is reenergized in response to the restoration of R480, the cyclic operation of this relay and the two relays R450 and R460 is resumed. During the first cycle of operation of these relays, following the restoration of R480, the relay R430 remains deenergized since, with the wiper 427 standing in its eleventh off-normal position, the operating circuit for this relay is open. The original energizing circuit for M485 is, however, completed at RA444 so that the wipers of the switch 420 are stepped to their respective twelfth off-normal positions. With the wiper 427 in this position, the operating circuit for R430 is again completed, it being identical with that traced above with the exception that it now extends by way of the thirteenth contact of the set 423 rather than the first contact of this set. Upon operating, R430 again completes, at RA432, its holding circuit and reprepares, at RA431, the operating circuit for the magnet 415.

With the apparatus of the identification switch in this condition, it is in readiness to transmit to the magnet 415 of the recorder 410 impulses for identifying the particular group of one hun-

dred lines which includes the line 101. To clarify this point, attention is again directed to the marking operations performed by the auxiliary line finder switch 190. Thus, with this switch standing in the particular position which corresponds to the line 101 and with R130 operated, battery is impressed on the particular one of the bank contacts included in the set 423 which corresponds to the group of one hundred lines including the line 101. In the particular case under consideration, this battery potential is applied to the fifteenth contact of the set 423 over a path extending from the exchange battery at the lower terminal of the winding R480 by way of this winding, RA475, RC477, C466, RA131 and C467. This marking identifies the calling line as being included in the group of lines including the lines numbered from 200 to 299, inclusive. From the preceding description, it will be apparent that, had the second marking relay R140 been operated instead of R130, this battery potential would have been applied by way of RA141 and C465 to the fourteenth contact of the set 423, thereby to identify the calling line as being included in the group of lines numbered from 100 to 199, inclusive. Similarly, if the calling line had been included in a group of two hundred lines associated with a different auxiliary line finder switch, a different one of the contacts numbered from 14 to 23, inclusive, in the set 423, would have been marked with battery potential.

Continuing now with the operation of the identification switch 400, it is again pointed out that, immediately R480 restores, the normal stepping operation of the switch 420 is resumed. Following the preliminary step required to cause the reoperation of R430 and to position the wipers of the switch 420 in the start position for the second cycle of operation, the magnet 415 is energized once during each step taken by these wipers. In the present assumed case, only two counting steps will be taken by the wipers of the switch 420 since, during the second of these two steps, the wiper 427 is moved into engagement with its associated fifteenth contact to again complete a circuit for energizing R480, this second circuit extending from ground, at RA472, by way of RC474, RA471, C455, the switch wiper 427, the fifteenth contact of the set 423, C467, RA131, C466, RC477, RA475 and through the winding of R480 to battery. The relay R480, upon operating, again functions to deenergize R430 and to interrupt the cyclic operation of R440, R450 and R460. In addition, this relay, namely, R480, completes a holding circuit for itself identical with that traced above and a branch circuit for energizing M485 by way of the self-interrupting contacts associated with the armature 486. This last-mentioned circuit extends from ground as applied to the multiplied contacts of the set 424 and, since all of the contacts numbered from 15 to 24, inclusive, of this set are included in the multiple, the wipers of the switch 420 are driven to their respective twenty-fourth off-normal positions. When the wiper 428 is stepped to its twenty-fourth off-normal position, or out of engagement with its associated twenty-fourth contact, the operating circuit for M485 is interrupted to arrest the stepping operation of the switch 420. Simultaneously, the holding circuit for R480 is interrupted, whereby this relay is restored to again initiate the cyclic operation of the three relays R440, R450 and R460 and to remove the shunt from across the exchange battery in series with the

resistor 488. With the wipers of the switch 420 in this position, one further step is required to cause the reoperation of R430. This step, as well as the following steps, is achieved through the resumed cyclic operation of the relays R440, R450 and R460, successively to energize and deenergize the operating magnet M485. At the end of the first step of the switch 420 resulting from the resumed cyclic operation of the relays noted, the switch wiper 425 engages its associated first contact to complete an alternative circuit for energizing R430, this circuit extending from ground at RA472 by way of RC474, RA471, C455, the switch wiper 425, the first contact of the set 421, C457, RA478, the winding of R430 and the resistor 488 to battery. When energized over the above-traced circuit, R430 reoperates to again prepare, at RA431, the circuit for energizing the magnet 415 and to complete, at RA432, a holding circuit for itself. It will be understood, in view of the preceding description, that the operating circuit for the magnet 415 is now in a condition to be completed once during each following step taken by the wipers of the switch 420.

Summarizing the description to this point, it is to be observed that the digit or number identifying the group of one thousand lines including the calling line has now been recorded and that the group of one hundred lines including the calling line has also been recorded. There remains to be considered, therefore, only the operation of the apparatus to identify the subgroup of ten lines including the calling line and the particular calling line in this subgroup.

Logically, the next step is to determine the particular ten-line subgroup including the line 101. This is achieved through the operation of the auxiliary finder switch 190 to mark this subgroup in the contacts of the set 421. To this end, each of the bank contacts, corresponding to and including the contact 179 in the mechanism 170 of the finder switch 190, is connected to one of the contacts numbered from 2 to 11, inclusive, in the set 421. Thus, all of the contacts corresponding to and including the contact 179 in the tenth level are multiplied together and connected by way of C462 to the eleventh contact of the set 421. Similarly, each of the contacts, corresponding to the contact 179, in the ninth level are multiplied together and connected to the tenth contact of the set 421, the corresponding contacts of the eighth level are multiplied together and connected to the ninth contact of the set 421, and so on. With the bank contacts of the two mechanisms 170 and the switch 420 wired in this manner, and with the finder switch 190 operated to a particular position, the particular ten-line group corresponding to this position and including a particular line, is determined. Thus, with the mechanism 170 standing in the position as described above and with R470 energized, the group of ten lines including the line 101 is marked by the application of battery potential to the eleventh contact of the set 421. This marking path extends from battery at the lower terminal of the winding of R480 by way of this winding, RA475, RC477, C466, RA133, the switch wiper 182, the contact 179 and C462 to the eleventh contact of the set 421. Hence, the subgroup of ten lines including the line 101 is determined as being the zero subgroup.

In view of the preceding description, it will be understood that, since the eleventh contact of the set 421 is the marked contact, the wipers

of the switch 420 will be caused to take ten steps following the operation of the wiper 425 into engagement with its associated first contact. This, of course, means that ten dashes will be recorded on the tape 419 during the stepping operation of the switch 420. During the tenth step, the wiper 425 is driven into engagement with its associated eleventh contact to complete a circuit for again energizing R480, this circuit extending from ground at RA472, by way of RC474, RA471, C455, the switch wiper 425, the eleventh contact of the set 421, C462, the contact 179, the wiper 182, RA133, C466, RC477, RA475 and through the winding of R480 to battery. In response to its energization over this circuit, R480 operates to again interrupt the cyclic operation of the three relays R440, R450 and C458 and to cause the deenergization of R430. Upon operating, R480 also completes a circuit for maintaining itself energized and for energizing M485 by way of the self-interrupting contacts associated with the armature 486. This circuit extends from ground as applied to the large group of multiplied contacts of the set 422 by way of the switch wiper 426 and C458 to RA482 where it divides, one branch extending by way of RA483 and the winding of R480 to battery and the other branch extending by way of the armature 486 and the winding of M485 to battery. Since the wiper 426 is standing in engagement with its associated eleventh contact, this circuit will only be held completed during the operation of M485 to step the wipers of the switch 420 one step or to a position such that the wiper 426 is no longer in engagement with any one of the grounded multiplied contacts of the set 422. With the wiper 426 in this position, the alternative operating circuit for M485 and for maintaining M480 energized is interrupted. The relay R480, upon restoring, functions in the identical manner set forth above to cause a resumption of the cyclic operation of the three relays R440, R450 and R460 and to remove the shunt from across the exchange battery in series with the resistor 488.

Obviously, when the cyclic operation of the three relays noted is resumed, M485 is again energized to drive the wipers of the switch 420. At the end of the first step taken by these wipers following the restoration of R480, the operating circuit for R430 is again completed, this circuit extending, in this instance, from ground at RA472 by way of RC474, RA471, C455, the switch wiper 425, the thirteenth contact of the set 421, C457, RA478, the winding of R430 and the resistor 488 to battery. The additional steps taken by the wipers of the switch 420, serve to identify the line 101 in the selected zero subgroup of ten lines. To this end, the contacts in each level of the mechanism 170, which correspond to and include the contact 171, are multiplied together and are connected to the contacts numbered from 14 to 23, inclusive, of the contact set 421. Thus, the tenth contact, corresponding to the contact 171, in each of the ten levels of the mechanism 170 is connected to the corresponding tenth contact of each of the other levels, and the multiple connection is connected by means of C463 to the twenty-third contact of the contact set 421. Similarly, the first contact, corresponding to the contact 171, in each level of contacts included in the mechanism 170, is connected to each of the other similar first contacts and to the fourteenth contact of the set 421. By virtue of this wiring arrangement and when

either of the two relays R130 and R140 is energized, a path, similar to those traced previously, is completed for applying battery potential by way of the winding of R480 and the selected contact of any selected level of the mechanism 170 to the one of the contacts in the set 421 which corresponds to the last digit of the number identifying the calling line. In the present assumed case, the line 101 is the tenth line of the selected zero subgroup of lines and, hence, the marking potential is applied to the twenty-third contact of the set 421. It will be appreciated, therefore, that the wipers of the switch 420 will be driven ten steps and that ten dashes will be recorded on the tape 419 before the stepping operation of the switch 420 is again discontinued. When the wiper 425 encounters the marked twenty-third contact at the end of the tenth step, another alternative circuit is completed for energizing R480, this circuit extending from ground at RA472 by way of RC474, RA471, C455, the switch wiper 425, the twenty-third contact of the set 421, C463, the contact 171, the wiper 174, RA132, C466, RC477, RA475 and through the winding of R480 to battery. The relay R480, upon operating, functions in the manner described previously to interrupt the cyclic operation of the three relays R440, R450 and R460 and to cause the deenergization of R430, thereby to prevent any further operation of the recorder 410. The relay R480 also completes a circuit for maintaining itself energized and for energizing M485, this circuit extending from ground, as applied to the large group of multiplied contacts of the set 422, by way of the switch wiper 426 and C458 to RA482 where it divides, one branch extending by way of RA483 and the winding of R480 to battery and the other branch extending by way of the armature 486 and the winding of M485 to battery. When energized over this circuit, M485 operates to drive the switch wipers 425 and 426 into engagement with their respective associated twenty-fourth contacts at which time the circuit, as traced above, for energizing M485 and for holding R480 energized is interrupted at the wiper 426. After a short time interval required for the restoration of R480, the operating circuit for R440 is again completed at RA481. The relay R440, upon operating, completes, at RA444, the originally traced operating circuit for M485, and this magnet operates to drive the wipers of the switch 420 to their respective home positions. Before any further cyclic operation of the three relays R440, R450 and R460 can occur, however, the operating circuit for the identification switch start relay R470 is interrupted, thereby completely to restore the apparatus embodied in this switch to normal in the manner pointed out immediately hereinafter. When the switch wiper 425 is stepped into engagement with its associated twenty-fourth contact, a circuit is completed for energizing R240, this circuit extending from ground at RA472 by way of RC474, RA471, C455, the switch wiper 425, C454 and through the winding of R240 to battery. The relay R240, upon operating, completes, at RA241, an obvious circuit for energizing the slow-to-operate relay R230 and, at RA242, a circuit for fully energizing the line lockout relay R110. The last-named circuit extends from ground at RA242 by way of C195, RA134, the switch wiper 175, the bank contact 172, C98 and through the winding of R110 to battery. When energized over the above-traced circuit, the line lockout relay R110 immediately assumes its fully operated posi-

tion to open, at RA114 and RC115, a point in the loop circuit extending to the operator's station, thereby to cause the deenergization of R360.

At its armatures RA111 and RA114 and their respective associated contacts RC113 and RC116, the relay R110 completes a circuit for holding itself energized by way of the subscriber's loop extending to the telephone A. Specifically, this circuit extends from ground at RA111 by way of RC113, C102, the bridge across C102 and C103 at the substation A, C103, RA114, RC116 and the winding of R110 to battery. If the calling condition created on the line 101 is the result of a short circuit between the conductors of this line, the relay R110 is maintained in its operated position until such time as this fault is cleared. If, on the other hand, the calling condition present on the line 101 results from the initiation of a call at the substation A, the above-traced holding circuit for R110 is interrupted through the removal of the bridge across the line conductors C102 and C103 when the receiver at the substation A is restored to its hook.

The relay R360, upon restoring, opens, at RA361, the operating circuit for the hold relay R365, which latter relay restores, after an interval, to open, at RA366, the holding circuit for R370. When R370 restores, it removes at RA374 and RA375, booster battery from the control conductor C214 of the trunk 211. Since, at this time, R365 is also restored, holding potential is entirely removed from C214 upon the restoration of R370. As a result, the two finder switches 210 and 100 are restored to normal in the usual manner. With the removal of holding potential from C218, the holding circuit for R290 is opened, causing this relay to restore. The removal of holding potential from C194 also results in the deenergization and restoration of the combined line and cut-off relay R120. Thus, the switch train by which the connection was extended to the operator's station is entirely released.

The lockout relay R110, upon operating, functions to interrupt, at RA111 and RC112, the operating circuits for R160 and R130. The relay R130, upon restoring, prepares, at RA137', a circuit for energizing the release magnet 167. The relay R160, upon restoring, interrupts, at RA161, the operating circuit for R280 and prepares, at RA162 and RC164, a path for marking the finder switch 190 as being associated with a group of two hundred lines not including a line which is to be locked out of service.

While the above-described operations are transpiring, the relay R230 operates to interrupt, at RA231, a point in the operating circuit for R220 and to complete, at RA232, a path for short-circuiting R260. This path extends from ground, at RA232, by way of C196, RA136, RC156, RA154, C199, the contact 235, the wiper 223, RA262, RC264, the armature 207, the winding of R260, RA265, and back to ground at RA266. The relay R260 now restores to interrupt, at RA261, the operating circuit for R150. The relay R260, upon restoring, further functions to open, at RA266, its own holding circuit. It will be observed that, when the winding of R260 is short-circuited over the above-traced path, a circuit is completed for energizing M206, thereby to cause the wipers of the switch 205 to be stepped from engagement with the contacts illustrated in the drawings. This stepping operation is only incidentally produced and is without effect at this time.

When R150 is deenergized, it retracts all of its armatures and, at RA158, completes the above-

mentioned circuit for energizing the release magnet 167, this circuit extending from ground at RA158 by way of the off-normal springs 186, RA148, RA137' and through the winding of the magnet 167 to battery. The release magnet, upon being energized, attracts its associated armature in a well-known manner to permit the wiper carriage structure of the switching mechanism 170 to be restored to its normal position. When this carriage structure reaches its home position, the springs 185 are returned to normal to open the operating circuit for the magnet 167. With this final operation, the apparatus embodied in the auxiliary line finder switch is completely restored to normal and is in readiness for further use.

Returning now to a consideration of the finder switch distributor 200, when R230 operates, following the operation of R240, it interrupts, as was pointed out above, the operating circuit for R220 causing this latter relay to restore. At RA221, the relay R220 opens the previously-traced operating circuit for R470. Shortly following this operation, the switch wiper 425 of the switch 420 is stepped from engagement with its twenty-fourth contact and to its home position to open the above-traced operating circuit for R240, whereby R240 is deenergized to open the operating circuit for R230. Thus, the distributor 200 is restored to normal and is in readiness for further use.

When the operating circuit for R470 is interrupted, this relay restores to open, at RA471, RA472 and RC474, the previously-traced operating and hold circuits for R430, R440, R450 and R460. Thus, all of the control relays included in the identification switch 400 are restored to normal, the switch wipers of the switch 420 are brought to rest in their home positions, and the identification switch is completely restored and in readiness for further use.

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

I claim:

1. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means for establishing a connection between a calling one of said lines and said operator's station, and means controllable from said station for locking out said calling line and for indicating the character identifying said calling line.

2. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means for establishing a connection between a calling one of said lines and said operator's station, line lockout means associated with said calling line and operative to lock said calling line out of service until the calling condition thereof is terminated, indicating means commonly associated with said plurality of lines, and means at said station for causing the operation of said line lockout means and for causing said indicating means to indicate the character identifying said calling line,

3. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including at least a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, line lockout means associated with said calling line and operative to lock said calling line out of service until the calling condition thereof is terminated, indicating means commonly associated with said plurality of lines, means at said station for causing the operation of said lockout means, and means controlled by said lockout means for causing said indicating means to indicate the character identifying said calling line.

4. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including at least a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, line lockout means associated with said calling line, indicating means commonly associated with said plurality of lines, means at said station for causing the operation of said lockout means, an auxiliary finder switch having a plurality of operating positions individually corresponding to individual ones of a group of said lines including said calling line, means included in said finder switch and responsive to the operation of said lockout means for causing said finder switch to operate to the one position corresponding to said calling line, and means responsive to the operation of said finder switch to said one position for causing said indicating means to indicate the character identifying said calling line.

5. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including at least a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, line lockout means associated with said calling line, indicating means commonly associated with said plurality of lines, means at said station for causing the operation of said lockout means, an auxiliary finder switch having a plurality of operating positions individually corresponding to individual ones of a group of said lines including said calling line, means included in said finder switch and responsive to the operation of said lockout means for causing said finder switch to operate to the one position corresponding to said calling line, an identification switch commonly associated with all of said plurality of lines, means included in said identification switch and responsive to the operation of said finder switch to said one position for initiating the operation of said identification switch, means whereby the operation of said identification switch is controlled in accordance with the operating position of said finder switch, and means included in said identification switch for causing said indicating means to indicate the character identifying said calling line.

6. In an automatic telephone system, a plu-

5 rality of subscribers' lines, each of said lines being
 identified by a particular character, a plurality of
 subscriber-controlled automatic switches for set-
 ting up connections between said lines, an oper-
 ator's station, means including at least a portion
 of said automatic switches for establishing a con-
 10 nection between a calling one of said lines and
 said operator's station, a line lockout relay associ-
 ated with said calling line, an operating circuit
 for said relay, said portion of said switches being
 operative partially to complete said operating
 circuit, means at said station for completing said
 circuit, indicating means commonly associated
 15 with said plurality of lines, and means responsive
 to the operation of said lockout relay for causing
 said indicating means to indicate the character
 identifying said calling line.

7. In an automatic telephone system, a plural-
 ity of subscribers' lines, each of said lines being
 20 identified by a particular character, a plurality of
 subscriber-controlled automatic switches for set-
 ting up connections between said lines, an oper-
 ator's station, means including at least a portion
 of said automatic switches for establishing a con-
 25 nection between a calling one of said lines and
 said operator's station, a line lockout relay associ-
 ated with said calling line, an operating circuit
 for said relay, said portion of said switches being
 operative partially to complete said operating cir-
 30 cuit, means at said station for completing said
 circuit whereby said relay is caused partially to
 operate, indicating means commonly associated
 with said plurality of lines, an auxiliary finder
 switch having a plurality of operating positions
 35 individually corresponding to individual ones of
 a group of said lines including said calling line,
 means included in said finder switch and respon-
 sive to the partial operation of said relay for
 causing said finder switch to operate to the one
 40 position corresponding to said calling line, means
 responsive to the operation of said finder switch
 to said one position for causing the complete oper-
 ation of said relay, whereby said relay is caused
 to operate to lock said calling line out of service,
 45 and means responsive to the operation of said
 finder switch to said one position for causing
 said indicating means to indicate the character
 identifying said calling line.

8. In an automatic telephone system, a plu-
 50 rality of subscribers' lines, each of said lines being
 identified by a particular character, a line lock-
 out relay associated with one of said lines, indi-
 cating means commonly associated with all of
 said lines, means for energizing said lockout re-
 55 lay, and means operative in response to the re-
 sulting operation of said relay for causing said
 indicating means to indicate the character iden-
 tifying said one line.

9. In an automatic telephone system, a plu-
 60 rality of subscribers' lines, each of said lines being
 identified by a particular character, a line lock-
 out relay associated with one of said lines, indi-
 cating means commonly associated with all of
 said lines, means for energizing said relay to
 65 cause the partial operation thereof, means opera-
 tive in response to the partial operation of said
 relay for causing said indicating means to indi-
 cate the character identifying said one line, and
 means included in said last-named means for
 70 causing said relay fully to operate to lock said
 one line out of service.

10. In an automatic telephone system, a plu-
 rality of subscribers' lines, each of said lines being
 75 identified by a particular character, a plurality
 of subscriber-controlled automatic switches for

setting up connections between said lines, an
 operator's station, means only operative in re-
 sponse to the continuance of a calling condition
 on one of said lines for a given time interval for
 establishing a connection between said one line
 5 and said operator's station, line lockout means
 associated with said one line, indicating means
 commonly associated with all of said lines, and
 means controllable from said operator's station
 for causing said indicating means to indicate the
 10 character identifying said one line and for caus-
 ing said lockout means to lock said one line out
 of service until said calling condition is termi-
 nated.

11. In an automatic telephone system, a plu-
 15 rality of subscribers' lines, each of said lines
 being identified by a particular character, a plu-
 rality of subscriber-controlled automatic
 switches, including a group of impulse responsive
 selector switches, for setting up connections be-
 20 tween said lines, certain of said switches other
 than said selector switches being effective to set
 up a link connection between one of said lines
 and one of said selector switches when a calling
 condition is created on said one of said lines, an
 25 operator's station, means only operative in the
 event no control impulses are transmitted to said
 one selector switch within a given time interval
 after said link connection is established for
 establishing a connection between said one line
 30 and said operator's station, line lockout means
 associated with said one line, indicating means
 commonly associated with said plurality of lines,
 and means controllable from said operator's sta-
 tion for causing said indicating means to indicate
 35 the character identifying said one line and for
 causing said lockout means to lock said one line
 out of service until said calling condition is termi-
 nated.

12. In an automatic telephone system, a plu-
 40 rality of subscribers' lines, each of said lines be-
 ing identified by a particular character, a plu-
 rality of subscriber-controlled automatic switch-
 es, including a group of impulse responsive se-
 45 lector switches, for setting up connections be-
 tween said lines, certain of said switches other
 than said selector switches being effective to set
 up a link connection between one of said lines
 and one of said selector switches when a calling
 condition is created on said one of said lines, an
 50 operator's station, means comprising a link find-
 er switch only operative in the event no control
 impulses are transmitted to said one selector
 switch within a given time interval after said
 link connection is established for establishing a
 55 connection between said one line and said opera-
 tor's station, line lockout means associated with
 said one line, indicating means associated with
 said one line, and means controllable from said
 operator's station for causing said indicating
 60 means to indicate the character identifying said
 one line and for causing said lockout means to
 lock said one line out of service until said call-
 ing condition is terminated.

13. In an automatic telephone system, a plu-
 65 rality of subscribers' lines, each of said lines be-
 ing identified by a particular character, a plu-
 rality of subscriber-controlled automatic
 switches, including a group of impulse respon-
 sive selector switches, for setting up connections
 70 between said lines, certain of said switches other
 than said selector switches being effective to set
 up a link connection between one of said lines
 and one of said selector switches when a calling
 condition is created on said one of said lines, an
 75

operator's station, a link finder switch operative to establish a connection between said one line and said operator's station, a relay included in said one selector switch, said relay only being operative in the event no control impulses are transmitted to said one selector switch within a given time interval after said link connection is established and functioning to initiate the operation of said link finder switch, line lockout means associated with said one line, indicating means associated with said one line, and means controllable from said operator's station for causing said indicating means to indicate the character identifying said one line and for causing said lockout means to lock said one line out of service until said calling condition is terminated.

14. In an automatic telephone system, a plurality of subscribers' lines, a plurality of subscriber-controlled automatic switches, including a group of impulse responsive selector switches, for setting up connections between said lines, certain of said switches other than selector switches being operative to establish a link connection between one of said lines and one of said selector switches when a calling condition is created on said one line, said one selector switch including line, hold and pulse circuit transfer relays operative in the order named in response to the completion of said link connection, a time pulse controlled relay included in said one selector switch, a primary operating circuit for said time pulse controlled relay, said circuit including contacts controlled by said pulse circuit transfer relay and being arranged to be completed to cause the partial operation of said time pulse controlled relay a given time interval after the operation of said pulse circuit transfer relay, a secondary operating circuit for said time pulse controlled relay, said secondary circuit being arranged to be completed to cause the complete operation of said time pulse controlled relay a predetermined time interval after the partial operation thereof, an operator's station, and means comprising a link finder switch operative in response to the complete operation of said time pulse controlled relay for establishing a connection between said one line and said operator's station.

15. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches, including a group of impulse responsive selector switches, for setting up connections between said lines, certain of said switches other than said selector switches being operative to set up a link connection between one of said lines and one of said selector switches when a calling condition is created on said one of said lines, an operator's station, means comprising a link finder switch only operative in the event no control impulses are transmitted to said one selector switch within a given time interval after said link connection is established for establishing a connection between said one line and said operator's station, line lockout means associated with said one line, indicating means commonly associated with said plurality of lines, means at said station for causing the operation of said lockout means, and means controlled by said lockout means for causing said indicating means to indicate the character identifying said one line.

16. In an automatic telephone system, a plu-

ality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches, including a group of impulse responsive selector switches, for setting up connections between said lines, certain of said switches other than said selector switches being operative to set up a link connection between one of said lines and one of said selector switches when a calling condition is created on said one of said lines, an operator's station, means comprising a link finder switch only operative in the event no control impulses are transmitted to said one selector switch within a given time interval after said link connection is established for establishing a connection between said one line and said operator's station, line lockout means associated with said one line, indicating means commonly associated with said plurality of lines, means at said station for causing the operation of said lockout means, an auxiliary finder switch having a plurality of operating positions individually corresponding to individual ones of a group of said lines including said one line, means included in said auxiliary finder switch and responsive to the operation of said lockout means for causing said auxiliary finder switch to operate to the one position corresponding to said one line, and means responsive to the operation of said auxiliary finder switch to said one position for causing said indicating means to indicate the character identifying said calling line.

17. In an automatic telephone system, a plurality of subscribers' lines, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means for setting up a connection between a calling one of said lines and said operator's station, line lockout means associated with said calling line, and means at said station for controlling said lockout means over an established connection extending by way of said first-named means to lock said calling line out of service until the calling condition thereof is terminated.

18. In an automatic telephone system, a plurality of subscribers' lines, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means comprising a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, a line lockout relay associated with said calling line, an operating circuit for said relay, said circuit including a branch extending by way of said portion of said switches to said operator's station, and means at said station for completing said operating circuit.

19. In an automatic telephone system, a plurality of subscribers' lines, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means only operative in response to the continuance of a calling condition on one of said lines for a given time interval for establishing a connection between said one line and said operator's station, line lockout means associated with said one line, and means at said operator's station for causing said lockout means to lock said one line out of service until said calling condition is terminated.

20. In an automatic telephone system, a plurality of subscribers' lines, a plurality of subscriber-controlled automatic switches, including a group of impulse responsive selector switches, 75

for setting up connections between said lines, certain of said switches other than said selector switches being operative to establish a link connection between one of said lines and one of said selector switches when a calling condition is created on said one line, an operator's station, means only operative in the event no control impulses are transmitted to said one selector switch within a given time interval after said link connection is established for establishing a connection between said one line and said operator's station, line lockout means associated with said one line, and means at said station for causing said lockout means to lock said one line out of service until said calling condition is terminated.

21. In an automatic telephone system, a plurality of subscribers' lines, a plurality of subscriber-controlled switches, including a group of impulse responsive selector switches, for setting up connections between said lines, certain of said switches other than said selector switches being operative to establish a link connection between one of said lines and one of said selector switches when a calling condition is created on said one line, an operator's station, means comprising a link finder switch only operative in the event no control impulses are transmitted to said one selector switch within a given time interval after said link connection is established for establishing a connection between said one line and said operator's station, a line lockout relay associated with said calling line, an operating circuit for said relay, said circuit including a branch adapted to extend by way of said link connection and said finder switch to said station, and means at said station for completing said operating circuit.

22. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches, including a group of impulse responsive selector switches, for setting up connections between said lines, certain of said switches other than said selector switches being operative to establish a link connection between one of said lines and one of said selector switches when a calling condition is created on one of said lines, an operator's station, means comprising a link finder switch only operative in the event no impulses are transmitted to said one selector switch within a given time interval after said link connection is established for establishing a connection between said one line and said operator's station, indicating means commonly associated with said plurality of lines, means including an auxiliary line finder switch commonly associated with a group of said lines including said calling line for causing said indicating means to indicate the character identifying said calling line, and means including circuit connections extending from said station by way of said link finder switch for initiating the operation of said auxiliary line finder switch.

23. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, line lockout means associated with said calling line, indicating means commonly associated with said plurality of lines, means at said station for causing said indicat-

ing means to indicate the character identifying said calling line and for causing the operation of said lockout means, and means responsive to the operation of said lockout means for causing the release of said portion of said switches.

24. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, a line lockout relay associated with said calling line, an operating circuit for said relay, said portion of said switches being operative partially to complete said operating circuit, means at said station for completing said circuit whereby said relay is caused partially to operate, indicating means commonly associated with said plurality of lines, an auxiliary finder switch having a plurality of operating positions individually corresponding to individual ones of a group of said lines including said calling line, means included in said finder switch and responsive to the partial operation of said relay for causing said finder switch to operate to the one position corresponding to said calling line, means responsive to the operation of said finder switch to said one position for causing the complete operation of said relay, whereby said relay locks said calling line out of service, means responsive to the operation of said finder switch to said one position for causing said indicating means to indicate the character identifying said calling line, and means responsive to the complete operation of said relay for causing the release of said portion of said switches.

25. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, means associated with one of said lines for locking said one line out of service, and means responsive to operation of said last-named means for indicating the character identifying said one line.

26. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, line lockout means associated with said calling line, indicating means commonly associated with said plurality of lines, means at said station for causing the partial operation of said lockout means, an auxiliary switch operative in response to the partial operation of said lockout means to cause said indicating means to indicate the character identifying said calling line, means controlled by said auxiliary switch for causing said lockout means to complete its operation, and means responsive to the last-mentioned operation of said lockout means for causing the release of said portion of said switches and said auxiliary switch.

27. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, a line lockout relay associated with

said calling line, an operating circuit for said relay, said portion of said switches being operative partially to complete said operating circuit, means at said station for completing said circuit whereby said relay is caused partially to operate, indicating means commonly associated with said plurality of lines, an auxiliary finder switch having a plurality of operating positions individually corresponding to individual ones of a group of said lines including said calling line, means included in said finder switch and responsive to the partial operation of said relay for causing said finder switch to operate to the one position corresponding to said calling line, means responsive to the operation of said finder switch to said one position for causing the complete operation of said relay, whereby said relay locks said calling line out of service, means responsive to the operation of said finder switch to said one position for causing said indicating means to indicate the character identifying said calling line, and means responsive to the complete operation of said relay for causing the release of said auxiliary finder switch and said portion of said switches.

28. In an automatic telephone system, a plurality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber-controlled automatic switches for setting up connections between said lines, an operator's station, means including a portion of said

automatic switches for establishing a connection between a calling one of said lines and said operator's station, a line lockout relay associated with said calling line, an operating circuit for said relay, said portion of said switches being operative partially to complete said operating circuit, means at said station for completing said circuit whereby said relay is caused partially to operate, indicating means commonly associated with said plurality of lines, an auxiliary finder switch having a plurality of operating positions individually corresponding to individual ones of a group of said lines including said calling line, means included in said finder switch and responsive to the partial operation of said relay for causing said finder switch to operate to the one position corresponding to said calling line, means responsive to the operation of said finder switch to said one position for causing the complete operation of said relay, a locking circuit for said relay, said locking circuit extending by way of said calling line and being completed in response to the complete operation of said relay, means responsive to the operation of said finder switch to said one position for causing said indicating means to indicate the character identifying said calling line, and means responsive to the complete operation of said relay for causing the release of said auxiliary finder switch and said portion of said switches.

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