

Dec. 19, 1939.

J. E. OSTLINE

2,183,656

AUTOMATIC TELEPHONE SYSTEM

Filed Feb. 12, 1938

4 Sheets-Sheet 1

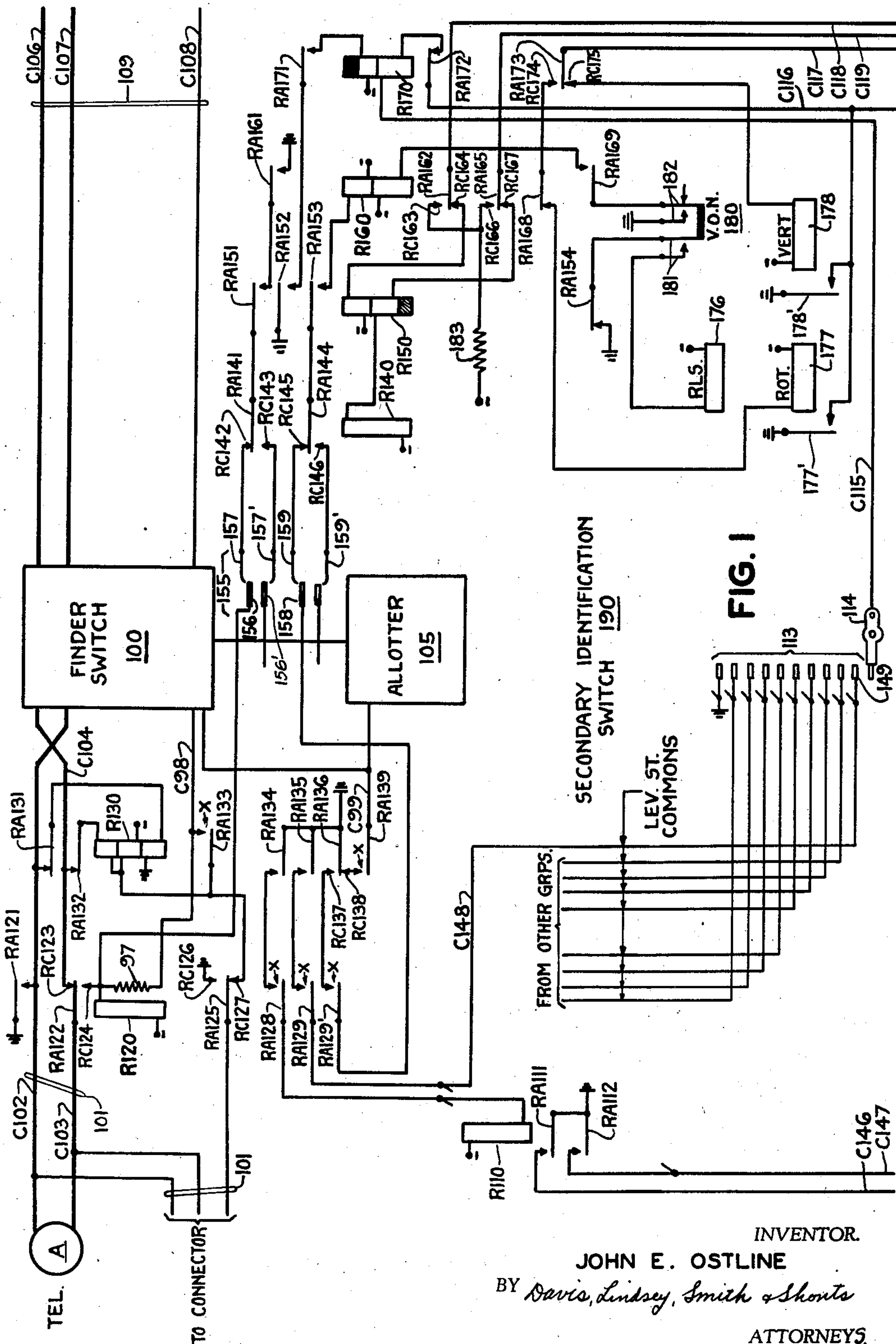


FIG. 1

INVENTOR.

JOHN E. OSTLINE

BY *Davis, Lindsey, Smith & Shonts*

ATTORNEYS.

Dec. 19, 1939.

J. E. OSTLINE

2,183,656

AUTOMATIC TELEPHONE SYSTEM

Filed Feb. 12, 1938

4 Sheets-Sheet 2

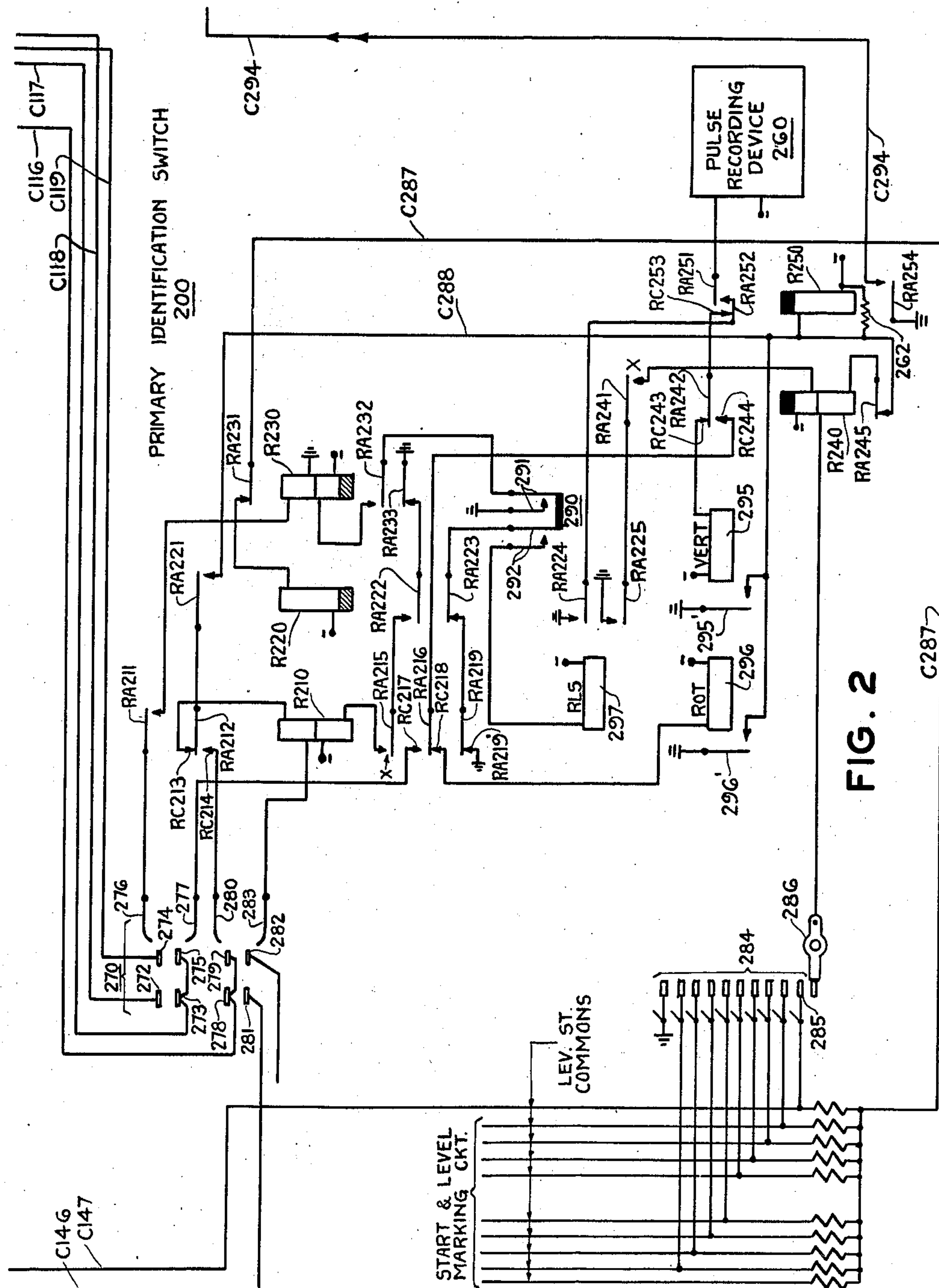


FIG. 2

INVENTOR.

JOHN E. OSTLINE

BY *Davis, Lindsey, Smith & Shonts*

ATTORNEYS.

Dec. 19, 1939.

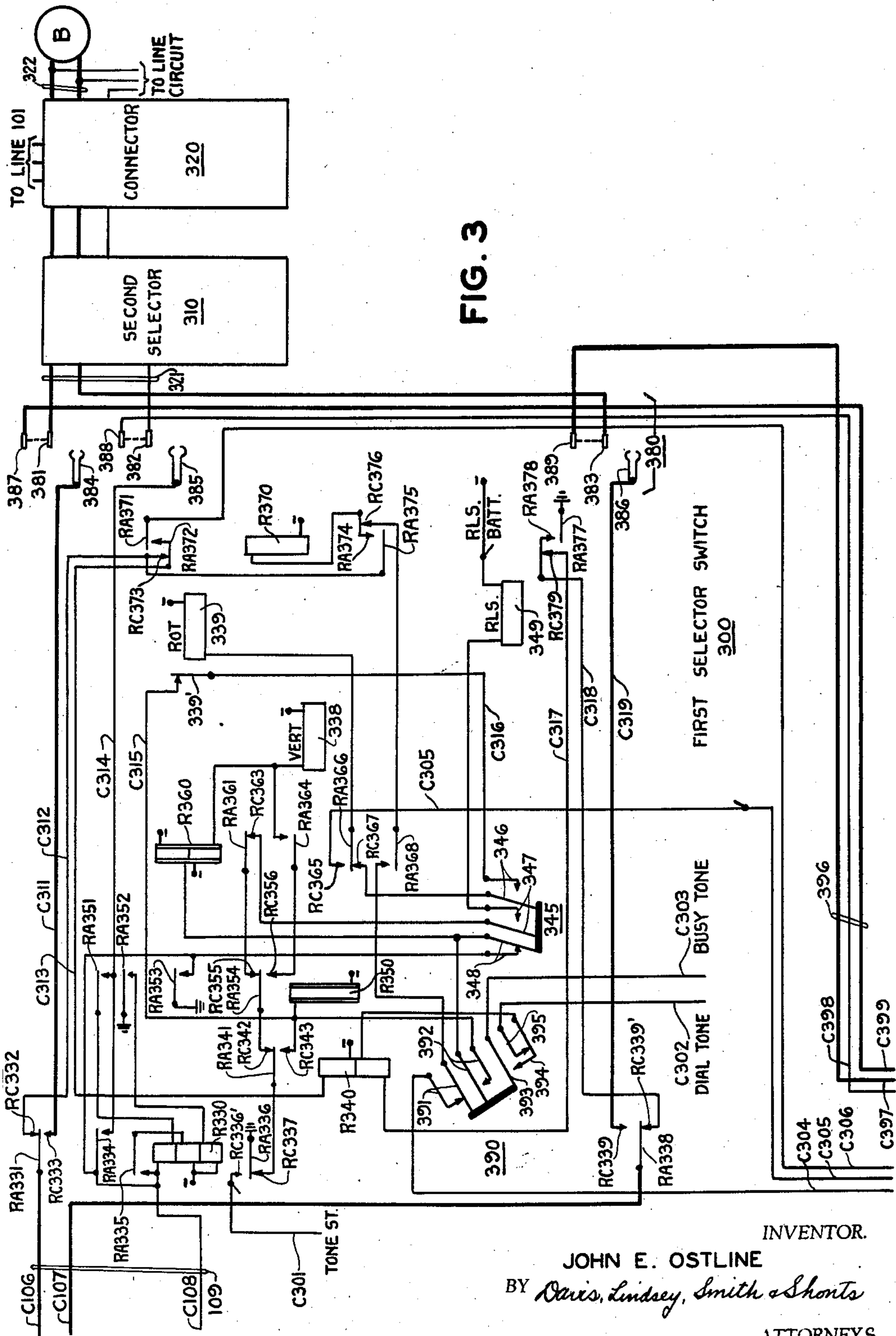
J. E. OSTLINE

2,183,656

AUTOMATIC TELEPHONE SYSTEM

Filed Feb. 12, 1938

4 Sheets-Sheet 3









## UNITED STATES PATENT OFFICE

2,183,656

## AUTOMATIC TELEPHONE SYSTEM

John Ellis Ostline, Chicago, Ill., assignor to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application February 12, 1938, Serial No. 190,181

32 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 existing fault.

In the copending application of Frederick L. Kahn, Serial No. 184,043, filed Jan. 8, 1938, there is disclosed an automatic telephone system wherein provisions are made for quickly locating a line which has a calling condition maintained thereon for an unreasonable time interval. Briefly, the telephone system therein disclosed comprises 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 between the lines. An emergency operator's station is provided in the exchange terminating the subscribers' lines, together with apparatus 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 more than a given time interval. Specifically, this apparatus comprises a link finder switch which is only operative in the event no

control impulses are transmitted to the seized one of the selector switches within a given time interval after a connection has been established thereto from a calling line. Each of the subscribers' lines has associated therewith line lockout means in the form of a lockout relay, and the plurality of lines have commonly associated therewith a recording device in the form of a tape type of pen recorder. The recording device is arranged to be controlled by any one of a group of auxiliary line finder switches, individually corresponding to different groups of the subscribers' lines, and an identification switch controlled in accordance with any particular operating position assumed by a selected auxiliary line finder switch. Each of the line lockout relays is controllable from the emergency operator's station to cause the line to be locked out of service and to initiate the operation of the finder switch associated with the particular group of lines including the line, thereby to cause the recording device to record the character or number identifying the associated line.

While the above described arrangement is entirely satisfactory in operation, it is somewhat expensive in that a considerable amount of equipment must necessarily be provided. Specifically, a group of auxiliary link finder switches and special trunks are required for use in routing the connections to the operator's board. In addition, a special identification switch is required for controlling the operation of the recording device. Moreover, the arrangement is such that a considerable time interval is required for the recording apparatus to record the character or number of a particular line.

It is an object of the present invention to provide an improved arrangement of the general character briefly described above, which requires a minimum of special equipment and operates in a manner such that a very short time interval is required for the recording apparatus completely to record the character identifying a particular line.

More specifically, it is an object of the invention to provide in an automatic exchange, improved and exceedingly simple apparatus for causing a connection to be established between a calling line terminating at the exchange and an operator's station in the exchange both when the operator's number is dialed at the calling substation and when no dialing operation is performed at the calling substation.

It is a further object of the invention to provide an arrangement of the character stated



wherein the same trunk line may be utilized in establishing a connection between the calling line and the operator's station irrespective of whether the connection results from dialing the operator's number at the calling substation or from the failure to dial a number.

The invention as described in detail hereinafter is illustrated in its embodiment in an automatic exchange which includes a "dial assistance 'A' operator's switch board", hereinafter referred to as a D. S. A. operator's board. This type of board is usually provided for the convenience of individuals who are unfamiliar with the method of operating the impulsing devices of the type conventionally provided at the subscriber substations of an automatic system. In the usual arrangement of this character, trunk lines, usually terminating at the bank contacts forming the zero level of the first selector switches, are provided for routing connections to the D. S. A. operator's board, so that a calling party may, by dialing the single digit zero, obtain a connection with a D. S. A. operator. In accordance with one feature of the present invention, the above-noted trunk lines are also utilized for forwarding calls to the D. S. A. operator's board when a calling condition is maintained on a subscriber's line for more than a given time interval. The term "calling condition" as used herein 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 a subscriber's line, or by other means. More specifically, an improved impulse generator is provided which is interconnected with each of the first selector switches in the exchange by way of a pair of supervisory conductors and which comprises apparatus for first applying a control pulse to one of the supervisory conductors and for thereafter impressing a predetermined series of impulses to the other conductor. The first control pulse is utilized to condition the seized first selector switch to respond to the series of impulses produced by the impulse generator. This series of impulses comprises the proper number of impulses to operate the wipers of the seized selector switch to a position opposite the level terminating the trunks leading to the D. S. A. operator's equipment. Thereafter, an idle one of these trunks is selected in the usual manner. A sufficient time lag is introduced between the operation of the first selector switch and the operation of the impulse generator to enable the selector switch to perform its usual trunk selecting functions in response to impulses transmitted thereto over a calling line, provided the impulses are dialed at the calling substation within a reasonable time interval after the switch is seized. The receipt of such impulses from a calling substation serves to render the switch non-responsive to the impulse output of the impulse generator.

The control equipment for the line number recording device comprises an auxiliary primary line finder switch common to all of the lines of the system and a plurality of auxiliary secondary line finder switches, each of the latter being associated with a particular group of subscribers' lines. A pulsing relay, arranged to control the recording means, is included in the primary line finder switch, which relay is connected to operate once for each step taken by the primary finder switch and also once for each step taken

by a selected secondary finder switch. For convenience, a recording device is provided both at the D. S. A. operator's board and at the wire supervisor's desk also located in the exchange, these two devices being arranged to be operated in parallel so that indications are given at two different stations as to any line which is locked out of service.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings. In the drawings, Figs. 1, 2, 3, 4 and 5 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 322, and a plurality of subscriber-controlled automatic switches, including a line finder switch 100, a first selector switch 300, a second selector switch 310 and a connector switch 320, 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 322, which is indicated as terminating in the bank contacts of the connector switch 320, 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 322, 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 two-step cut-off relay R130 and line lockout means comprising a two-step relay R120.

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 300 in Fig. 3. In brief, this switch comprises a switching mechanism, indicated at 380, 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 338 for stepping the wiper carriage structure vertically to position the wipers opposite a particular selected level; means comprising a rotary magnet 339 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 300 are the usual line, hold and impulse circuit control relays R340, R350 and R360, respectively, a line switching relay R330 and rotary and vertical off-normal springs indicated respectively at 390 and 345. In addition to the conventional elements as identified above, there is provided in this selector switch a time pulse controlled relay R370 which enters into the operation of the apparatus to perform the novel functions outlined above. For the purpose of

controlling this and the other similar relays, there is commonly associated with all of the first selector switches a pulse generator indicated generally at 500 and described in detail hereinafter.

As pointed out in the introductory portion of the specification, provisions are made whereby a calling subscriber may obtain a connection to a D. S. A. operator's station by dialing the single digit zero. To this end, the tenth level of contacts in each of the first selector switches is used to terminate trunk lines extending to the D. S. A. operator's board. Thus, the trunk line 396 is terminated at the set of contacts 387, 388, 389 included in the tenth level of contacts, and extends to the control equipment provided at the D. S. A. operator's station illustrated generally at 400. Each of the other trunk lines terminating at the contact sets forming the tenth contact level of the switch 300 terminates at equipment identical to that shown in Fig. 4. These special trunk lines are preferably multiplied to the corresponding contact sets of each of the first selector switches provided in the system, whereby a connection to the assistance operator's station may be set up by way of any one of these switches.

In brief, the equipment provided at the station 400 comprises a line relay R420, a hold relay R430, an answer and hold key switch 450 of the locking type, an operator's cord circuit and telephone set, not shown, but connected between the two line conductors C472 and C473, a calling signal lamp 458 and a guard lamp 459. The additional apparatus provided at this station for performing the particular services outlined above comprises the recording device 470, the key switch 460, and the slow-to-release control relay R440.

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 R130 in series, this circuit extending from ground at the supper terminal of the lower winding of R130 by way of RA131, C102, the bridge across C102 and C103 at the substation A, C103, RA122, RC123, RA132 and through the upper and intermediate windings of R130 in series, to battery. Due to the high series resistance of this circuit, R130 only partially operates to close the "X" contacts associated respectively with RA133 and RA139. At RA139, ground from RA136 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 RA133, 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 RA133, battery as applied to the lower terminal of the intermediate winding of R130 is extended to the control conductor C99 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 preferably 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 C98 thereof, is found, the hunting operation is automatically discontinued and the control apparatus embodied in the switch functions automatically to switch the calling line through and establish a connection between this line and the trunk line 109 incoming to the first selector switch 300. 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 R130. As a result, R130 now fully operates to remove, at RA136, 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 300, a circuit is completed for energizing the line relay R340 embodied in this switch. This circuit extends from ground on the dial tone conductor C302 by way of the off-normal springs 395 and 394, the lower winding of R340, C317, RC379, RA378, C318, RC339', RA338, C107, C102, the bridge across C102 and C103 at the substation A, C103, RA122, RC123, C104, C106, RA331, RC332, C312, RC373, RA372, C313 and through the upper winding of R340 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 RA341 and RC343, the relay R340, upon operating, completes an obvious circuit for energizing the hold relay R350. The last-mentioned relay, in turn, operates to complete a circuit for energizing the pulse circuit control relay R360, this latter circuit extending from ground at RA353 by way of the off-normal springs 348 and through the upper winding of R360 to battery. At RA353, the relay R350 completes an obvious path for applying ground potential to the control conductor C108 of the trunk line 109, thereby to hold the preceding finder switch 100 operated. At RA352, the relay R350 completes an obvious circuit for energizing the lower winding of the polarized line switching relay R330, thereby to render this relay exceedingly fast to operate when its upper winding is subsequently energized. At RA351, the relay R350 prepares a test circuit, traced hereinafter, for energizing the upper winding of R330, following the operation of the switching mechanism 380 embodied in the selector switch 300 to a position corresponding to an idle trunk in a selected trunk group. At RA354 and RC356, the relay R350 prepares an impulsing circuit for energiz-

ing the vertical operating magnet 338 in accordance with the impulses comprising the first digit dialed at the calling substation A. The relay R360, upon operating, completes at RA366 and RC365 a circuit, traced hereinafter, for energizing the relay R510 embodied in the time pulse generator 500, thereby to initiate the operation of this generator at RA364, the relay R360 prepares a circuit, traced hereinafter, for energizing the vertical magnet 338.

The impulsing circuit for the vertical magnet 338 is completed at the beginning of the first impulse of the first series of impulses dialed at the calling substation and when the line relay R340 restores. This circuit extends from ground at RA336 by way of RC337, RA341, RC342, RA354, RC356, RA364, and through the winding of the magnet 338 to battery. When energized over the above-traced circuit, the vertical magnet 338 lifts the wipers of the mechanism 380 one step or to a position opposite the first level of bank contacts. Simultaneously with this operation, the off-normal springs 345 are operated to the off-normal position, whereby the above-traced operating circuit for R360 is interrupted at the springs 348, and circuits, traced hereinafter, are prepared at the springs 347 and 346, respectively, for energizing the release and rotary magnets 349 and 339, respectively. During each impulse of the first series of impulses, the vertical magnet 338 is energized in the above-described manner so that, at the conclusion of the first digit dialed, the wipers of the mechanism 380 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 322 terminates. Each time this magnet is energized, the lower winding of R360 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 R350 is held operated during impulsing.

With the wipers of the mechanism 380 standing opposite the level of bank contacts terminating the group of trunks leading to the respective second selector switches of the group including the switch 310, the first selector switch 300 is automatically conditioned to search for an idle one of these trunks. Thus, shortly following the end of the first series of impulses, R360 restores to open, at RA364, the impulsing circuit for the vertical magnet 338 and to complete, at RA366, a circuit for energizing the rotary magnet 339. This last-mentioned circuit extends from ground at RA336 by way of RC337, RA341, RC343, C315, the armature 339', C316, the springs 346, RC367, RA366, and through the winding of the magnet 339 to battery. Upon being energized over the above-traced circuit, the rotary magnet steps the wipers of the mechanism 380 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 339 operates in the manner of a buzzer to drive the wipers of the mechanism 380 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 310 is the first switch of the selected group found idle, the wipers 384, 385 and 386 of the mechanism 380 are rotated until they encounter the bank contacts 381, 382 and 383 terminating the conductors of the trunk 321 leading to this switch. Since battery potential is present on the control conductor of this trunk, the upper winding of R330 is energized over a circuit extending from ground at RA353, by way of the upper winding noted, RA351, C314 and the wiper 385 to battery on the contact 382, immediately the contacts terminating the conductors of the trunk 321 are engaged by the enumerated wipers of the mechanism 380. This relay immediately operates to interrupt, at RA335, the above-traced operating circuit for the rotary magnet 339, thereby to arrest the rotary movement of the switch wipers.

When R330 operates, it switches the partially completed connection through to the trunk line 321 extending to the switch 310, through the operation of its armatures RA331 and RA338 into engagement with their associated contacts RC333 and RC339, respectively. There is thus completed a loop circuit for energizing the line relay conventionally included in the switch 310, which relay, upon operating, causes the operation of the associated hold relay. The last-mentioned relay functions to apply ground to the control conductor of the trunk incoming to the switch 310 which ground is extended by way of the contact 382 and the wiper 385 to the control conductor C314. Since R330 is now in its fully operated position, this ground is further extended by way of RA334 to the control conductor C108 and, hence, serves to hold the finder switch 100 in its operated position. At RA335 the relay R330, upon operating, completes an obvious circuit extending from ground on C108 for energizing its intermediate winding, thereby to hold itself operated independently of the condition of the line and hold relays R340 and R350.

At RA331 and RA338 and their respective associated contacts RC332 and RC339, the relay R330, upon operating, opens two points in the above-traced operating circuit for R340, causing this latter relay to restore. This operation also serves to interrupt the path for conducting dial tone current through the receiver at the calling substation. When R340 falls back, it opens, at RA341 and RC343, a further point in the operating circuit for R350, this latter relay having been previously deenergized in response to the operation of R330. With R340, R350 and R360 deenergized and the off-normal springs 345 operated to their respective off-normal positions, a circuit, traced hereinafter, is prepared for energizing the release magnet 349. The selector switch 300 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 339 will cause the wipers of the mechanism 380 to be stepped to their respective eleventh off-normal positions, at which time the springs 390 are moved to the off-normal position. When this occurs, an alternative circuit is completed for energizing the upper winding of R360, this circuit

extending from ground at RA336 by way of RC337, RA341, RC343, the switch springs 392, and through the upper winding of R360 to battery. The relay R360, upon operating, interrupts, at RA366 and RC367, a point in the above-traced operating circuit for the rotary magnet 339, thereby to arrest the movement of the wipers embodied in the mechanism 380. At the off-normal springs 394 and 395, 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 393 and 394, a circuit including the busy tone conductor C303 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. It is noted that ground as extended through the busy tone current transformer, not shown, to C303, is substituted for ground as applied to C302 through the dial tone current transformer, not shown, to maintain the line relay R340 operated following operation of the springs 390 to the off-normal position.

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 R340 is held operated. This relay, upon restoring, opens, at RA341 and RC343, points in the above-traced operating circuits for the relays R350 and R360. These two relays restore, after an interval, to complete a circuit for energizing the release magnet 349, this circuit extending from ground at RA336 by way of RC337, RA341, RC342, RA354, RC355, RA361, RC363, the switch springs 347, and through the winding of the magnet 349 to battery. In response to the energization of the release magnet, the wipers of the mechanism 380 are restored to normal, at which time the off-normal springs 345 and 390 are returned to normal. When the hold relay R350 restores, ground is removed at RA353 from the control conductor C108 of the trunk 109 incoming to the selector switch 300, thereby to release the line finder switch 100 and cause the restoration of the combined cutoff and line relay R130. Thus, the partially completed connection is cleared out and the switches involved therein are released for further use.

Continuing now with the operation of the apparatus to establish a connection to the called line 322 and assuming that the second selector switch 310 is selected by the first selector switch 300 to forward the connection, immediately the loop circuit is extended to the switch 310, 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 its essentials be identical with the switch 300, it will be understood that the second dialed digit results in the elevation of the wipers of the switch 310 to a position opposite the level of bank contacts terminating the trunks leading to the connector switches having access to the called line. Following this operation, the wipers of the switch 310 are automatically stepped over the contacts of the selected level until a trunk leading to an idle connector switch of the selected group is found. Assuming, for example, that the connector switch 320 is the first idle connector switch in the selected group, when the wipers of the switch 310 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 310, 300, and 100. With the apparatus in this condition, the connector switch 320 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 320 are stepped vertically opposite the level of bank contacts at which are terminated the lines of the ten line group including the called line 322. 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 320 are stepped into engagement with the set of bank contacts terminating the called line 322. 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 this switch 320 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 320, 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 first selector switch 300. During the release of the switch train and when ground is removed from C98, the holding circuit for R130 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.

As pointed out in the introductory portion of the specification, provisions are made for routing a connection from a calling subscriber's substation to a D. S. A. operator's station upon the dialing of a predetermined digit at the calling substation. If, for example, a party at the substation A desires the assistance of an operator in completing a connection to another subscriber's line, such assistance may be obtained by initiating a call in the usual manner and dialing the single digit zero. If it be assumed that the finder switch 100 and the associated first selector switch 300 are assigned by the allotter 105 to the use of the calling line, the apparatus in the switch 300 is conditioned to respond to the impulses of the dialed digit, following the operation of the finder switch to find the calling line and to switch the

connection through to the trunk line 109 in the manner set forth above. Thereafter, and when the predetermined digit zero, comprising ten impulses, is dialed at the substation A, the wipers of the mechanism 380 are translated vertically to a position opposite the tenth bank contact level wherein the trunks extending to the D. S. A. operator's board are terminated. Following this operation, the wipers are automatically rotated successively to test the trunks of this group for the purpose of selecting a trunk leading to an operator's station which is not in use. From a consideration of the apparatus illustrated in Fig. 4, it will be seen that, if the apparatus at any particular station is in use, the control conductor of the trunk line leading to this station has impressed thereon ground potential, whereas, if the apparatus is idle, battery potential is impressed on the control conductor of the trunk incoming thereto. Thus, with the apparatus at the station 400 idle, the line relay R420 and the hold relay R430 are restored, so that battery potential is extended through the resistor 462, RC 434 and RA432 to the control conductor C398 of the trunk 396. When, on the other hand, the apparatus at this station is busy, the two relays noted are energized and ground at RA431 is extended by way of RC447, RA446, RC433 and RA432 to the control conductor C398.

The operation of the selector switch 300 to test the several trunk lines terminating at the zero level of bank contacts is exactly the same as that described above with reference to the operation of the apparatus during a call from the substation A to the substation B, and, hence, need not be repeated. Assuming that the trunk line 396 is the first idle trunk line of the group terminating at the zero level of bank contacts, when the wipers of the mechanism 380 encounter the contacts 387, 388 and 389, the hunting operation of the selector switch is interrupted through the operation of R330, which relay also functions to extend the subscriber's loop by way of the line conductors C397 and C399 of the trunk line 396 to the operator's station, thereby to complete a circuit for energizing the line relay R420. This relay, upon operating, completes, at RA421, an obvious circuit for energizing the slow-to-release hold relay R430. The hold relay, in turn, completes a path extending by way of RA431, RC447, RA446, RC433, RA432 and C398 for applying ground to the control conductors of the operated switches 300 and 100, thereby to maintain these switches operated. The presence of ground on C398 marks the trunk line 396 as busy in all of the other first selector switches at which this line is terminated, thereby to prevent the apparatus at the station 400 from being seized on another call to the D. S. A. operator's board initiated before the release of the apparatus provided at the station 400. At RA431, the relay R430, upon operating, completes a circuit for energizing the call lamp 458, this circuit extending from ground at RA431 by way of RA442, RC443, the switch springs 456 and 455, the switch springs 453 and through the filament of the lamp 458 to battery. The resulting illumination of the lamp 458 gives a visual indication to the operator at the station 400 that an incoming call awaits attention. To answer the call, the operator actuates the key switch 450 to its answer position, thereby to complete a talking connection to the calling substation. More specifically, when the key 450 is operated to its right off-normal position, the springs 451



and 452 are moved into engagement, effectively to connect the conductors C472 and C473, extending to the operator's telephone, to the line conductors C397 and C399, respectively, of the trunk line 396. At the springs 453, the above-traced circuit for energizing the signal lamp 458 is opened.

Following receipt of the information as to the line desired by the calling subscriber, the operator may either advise the subscriber as to the method of dialing the desired number, or set up the desired connection in the manner conventionally employed in exchanges of the manual type. If the operator desires to hold the connection to the calling line while calling another line, she may operate the key switch 450 to the hold position, thereby to prevent the switch train from being released even though the calling party hangs up. When this key is operated to its left off-normal or hold position, an obvious holding circuit extending from ground at the springs 454 is completed for maintaining the hold relay R430 operated independently of the line relay R420. Thus, the connection can not be cleared out even though the calling subscriber hangs up. When the key 450 is operated to its hold position, the springs 455 and 456 are opened to interrupt the above-traced circuit for the lamp 458 and the springs 456 and 457 are closed to complete a circuit for energizing the guard lamp 459. The last-mentioned circuit extends from ground at RA431 by way of RA442, RC443, the springs 456 and 457 and through the filament of the lamp 459 to battery. Obviously, if the key 450 is thereafter operated to the answer position, the above-traced holding circuit for R430 is opened, the energizing circuit for the lamp 459 is opened, and the operating circuit for the lamp 458 is opened. If the calling subscriber has previously restored his receiver to its hook, the operation of the key 450 from the hold position to the answer position results in the release of the established connection, since under this condition the line relay R420 is deenergized and no circuit is available for holding R430 operated.

The release of a connection established to the operator's station 400 is entirely under the control of the calling subscriber providing the key 450 is not operated to its hold position. Specifically, when the calling subscriber restores his receiver to its hook, the loop circuit over which R420 is held operated is opened, causing this relay to restore. When R420 restores, it opens the operating circuit for R430 and the latter relay, upon restoring, removes holding ground from the control conductor C398. Thus, the operated switches 300 and 100, and the combined line and cut-off relay R130 are caused to restore in the manner pointed out above.

Referring now more particularly to the apparatus provided in the system for rendering the various services discussed briefly in the introductory portion of this specification, it is pointed out that this apparatus comprises, in addition to the equipment located at the D. S. A. operator's board and the trunk lines interconnecting this board with the various first selector switches, an impulse generator 500 for causing any one of the first selector switches to route the connection to the D. S. A. operator's board in the event a calling condition is maintained on the calling line for an unreasonably long predetermined time interval. This apparatus also includes a recording device 470 located at the D. S. A. operator's board,

a similar recording device 260, which is located at a second telephone station, preferably the wire chief's desk, and a plurality of auxiliary finder switches for causing each of the two recording devices 260 and 470 to register the number or character identifying a calling subscriber's line in response to the partial operation of the line lockout relay R120 associated with the line 101, or a corresponding relay associated with any one of the other subscribers' lines. More particularly, there is provided a primary finder switch 200, which is commonly associated with all of the plurality of subscribers' lines terminating in the exchange, and a plurality of auxiliary secondary line finder switches, one of which is indicated at 190, which are respectively associated with different groups of two hundred subscribers' lines. Each of the auxiliary line finder switches is of the well-known Strowger type, similar in all respects to the finder switch diagrammatically illustrated at 100. Thus, the primary auxiliary finder switch 200 comprises a switching mechanism 270 which includes a plurality of bank contacts arranged in levels, and a set of wipers 276, 277, 280 and 283 adapted to be translated vertically opposite a selected contact level by means comprising a vertical operating magnet 295 and thereafter to be rotated into engagement with a selected set of contacts in the selected level by means comprising a rotary operating magnet 296. For the purpose of selecting a desired level of contacts, there is also included in the switching mechanism a set of test contacts 284, individual ones of which are oppositely disposed with respect to the various contact levels, and a test wiper 286 for successively engaging the contacts of the contact set 284 as the wiper carriage mechanism is translated vertically through the operation of the magnet 295. In order to release the wiper carriage mechanism following its operation to a particular position, there is provided a release magnet 297. Also included in the finder switch 200 are five relays, R210, R220, R230, R240 and R250, and off-normal springs indicated generally at 290. The relay R250 is a pulsing relay which is connected and arranged to operate once during each step taken by wipers of the switch 200 during the vertical and rotary movements thereof and also once during each step taken by the wipers embodied in any selected one of the auxiliary secondary finder switches. It is through the operation of this relay that the two recording devices 260 and 470 are caused to record the number or character identifying a particular calling line.

Each of the auxiliary secondary finder switches is substantially identical with the primary finder switch 200 insofar as its construction and arrangement is concerned. Thus, the switch 190 comprises a switching mechanism 155, which includes a plurality of bank contacts arranged in levels and a set of wipers 157, 157', 159 and 159' which are adapted to be translated vertically opposite a particular contact level through the operation of a vertical magnet 178 and thereafter to be rotated into engagement with a selected set of contacts in the selected level by means comprising a rotary magnet 177. A set of test contacts 113, the individual ones of which are oppositely disposed with respect to the various contact levels, and a test wiper 114, arranged successively to engage the contacts of the set 113 as the wiper carriage structure is translated vertically through the operation of the magnet 178, are provided for the purpose of selecting a desired marked level



of the bank contacts. For the purpose of releasing the wiper carriage mechanism following its operation to a particular position, there is provided a release magnet 176. This switch further comprises a set of off-normal springs indicated generally at 180 and four control relays R140, R150, R160 and R170, the first three of which comprise means for causing the full operation of any lockout relay associated with a calling line included in the group of lines corresponding to the switch 190.

The recording devices may be of identical construction and of any desired form which responds to pulses of ground potential applied to one of its input terminals. One type of recording device well suited to the present application is the well-known pen recorder which conventionally comprises a stylographic pen arranged to have its marking tip moved into engagement with a recording tape moving at uniform speed, thereby to make a mark or dash on the tape, each time the operating magnet embodied in the recorder responds to a ground pulse applied to one of the input terminals of the recorder.

As pointed out above, the primary finder switch 200 is commonly associated with all of the subscribers' lines terminating at the exchange. This switch responds to the partial operation of any one of the lockout relays associated with the respective subscribers' lines and functions, during the vertical movement of its wipers, to select the particular group of one thousand lines which includes the calling line and, during the rotary movement of its wipers, to select the particular group of one hundred lines which includes the calling line. Through this last-mentioned selection, the primary finder switch incidentally selects the auxiliary secondary finder switch associated with the group of lines including the calling line. Each of the latter switches is capable of selecting any one of a group of two hundred lines, but, when conditioned for operation following the operation of the switch 200, is confined in its operation to a determination of the particular subgroup of ten lines in the previously selected group of one hundred lines which includes the calling line, and to a determination of the calling line in the selected subgroup of lines. The particular mode of operation of the switches to select a particular calling line is pointed out more in detail hereinafter.

Considering now the arrangement of the apparatus making up the novel impulse generator 500, it is pointed out that this generator comprises, in general, a start relay R515 under the control of a time delay device indicated as a dashpot relay R510, a pair of output terminals 597 and 598 and a relay network comprising the relays R520, R530, R540 and R560, which operate in response to the operation of the start relay to impress a control pulse on the output terminal 597 a predetermined time interval after the dashpot relay R510 is energized. This generator further includes apparatus comprising a rotary switch 590, the relay network noted and four relays R550, R560, R570 and R580 for impressing a predetermined number of impulses on the other output terminal 598 following the application of the control pulse to the terminal 597. Each of the two relays R540 and R570 is of the well-known pendulum type and includes a weighted armature which, when attracted and thereafter released, vibrates, pendulum fashion, periodically to make contact with its associated

contacts. The switch 590 is of the well-known rotary type and comprises two sets of bank contacts 591 and 592 of eleven points each, wipers 593 and 594 respectively associated with the enumerated contact sets, and means comprising an operating magnet 595 and a ratchet and pawl mechanism, not shown, for driving the wipers over their respective associated contacts.

#### *Operation of the impulse generator 500*

Before describing the operation of the apparatus to extend a connection to the D. S. A. operator's board when a calling condition is created on one of the subscriber's lines and no impulses are transmitted thereover, the operation of the impulse generator 500 will be considered. This generator is started in operation immediately any one of the first selector switches is seized, and continues to operate until the wipers of the seized selector switch are translated vertically to a position opposite the selected level and the trunk hunting operation is started. Thus, when R360 operates in the sequence of operations described above, it completes a circuit for energizing the dashpot relay R510, this circuit extending from ground at the upper terminal of the winding of R510 by way of this winding, RA516, C305, RC365, RA366 and through the winding of the rotary magnet 339 to battery. Due to the high resistance of the winding of R510, the magnet 339 is not sufficiently energized to operate. The relay R510, however, attracts its associated armature and, after a time interval sufficient to overcome the retarding force exerted by the dashpot 514, closes its contact springs 512 to complete a circuit for energizing the start relay R515. The circuit noted extends from ground at the upper terminal of the winding of R515 by way of this winding, RA518, RC519 and through the springs 512 to battery. The relay R515, upon operating, completes a holding circuit for itself in series with the rotary magnet 339, this circuit being similar to that traced above for R515 but differing therefrom in that it extends by way of RA517, RA518 and the winding of R515 to ground rather than by way of RA516 and the winding of R510 to ground. Due to the high resistance of the winding of R515, the rotary magnet 339 does not operate when energized in series with this winding. At RA516, the relay R515 opens a point in the operating circuit for R510 and, at RA518 and RC519, it opens a point in its own operating circuit.

At RA519, the relay R515 completes an obvious circuit for energizing the pendulum type relay R540, causing the latter relay to attract its weighted armature RA541 to complete a circuit for energizing the slow-to-operate relay R530. The last-mentioned circuit extends from ground at RA541 by way of RC543, RC542, and the winding of R530 to battery. The relay R530 operates, after an interval, to prepare, at RA531, a holding circuit for itself, and to complete, at RA532, a circuit for energizing the slow-to-operate relay R520, this latter circuit extending from ground on the wiper 593 by way of the first contact of the contact set 591, RA532, RC533 and through the winding of the relay R520 to battery. The relay R520 now operates to prepare, at RA522, a circuit for energizing R560 and to open, at RA521, a point in the operating circuit for R540. With R540 deenergized, its armature RA541 is released and starts vibrating, pendulum fashion, alternately to make contact with RC544 and



RC543. Due to the rapidity of movement of the armature RA541 between its two extreme positions, R530 is held energized so long as the amplitude of vibration of this armature is sufficient to insure its engagement with the two contacts RC543 and RC544. When the amplitude of vibration of RA541 is reduced to a point where this armature no longer engages the two contacts noted, the holding circuit for R530 is opened and this relay restores to complete a circuit for energizing R560. The last-mentioned circuit extends from ground at the switch wiper 593 by way of RA532, RC534, RA522, RA552, RC553 and through the winding of R560 to battery. The relay R530, upon restoring, also opens, at RA532 and RC533, the operating circuit for R520, causing this relay to slowly restore to recomplete, at RA521, the operating circuit, traced above, for R540 and to open, at RA522, the operating circuit for R560. Before R520 restores, however, R560 operates to complete a circuit for holding itself energized in series with the upper winding of R550, this circuit extending from ground at RA519' by way of the switch wiper 594, the first contact of the contact set 592, the upper winding of R550, RA561 and through the winding of R560 to battery. The relay R560, upon operating, also applies a control pulse to the output terminal 597 to which is connected the supervisory conductor C304. Specifically, this pulse consists in the application of ground potential to the terminal 597 over a path extending by way of RA551 and RA563. Shortly thereafter and when the winding of R560 is connected in series with the upper winding of R550, the last-mentioned relay operates to open, at RA551, the path for applying ground to the terminal 597. This operation serves to conclude the control pulse applied to the terminal noted.

When the relay R560 operates, it completes, at RA562, a circuit extending from ground at the switch wiper 593 for energizing R570, causing the latter relay to attract its weighted armature RA571 to open points in the respective circuits, traced hereinafter, for energizing the relay R580 and the operating magnet 595 of the switch 590. At RA552, the relay R550, upon operating, opens a point in the operating circuit for R560 and prepares a circuit for energizing the operating magnet 595 of the switch 590. At RA555, the relay R550 prepares a point in the common portion of circuits, traced hereinafter, for energizing the pulsing relay R580, the pendulum type relay R570, and the magnet 595.

When the relay R520 restores to recomplete, at RA521, the operating circuit for R540, the second cycle of operation of the three relays R520, R530 and R540 is started. The relay R540, upon operating, completes the above-traced circuit for energizing R530, which latter relay, in turn, reoperates to complete the operating circuit for R520. Due to the vibration of the weighted armature RA541, the two relays R530 and R520 are held energized for a predetermined time interval, at the expiration of which R530 restores to open the operating circuit for R520.

When R530 restores during this second cycle of operation of the three relays noted, a circuit is completed for energizing the operating magnet 595, this circuit extending from ground on the switch wiper 593 by way of RA532, RC534, RA522, RA552, RC554 and through the winding of the magnet 595 to battery. When energized over the above-traced circuit, the magnet 595 attracts its armature, thereby to condition the associated

ratchet and pawl mechanism to step the wipers 593 and 594 to their respective first off-normal positions. Shortly thereafter and when R520 restores, the above-traced energizing circuit for the magnet 595 is opened, causing the two switch wipers noted to be stepped into engagement with their respective associated second contacts. When this occurs, the above-traced circuit over which R550 and R560 are held energized is opened at the switch wiper 594, causing R560 to restore. The relay R550, however, is held operated since a new circuit is completed for energizing its lower winding simultaneously with the interruption of the energizing circuit for its upper winding. The circuit noted, namely, that for energizing the lower winding of R550, extends from ground at RA519' by way of the switch wiper 594, the second contact of the set 592 and the lower winding of R550 to battery. At the switch wiper 593, the above-traced operating circuit for the pendulum relay R570 is interrupted, causing this relay to release its weighted armature RA571. This armature now starts to vibrate to deliver ground pulses to the magnet 595 and the pulsing relay R580. Specifically, each time RA571 engages its two associated contacts RC572 and RC573, circuits extending from ground at RA555 are completed for energizing R580 and the operating magnet 595. Each time RA571 engages its associated contact RA572, a priming circuit is completed for energizing R570, this circuit extending from ground at RA555 by way of RA571, RC572, the resistor 596 and through the winding of R570 to battery. By virtue of this arrangement, the weighted armature RA571 is caused to vibrate continuously at a fixed rate, this rate being of the order of ten vibrations per second. Each time a ground pulse is delivered to the operating magnet 595, this magnet steps its wipers one step and, each time a ground pulse is delivered to the pulsing relay R580, this relay operates to disconnect, at RA584, ground from the output terminal 598 terminating the supervisory conductor C306. When the wipers of the switch 590 are returned to their respective home positions by the operating magnet 595 and its associated ratchet and pawl mechanism, the above-traced holding circuit including the lower winding of R550 is interrupted at the switch wiper 594, causing this relay to restore. When R550 restores its armature RA555, operation of the switch 590 and of the impulsing relay R580 is arrested, since ground for completing the respective operating circuits for these elements is no longer present on RA571. The restoration of R550 further results in the deenergization of R570 so that RA571 gradually assumes its resting position wherein it engages its associated contacts RC572 and RC573.

During the interval when the pendulum relay R570 is operating to deliver pulses to the magnet 595 and the impulsing relay R580, the cyclic operation of the three relays R520, R530 and R540 is interrupted. Thus, immediately the switch wiper 593 is stepped from its home position, a point is opened in the operating circuit for R520 so that this relay can not operate following the sequential operation of the two relays R540 and R530. Hence, no further operation of the three relays noted occurs until such time as the wipers of the switch 590 are returned to their respective home positions. If the start relay R515 is still operated when the switch wipers 593 and 594 are returned to their respective home positions, the above-described sequence of operations is re-



peated. Thus, immediately the switch wiper 593 engages the first contact of the contact set 591 and with the two relays R530 and R540 operated, the above-traced circuit is completed for energizing R520. From this point on, the operation of the apparatus is identical with that described above.

Once the switch 590 starts to operate, the wipers thereof are driven through a complete cycle independently of the position of the start relay R515, but immediately this start relay restores the operation of the pulsing relay R580 is arrested. Thus, if the start relay restores after five ground pulses have been delivered to R580 and the operating magnet 595, the holding circuit for the relay R550 is opened at RA519', causing R550 to restore to open, at RA555, a point in the common portion of the circuits for delivering pulses to the magnet 595 and the pulsing relay R580 thereby to prevent further operation of the pulsing relay. When R550 restores, however, it completes a circuit for energizing the magnet 595 by way of the self-interrupting contacts associated with the armature 596, this circuit extending from ground on the wiper 593 by way of any one of the multiplied contacts of the contact set 591, the armature 596, RC558, RA556 and through the winding of the magnet 595 to battery. Due to the circuit interrupting action of the armature 596, the magnet 595 is repeatedly energized to drive its wipers to the home position, at which time its operating circuit is opened at the switch wiper 593. Obviously, if the start relay R515 is deenergized following the application of the control pulse to the output terminal 597 and before any impulses are impressed on the terminal 598, further operation of the impulse generator is prevented. This is true for the reason that ground from RA519' is relied upon to maintain the relays R520, R530 and R540 operating and to hold operated the two relays R550 and R560.

*Operation of the apparatus to extend a connection from a calling line to the operator's station when no impulses are transmitted over the calling line*

Referring now more particularly to the operation of the apparatus automatically to extend a connection to the D. S. A. operator's board when a calling condition is created on one of the lines and no impulses are thereafter transmitted thereover, the first selector switch 300 in its operation to extend a connection from the calling line 101 to the called line 322 will again be briefly considered. Immediately the link connection is established to this selector switch from the calling line, the relay R360 operates to initiate the operation of the impulse generator 500 in the manner described above. When R360 operates, it also prepares, at RA368, a circuit, traced hereinafter, for energizing R370 in response to the application of a control pulse to the output terminal 597 of the impulse generator 500. 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 station, no impulses will be transmitted by way of the calling line and the established link connection to the seized first selector switch 300. Hence, only the relays R340, R350 and R360 of this switch are operated. After this condition has prevailed for a given time interval, the relay R560 embodied in the impulse generator 500 operates in the manner described above

to apply a ground pulse to the supervisory conductor C304. This pulse serves to energize R370 over a circuit which extends from ground on the conductor C304 by way of the switch springs 391, RA368, RC376, RA374 and through the winding of R370 to battery. The relay R370, upon operating, completes a holding circuit for itself, which circuit includes the conductors of the loop extending to the calling subscriber's substation. Specifically, this circuit extends from ground at RA377 by way of RA378, C318, RC339', RA338, C107, C102, the bridge across C102 and C103 at the calling substation, C103, RA122, RC123, C104, C106, RA331, RC332, C312, RA375, RA374 and through the winding of R370 to battery.

With R370 operated, the previously traced operating circuit for the line relay R340 is interrupted at RA372 and RA378. The relay R340 is, however, held operated over an alternative circuit which extends from ground at RA584 by way of C306, RA371, RA372, C313 and through the upper winding of R340 to battery. This circuit constitutes an impulsing circuit by way of which the line relay R340 is made to respond to the impulse output of the impulse generator 500. Thus, each time R500 operates, it opens, at RA534, a point in the impulsing circuit, just traced, to cause R340 to restore. Since with R350 and R360 operated, an impulsing circuit is prepared to the vertical magnet 338, this magnet is energized in accordance with the pulses produced by the generator 500 and translates the wipers of the mechanism 380 to a position opposite the bank contact level corresponding to the number of impulses produced by the generator 500. In the particular case under consideration, this generator delivers ten impulses in each cycle of its operation so that, at the conclusion of the series of impulses delivered to R340, the wipers 384, 385 and 386 stand opposite the tenth bank contact level, or the level terminating the trunk lines extending to the D. S. A. operator's board. Thereafter and when R360 restores, the trunk hunting operation of the selector switch is initiated to select an idle one of these trunk lines. Assuming that the trunk line 396 is the first idle line available, when the wipers 384, 385 and 386 are driven into engagement with the contacts 387, 388 and 389 terminating the respective conductors of this trunk line, the relay R330 is caused to operate to interrupt the trunk hunting operation of the selector switch 300 and to switch the subscriber's loop through to the operator's station 400. In response to this operation, R420 and R430 operate, in the order named, and the last-mentioned relay returns ground over the control conductor C393 to hold the selector switch 300, the finder switch 100 and the relay R130 operated. When the hold relay R430 operates, it completes, at RA431, the previously traced circuit for energizing the call lamp 453. The apparatus remains in this condition until the call is answered at the operator's station.

It is pointed out that, if the calling condition on the line 101 is removed before the generator 500 starts to deliver pulses to the line relay R340, the selector switch 300 will be rendered ineffective to forward the connection to the operator's station. Thus, if the calling condition present on the line 101 results from a call initiated at the substation A and the calling subscriber hangs up, the loop circuit over which R370 is held operated is interrupted, causing this relay to restore to open the impulsing circuit extending from the generator 500 to the line relay R340. When R340 restores, it causes the



sequential restoration of R350 and R360 to initiate the release of the established switch train. If, on the other hand, the calling subscriber commences to dial a desired number after R370 has been caused to operate, the first pulse dialed at the calling substation causes R370 to restore to reconnect the windings of the line relay R340 across the subscriber's loop. Since the loop is now open, the line relay R340 restores to transmit a pulse to the vertical magnet 338. The remaining impulses dialed at the calling substation are delivered to R340 and cause the operation of the selector switch in the manner set forth above. In the event the subscriber's loop circuit is opened after the generator 500 has started to deliver pulses to the line relay R340 but before the series of pulses is completed, the established switch train will either be released or the call will be routed to the wrong subscriber's line, depending upon whether the calling subscriber hangs up or starts to dial a desired number after holding the two switches 100 and 300 operated for a prolonged time interval.

As pointed out above, the incoming call to the operator's station 400 is indicated by the energization of the signal lamp 458 and the call may be answered through the actuation of the key switch 450 to its answer position, thereby to connect the operator's telephone to the loop extending to the calling substation and to open the circuit for energizing the signal lamp 458. The operator at the station 400 may now 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 calling condition results from the first of these two causes, obviously no reply will be received when the connection is challenged. If, on the other hand, the call 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 to an emergency requiring the assistance of the operator. Assuming that the call was originated by a party unfamiliar with the mode of operating dialing devices as conventionally employed in automatic telephone systems, the operator may either advise this party as to the operations required for obtaining the desired line, or extend the connection to the desired line in the manner conventionally employed in manual exchanges.

In many cases of emergency, such for example, as those occasioned by sudden illness, the party who initiates the call may have only sufficient time or 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 those 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 primary line finder switch 200, the auxiliary secondary line finder switch 190 and the recording device

470. As indicated previously, the auxiliary primary line finder switch 200 is controllable from the operator's station. More specifically, if the operator, upon challenging the connection extending from the line 101, deems it necessary to determine the number identifying this line, she may initiate the operation of the switch 200 to cause the recording device 470 to register the first two digits of the number identifying the calling line by momentarily actuating the key switch 460 to its off-normal position. When this operation is performed, an obvious circuit is completed for energizing the slow-to-release relay R440. This relay, upon operating, completes a holding circuit for itself, which circuit extends from ground at RA431 by way of RA442, RC444 and through the winding of R440 to battery. At RA446 and RC447, ground is removed from the control conductor C398 of the trunk line 396. Simultaneously with the last-mentioned operation, there is completed, at RA446 and RC448, a path for applying booster battery potential, as applied to C463, by way of RC433 and RA432 to the control conductor C398. It will be understood that this operation in no way affects those operated relays which depend for energization on the presence of ground on C398 or the control conductors C314 and C108. This is true for the reason that the booster battery voltage is connected in series with the exchange battery, effectively to increase the energization of those relays having windings connected to the control conductors noted. The application of booster battery voltage to C398 obviously causes an increase in the positive potential on the control conductor C398 and this increase in potential results in the substantial energization of the line lockout relay R120 over a circuit extending from the positive side of the booster battery as extended to C398 by way of C314, C108, C98, the resistor 97 and the winding of R120 to the negative terminal of the regular exchange battery.

When energized over the above-traced circuit, the relay R120 partially operates to close only the "X" contacts associated with its armatures RA128, RA129 and RA129'. This partial operation of R120 serves to mark in the bank contacts of the finder switch 190 the particular subgroup of ten lines which includes the calling line, and also to mark the particular calling line of the marked subgroup. Thus, the relay R120, by applying ground from RA136 by way of RC137 and RA129' to the contact 158, marks the particular calling line of the marked ten-line subgroup. By applying ground from RA135 and by way of RA129 and C148 to the test contact 149 of the contact set 113, the relay R120 marks the calling line as being included in the first ten-line subgroup of a particular group of one hundred lines.

The partial operation of R120 further results in the completion of a circuit for energizing the start relay R110, this circuit extending from ground as applied to RA134 by way of RA128 and the winding of R110 to battery. The start relay noted is one of two such relays associated with the particular group of two hundred lines corresponding to the finder switch 190. One of these relays, namely, R110, is commonly associated with an odd numbered group of one hundred lines associated with the finder switch 190 and the other similar relay, not shown, is commonly associated with an even numbered group of one hundred lines associated with the finder switch 190. Hence, through the operation



of the start relay R110, rather than the other start relay associated with the switch 190, the particular group of one hundred lines, including the calling line, is marked in the bank contacts of the auxiliary primary finder switch 200. More specifically, when R110 operates, ground is applied to the first contact 285 of the contact set 284 over a path extending by way of RA112 and C147. This marking also serves to identify the particular group of one thousand lines which includes the calling line 101. At RA111, a path is completed for applying ground by way of C146 to the bank contact 281, thereby to mark in the marked one thousand-line group the particular group of one hundred lines which includes the calling line. The application of ground to C147 further results in the energization of R223 over a circuit extending from ground on the conductor noted by way of C237, RA231 and the winding of R223 to battery. The relay R223, upon operating, prepares, at RA221, a test circuit over which the upper winding of R210 is subsequently energized; prepares, at RA222, a holding circuit for R210; opens, at RA223, a point in the circuit, traced hereinafter, for energizing the release magnet 297; prepares, at RA225, a holding circuit for the test relay R240; and completes, at RA224, an operating circuit for the vertical magnet 295. The last-mentioned circuit extends from ground at RA224 by way of RA252, RC253, RA242, RC243 and through the winding of the magnet 295 to battery. This magnet, upon being energized over the above-traced circuit, causes the wipers of the mechanism 270 to be translated one step vertically and attracts its armature 295' to complete an obvious circuit for energizing R250. When R250 operates, it delivers a ground pulse to the recording device 260 over a path extending from ground at RA224 and by way of RA252 and RA251. The recording device responds to this ground pulse in the usual manner by recording a dash on its register tape. In a similar manner, a ground pulse is delivered to the recording device 470 provided at the operator's station over a path extending from ground at RA254 and by way of C234. Thus, the two recording devices 260 and 470 are caused to register the first vertical step taken by the finder switch 200. When this first vertical step is taken, the off-normal springs 293 are moved to the off-normal position to prepare a circuit for energizing the release magnet 297 and a holding circuit for R233.

When the relay R250 attracts its armature RA251, it opens, at RC253 and RA252, a point in the above-traced operating circuit for the vertical magnet 295, causing this magnet to restore its armature 295' whereby the operating circuit for the relay R250 is opened. The relay R250, upon restoring, again completes the above-traced operating circuit for the vertical magnet 295, causing the wipers of the mechanism 270 to be translated a second step vertically and the operating circuit for R250 again to be completed at the armature 295'. The relay R250 operates a second time to open the operating circuit for the vertical magnet 295 and to deliver ground pulses to the two recording devices 260 and 470. Through the interrelated operation of the magnet 295 and R250, the wipers of the mechanism 270 are caused to be translated vertically in a step-by-step manner until such time as a marked contact in the set 284 is encountered by the test wiper 286. Each step taken by these wipers in a vertical direction is recorded by the two devices

260 and 470 through the operation of R250 to deliver ground pulses thereto.

In the present assumed case, the wipers of the mechanism 270 will be translated only one step in a vertical direction, since immediately the first step is completed, the test wiper 286 is brought into engagement with the marked contact 285 to complete a circuit for energizing the lower winding of the slow-to-operate relay R240. This circuit extends from ground at RA112 by way of C147, the test contact 285, the wiper 286, the lower winding of R240, RA245 and through the resistor 262 and the winding of R250 in parallel to battery. Due to the relatively high resistance of the lower winding of R240, the relay R250 does not operate when energized over the above-traced circuit. The relay R240, however, operates, after an interval, to complete a holding circuit for itself, which circuit extends from ground at RA225 by way of the "x" contacts associated with RA241 and the upper winding of R240 to battery. At RA242, the relay R240 opens a point in the circuit for energizing the vertical magnet 295 and completes a circuit for energizing the rotary magnet 296, this latter circuit extending from ground at RA224 by way of RA252, RC253, RA242, RC244, RA216, RC218 and through the winding of the magnet 296 to battery.

It will be apparent that only one ground impulse is delivered to each of the two recording devices 260 and 470 in the particular case under consideration since only one vertical step on the part of the wipers embodied in the mechanism 270 is required to find the particular marked contact level. Hence, the calling line is identified as being included in the No. 1 group of one thousand lines. The next operation on the part of the auxiliary primary finder switch 200 is to select the particular group of one hundred lines which includes the calling line 101. This is achieved through the interrelated operation of the rotary magnet 296 and the relay R250 to drive the wipers of the mechanism 270 into engagement with the particular set of marked contacts corresponding to the group of one hundred lines which includes the calling line. Thus immediately the rotary magnet 296 is energized, it steps the wipers of the mechanism 270 into engagement with the contacts of the first set in the selected contact level and simultaneously completes, at its armature 296', an obvious circuit for energizing R250. The relay R250, upon operating, delivers a ground pulse to each of the two recording devices 260 and 470 and interrupts, at RA252 and RC253, a point in the operating circuit, traced above, for the rotary magnet 296. The rotary magnet again opens, at its armature 296', a circuit for energizing R250. Thus, the rotary magnet 296 and R250 are alternately energized to drive the wipers of the mechanism 270 until such time as the wipers are stepped into engagement with the set of contacts including the marked contact 281. Since a ground pulse is delivered to each of the two recording devices 260 and 470 each time R250 operates, each step taken by the wipers is recorded by each of these two devices. It will be observed that a slight pause or time delay occurs between the end of the vertical movement of the switch wipers and the beginning of the rotary movement. This pause is caused by the slow-to-operate characteristic of the relay R240 and is for the purpose of spacing the dashes recorded by the two devices 260 and 470 during the vertical



movement of the wipers and representing the first digit of the number identifying the calling line, from the dashes recorded during the rotary movement of the wipers and representing the second digit of the number identifying the calling line.

When, during rotary movement of the switch wipers, the wiper 283 is moved into engagement with the marked contact 281, a circuit is completed for energizing the upper winding of the test relay R210, this circuit extending from ground at RA111 by way of C146, the contact 281, the wiper 283, the upper winding of R210, RC213, RA212, RA221, C288 and through the resistor 262 and the winding of R250 in parallel to battery. Due to the relatively high resistance of the upper winding of R210, the relay R250 does not operate when energized over the above-traced circuit. The relay R210, however, operates and completes, at RA215, a circuit for energizing its lower winding, which circuit extends from ground at RA233 by way of RA222, RA215 and through the lower winding of R210 to battery. The relay R210 now opens, at RA216 and RC218, a point in the above-traced operating circuit for the rotary magnet 296, thereby to arrest the rotary movement of the switch wipers. At RA219, the relay R210 opens a further point in the circuit, traced hereinafter, for energizing the release magnet 297.

At RA211, the relay R210, upon operating, completes a circuit for energizing the upper winding of R150 in series with the upper winding of R230, this circuit extending from ground at the lower terminal of the upper winding of R230, by way of this winding, RA211, the wiper 275, the contact 272, C118, RA162, RC164, and through the upper winding of R150 to battery. Due to the high resistance of the upper winding of R150 and the relatively low resistance of the upper winding of R230, the relay R230 does not operate. The relay R150, however, operates to open, at RA154, a point in the circuit, traced hereinafter, for energizing the release magnet 176; to prepare, at RA153, a test circuit leading to the test relay R160; to prepare, at RA152, a holding circuit for the slow-to-operate test relay R170; and to prepare, at RA151, a path for fully energizing the lockout relay R120 following the operation of the switch 190 to the position corresponding to the line 101.

Following operation of R210, the operation of the primary finder switch 200 to cause the two recording devices 260 and 470 to register the first two digits of the number identifying the calling line is completed. In this connection, it will be apparent that, if the contact set comprising the marked contact 281 is the fifth set of the selected first contact level, five rotary steps will be required on the part of the switch wipers before this contact set is selected. Hence, the first two digits of the number identifying the line 101 are one and five, respectively. The final two digits of this number are recorded in response to the operation of the switch 190 following the operation of R210. Thus, when R210 operates, it completes, at RA216, a circuit for energizing the vertical magnet 178 and prepares, at RA212, a circuit for energizing R250. The first-mentioned circuit, namely, that for energizing the magnet 178, extends from ground at RA224 by way of RA252, RC253, RA242, RC244, RA216, RC217, the wiper 277, the contact 273, C117, RA173, RC175 and through the winding of the magnet 178 to battery. This vertical mag-

net, upon being energized, causes the wipers of the mechanism 155 to be translated one step vertically and attracts its armature 178' to complete the above-noted circuit for energizing R250. This circuit extends from ground at the armature 178' by way of C116, the contact 278, the wiper 280, RC214, RA212, RA221, C288 and through the winding of R250 to battery. The relay R250, upon operating, delivers a ground pulse to each of the two recording devices 260 and 470 and interrupts, at RA252 and RC253, the above-traced operating circuit for the vertical magnet 178. Thus, it will be seen that the magnet 178 and R250, through their interrelated operation, cause the wipers of the mechanism 155 to be translated in a vertical direction to a position opposite the marked level of contacts. Moreover, for each step taken by these wipers a ground pulse is delivered to each of the two recording devices so that, at the conclusion of the vertical stepping operation, the third digit of the number identifying the calling line is recorded by each of these two devices. When the first vertical step is taken by the switch wipers, the off-normal springs 180 are moved to the off-normal position. At the springs 181, a circuit is prepared for energizing the magnet 176 and, at the springs 182, a holding circuit is prepared for R160.

In the present assumed case, the contact 149 standing opposite the first level of bank contacts, is the marked contact of the test contact set 113. Hence, the wipers of the mechanism 155 will only be translated one step vertically, at which time the wiper 114 engages the test contact 149 to complete a circuit for energizing R170, this circuit extending from ground at RA135 by way of RA129, C148, the contact 149, the wiper 114, C115, the lower winding of R170, RA172, C116, the contact 278, the wiper 280, RC214, RA212, RA221, C288 and through the resistor 262 and the winding of R250 in parallel to battery. Due to the relatively high resistance of the lower winding of R170, the relay R250 does not operate when energized over the above-traced circuit. The relay R170, however, operates, after an interval, to complete, at RA171, a holding circuit for itself, this circuit extending from ground at RA152 by way of the "x" contacts associated with RA171 and the upper winding of R170 to battery. At RA172, the relay R170 opens a point in its operating circuit, as traced above. At RA173 and RC175, the relay R170 opens a point in the above-traced operating circuit for the vertical magnet 178, thereby to arrest the vertical movement of the switch wipers. At RA173 and RC174, the relay R170 completes a circuit for energizing the rotary magnet 177, this circuit being similar to that for the vertical magnet 178, but extending by way of RC174, RA168 and the winding of the magnet 177 to battery, rather than by way of RC175 and the winding of the vertical magnet 178 to battery. The rotary magnet 177, upon being energized over the above-noted circuit, causes the wipers of the mechanism 155 to be stepped into engagement with the first contact set of the selected first contact level and, at its armature 177', completes the above-traced circuit for energizing R250. The relay R250 operates to again deliver a ground pulse to each of the two recording devices 260 and 470 and to open, at RA252 and RC253, a point in the circuit for energizing the rotary magnet 177. With the apparatus in this condition, the rotary magnet and R250 interact to drive the wipers



of the mechanism 155 until they are moved into engagement with the marked contact corresponding to the line 101, which contact, in the present case, is the contact 158. If the contact set including the contact 158 is the fourth set in the selected first contact level, four steps will be required on the part of the wipers before this contact set is found. Hence, four ground pulses will be delivered to each of the two recording devices 260 and 470 and the final digit of the number identifying the calling line will be recorded as four, making the complete number identifying the line 101 one-five-one-four. As indicated above, a slight pause in the operation of R250 occurs each time the dashes representing one of the digits of this number are recorded, thus insuring sufficient spacing between the dashes representing each digit to enable the digits to be separated and read. These pauses are due to the time intervals respectively required for the control apparatus to initiate the rotary movement of each of the two switches 200 and 190 following the completion of the vertical movement and for the switch 190 to start operating after the operation of the switch 200 is completed.

When the wiper 159 is driven into engagement with the marked contact 158, a circuit is completed for energizing the upper winding of the test relay R160, this circuit extending from ground at RA136 by way of RC137, RA129', the contact 158, the wiper 159, RC145, RA144, RA153 and through the upper winding of R160 to battery. The relay R160, upon operating, completes, at RA169, a holding circuit for itself, which circuit extends from ground at the off-normal springs 182 by way of RA169 and the lower winding of R160 to battery. At RA168, the relay R160 opens a point in the above-traced operating circuit for the rotary magnet 177, thereby to stop the interrelated operation of this magnet and R250 and arrest the rotary movement of the switch wipers. At RA162, the relay R160 completes a circuit for fully energizing the upper winding of R230, this circuit extending from ground at the lower terminal of the upper winding of R230 by way of this winding, RA211, the wiper 276, the contact 272, C118, RA162, RC163 and through the resistor 183 to battery. The resistance value of the resistor 183 is chosen so that the full rated current is passed through the upper winding of R230 when this winding is energized over the above-traced circuit. Hence, R230 is caused to operate to complete, at RA232, a holding circuit for itself, which circuit extends from ground at the off-normal springs 291 by way of RA232 and the lower winding of R230 to battery. The operation of R230 initiates the release of the switch 200 in the manner pointed out in detail hereinafter. Similarly, the operation of R160 initiates the release of the selected secondary finder switch 190.

Before describing the release of the two finder switches, however, it is pointed out that R160, upon operating, completes a circuit for fully energizing the lockout relay R120. The circuit noted extends from ground at RA161 by way of RA151, RA141, RC142, the wiper 157, the contact 156 and through the winding of R120 to battery. The relay R120 now fully operates to complete, at RA121 and RA122, a holding circuit for itself, which circuit extends from ground at RA121 by way of C102, the bridge across the conductors C102 and C103, C103, RA122, RC124 and through the winding of R120 to battery. Since the bridge

across the two conductors of the line 101 is an integral part of this holding circuit, it will be apparent that the lockout relay is maintained energized until such time as this bridging path is interrupted. Obviously, if the bridge across the conductors C102 and C103 is the result of a call initiated at the substation A, the holding circuit noted will be interrupted when the receiver at this station is restored to its hook. If, on the other hand, the holding bridge is caused by a faulty condition of the line or, more particularly, a short circuit between the conductors C102 and C103, the lockout relay R120 will only be released when the fault is cleared.

In any case, when R120 operates, it opens, at RA122, the loop circuit over which the line relay R420 at the operator's station 400 is held operated, causing this relay to restore to open the operating circuit for the hold relay R430. The relay R430 now restores to open, at RA431, the hold circuit for R440 and to prevent ground from being applied to the control conductor C398 when R440 restores. At RA432 and RC433, booster battery potential is removed from C398. At RA432 and RC434, the negative terminal of the regular exchange battery is connected by way of the resistor 462 to C398, thereby to mark the trunk line 396 as idle in the bank contacts of the first selector switches. When R440 restores, it opens, at RA441, the circuit for energizing the guard lamp 459, causing this lamp to be extinguished to indicate that the recording operation is complete and the operated switch train is released.

When booster battery potential is removed from the control conductor C398, the holding circuit for R330 is interrupted, causing this relay to restore to initiate the release of the selector switch 300. Similarly, the removal of booster battery potential from the control conductor C98. Thus, the holding circuit over which the combined line and cut-off relay R130 was maintained operated, is opened and this relay restores. When R130 restores, it interrupts, at RA133, a point in its own holding circuit and opens, at its armatures RA135, RA136, and RA139, points in the above-traced marking paths. At RA134, the relay R130 opens a point in the operating circuit for the start relay R110, causing this relay to restore to open, at RA111, a point in the marking path leading to the bank contacts of the switch 200 and, at RA112, a point in the common portion of the marking path leading to the test contact 285 and the operating circuit for R220. Thus, the operated switch train extending between the line 101 and the operator's station is entirely cleared out, the line 101 is locked out of service and the switches involved in the switch train are conditioned for further use.

Considering now the release of the finder switch 200, when R230 operates, it opens, at RA231, a point in the operating circuit for R220 and, at RA233, a point in the holding circuit for R210, causing these two relays to restore. At RA224, the relay R220, upon restoring, opens a point in the common portion of the above-traced circuits by way of which the magnets 295, 296, 178 and 177 are repeatedly energized. At RA225, the relay R220 opens a point in the holding circuit for R240, causing this relay to restore. When the two relays R210 and R220 fall back, a circuit is completed for energizing the release magnet



297, this circuit extending from ground at RC219' by way of RA219, RA223, the off-normal springs 292 and through the winding of the magnet 297 to battery. The resulting operation of this release magnet 297 causes the wiper carriage structure of the mechanism 270 to be restored to normal, at which time the off-normal springs 290 are moved to the normal position to open, at the springs 292, a point in the operating circuit for the release magnet and, at the springs 291, a point in the holding circuit for R230. Thus, the auxiliary primary finder switch 200 is completely released.

Considering now the release of the finder switch 190, when the relay R160 operates, it opens, at RA162 and RC164, a point in the previously traced circuit for energizing the upper winding of R150, causing the last-mentioned relay to restore. When the slow-to-release relay R150 falls back, it opens, at RA151, the above-traced operating circuit for the lockout relay R120; opens at RA152, the above-traced holding circuit for R170 causing this relay to restore; opens, at RA153, a point in the operating circuit for R160; and completes, at RA154, a circuit extending by way of the off-normal springs 181 for energizing the release magnet 176. The resulting operation of the release magnet causes the wiper carriage structure of the switching mechanism 155 to be restored to normal, whereby the off-normal springs 180 are returned to normal to open, at the springs 181, a point in the operating circuit for the release magnet and, at the springs 182, a point in the holding circuit for R160. Thus, the finder switch 190 is entirely released.

The relay R140 is provided in the switch 190 for the purpose of determining which of two sets of test contacts will be tested during rotary movement of the wipers embodied in the mechanism 155. More specifically, the finder switch 190 has an operating position corresponding to each line of two, one hundred line groups and the relay R140 determines by its position whether the test contacts corresponding to the lines of a ten line subgroup in one of the two groups of lines will be tested during rotary movement of the switch, or whether the test contacts corresponding to the lines of a ten line subgroup in the other group will be tested. Since, in the case just described the line 101 is included in a ten line subgroup forming a part of the odd numbered group of one hundred lines associated with the switch 190, it is necessary that the relay R140 be maintained deenergized during rotary movement of the switch wipers. This is insured by the operation of the switch 200 to select the contact set including the marked contact 281 rather than a preceding or succeeding contact set.

To clarify this point the case of a calling line included in the even numbered group of one hundred lines associated with the switch 190 will now be briefly considered. In this last assumed case, the group start relay, corresponding to R110 but associated with the even numbered one hundred line group which includes the calling line, marks the bank contact 282 with ground potential rather than the contact 281. Hence, the test relay R210 is not caused to operate until the wipers of the switch 200 are, during the rotary movement thereof, driven into engagement with the contacts of the set including the marked contact 282. In this case and when R210 operates, a circuit is completed for energizing R140, this circuit extending from ground at the lower terminal of the upper winding of R230 by way of

this winding, RA211, the wiper 276, the contact 274, C119, RA165, RC167, the lower winding of R150 and the winding of R140 to battery. The resulting operation of R140 serves to prepare, at RA144 and RC146, a test circuit which extends to R160 from the wiper 159' rather than the wiper 159, so that, during rotary movement of the wipers embodied in the mechanism 155, the contacts corresponding to the lines forming a ten line subgroup of the even numbered group of one hundred lines associated with the switch 190, are tested. At RA141, the relay R140, upon operating prepares a circuit for fully energizing the lockout relay associated with the calling line included in the even numbered group of one hundred lines. The relay R150 also operates, when energized in the above-traced circuit, to perform the functions described above.

From this point on the operation of the apparatus and, more particularly, the finder switch 190 to cause the final two digits of the number identifying the calling line to be recorded, is exactly as described above. Following the operation of this finder switch to the position corresponding to the calling line the lockout relay associated with the line is caused to operate over a circuit extending from ground at RA161 by way of RA151, RA141, RC143, the switch wiper 157', the contact 156' and the winding of the lockout relay, not shown, to battery. The resulting operation of the lockout relay causes the operated switch train to be released and the calling line to be locked out of service until such time as the calling condition thereon is terminated. During the release of the apparatus the relay R230 is caused to operate to initiate the release of the finder switch 200 in response to its energization over a circuit different from that traced above. This new circuit extends from ground at the lower terminal of the upper winding of R230 by way of this winding, RA211, the wiper 276, the contact 274, C119, RA165, RC166 and through the resistor 183 to battery. Obviously, the operation of R160 to complete this circuit results in the deenergization of R140. The remaining steps in the release of the two finder switches 190 and 200 are exactly as described above.

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, including a group of selector switches, for setting up connections between said lines, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, whereby a connection may be established by way of said trunk line between a calling one of said lines and said operator's station, line lockout means associated with the calling line, indicating means commonly associated with said plurality of lines, and means controllable from said operator's station for causing said indicating means to indicate the character identifying said calling line and for causing said lockout means to lock said calling line out of service.

2. 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, including a group of selector switches, for setting up connections between said lines, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, whereby a connection may be established by way of said trunk line between a calling one of said lines and said operator's station, line lockout means associated with the calling line, a second station remotely located with respect to said operator's station, indicating means located respectively at said stations and each commonly associated with said plurality of lines, and means controllable from said operator's station for causing each of said indicating means to indicate the character identifying said calling line and for causing said lockout means to lock said calling line out of service.

25 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, including a group of impulse responsive selector switches, for setting up connections between said lines, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, certain of said switches other than said selector switches being effective to set up a link connection between one of said subscribers' lines and one of said selector switches when a calling condition is created on said one of said lines, means only operative in the event no control impulses are transmitted to said one selector switch by way of said one line within a given time interval after said link connection is established for causing said one switch to extend said link connection by way of said trunk line to 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 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.

50 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, including a group of impulse responsive selector switches, for setting up connections between said lines, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, certain of said switches other than said selector switches being effective to set up a link connection between one of said subscribers' lines and one of said selector switches when a calling condition is created on said one of said lines, an impulse generator, means included in said one selector switch and operative during the establishing of said link connection for initiating the operation of said impulse generator, means including said impulse generator for causing said one selector switch to extend said link connection by way of said trunk line to said operator's station, said last-named means only being operative in the event no control impulses are transmitted to said one selector switch by way of said one line within a predetermined time in-

terval after said link connection is established, line lockout means associated with said one line, indicating means commonly associated with said plurality of lines, and means controllable from said operator's station and by way of said trunk line for causing said indicating means to indicate the character identifying said calling line and for causing said lockout means to lock said one line out of service until said calling condition is terminated.

5 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, including a group of impulse responsive selector switches, for setting up connections between said lines, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, certain of said switches other than said selector switches being effective to set up a link connection between one of said subscribers' lines and one of said selector switches when a calling condition is created on said one of said lines, an impulse generator, a pair of conductors interconnecting said one selector switch and said impulse generator, means included in said one selector switch and operative during the establishing of said connection for initiating the operation of said impulse generator, said generator including means for applying a control pulse to one of said conductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be energized in response to the application of said control pulse to said one conductor and being operative to condition said one switch to respond to the impulses impressed on said other conductors, means included in said one switch and responsive to the impulses impressed on said other conductor for causing said one switch to extend said link connection by way of said trunk line to said operator's station, and means responsive to impulses transmitted to said one switch by way of said one line for preventing the operation of said last-named means.

55 6. 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, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, certain of said switches other than said selector switches being effective to set up a link connection between one of said subscribers' lines and one of said selector switches when a calling condition is created on said one of said lines, an impulse generator, a pair of conductors interconnecting said one selector switch and said impulse generator, means included in said one selector switch and operative during the establishing of said connection for initiating the operation of said impulse generator, said generator including means for applying a control pulse to one of said conductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be energized in response to the application of said



control pulse to said one conductor and being operative to condition said one switch to respond to the impulses impressed on said other conductor, means included in said one switch and responsive to the impulses impressed on said other conductor for causing said one switch to extend said link connection by way of said trunk line to said operator's station, means responsive to impulses transmitted to said one switch by way of said one line for preventing the operation of said last-named means, line lockout means associated with said one line, indicating means commonly associated with said plurality of lines, and means controllable from said operator's station and by way of said trunk line 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.

7. 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 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; said one selector switch including bank contacts arranged in levels, wipers for engaging said bank contacts, a stepping magnet for translating said wipers opposite a desired level and means for automatically rotating said wipers into engagement with a particular set of contacts following the translation thereof to a position opposite a desired contact level; an operator's station, a trunk line extending from said station and terminating at one set of bank contacts included in a predetermined level, an impulse generator, a pair of conductors interconnecting said one selector switch and said generator, means included in said one selector switch and operative during the establishing of said link connection for initiating the operation of said impulse generator, said generator including means for applying a control pulse to one of said conductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be energized in response to the application of said control pulse to said one conductor and being operative to condition said stepping magnet to respond to the impulse impressed on said other conductor, whereby said wipers are translated opposite said predetermined level and are thereafter rotated into engagement with the set of contacts terminating said trunk line thereby to extend said link connection to said operator's station, and means responsive to impulses transmitted to said switch by way of said one line for preventing said magnet from responding to the impulses impressed on said other conductor, line lockout means associated with said one line, indicating means commonly associated with said plurality of lines, and means controllable from said operator's station and by way of said trunk line 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.

8. 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 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; said one selector switch including bank contacts

arranged in levels, wipers for engaging said bank contacts, a stepping magnet for translating said wipers opposite a desired level and means for automatically rotating said wipers into engagement with a particular set of contacts following the translation thereof to a position opposite a desired contact level; an operator's station, a trunk line extending from said station and terminating at one set of bank contacts included in a predetermined level, an impulse generator, a pair of conductors interconnecting said one selector switch and said generator, means included in said one selector switch and operative during the establishing of said link connection for initiating the operation of said impulse generator, said generator including means for applying a control pulse to one of said conductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be energized in response to the application of said control pulse to said one conductor and being operative to condition said stepping magnet to respond to the impulses impressed on said other conductor, whereby said wipers are translated opposite said predetermined level and are thereafter rotated into engagement with the set of contacts terminating said trunk line thereby to extend said link connection to said operator's station, means responsive to impulses transmitted to said switch by way of said one line for preventing said magnet from responding to the impulses impressed on said other conductor, line lockout means associated with said one line, indicating means commonly associated with said plurality of lines, and means controllable from said operator's station and by way of said trunk line 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.

9. 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, an operator's station, a trunk line extending to said station and accessible to each of the selector switches of said group, one of said selector switches including means responsive to at least one predetermined series of impulses transmitted by way of a calling one of said subscribers' lines for establishing a connection by way of said trunk line and between said station and said calling line, and means for causing said one selector switch to establish a connection by way of said trunk line and between said station and said calling line in the event no impulses are transmitted to said one selector switch over said calling line.

10. 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 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, a trunk line extending to said operator's station and accessible to said one selector switch, a local impulse generator, means included in said one selector switch and operative during the establishing of said link connection for initiating



the operation of said generator, means included in said one selector switch and responsive to the impulse output of said generator for causing said one switch to extend said link connection by way of said trunk line to said operator's station, and means responsive to impulses transmitted to said one switch by way of said one line for preventing said one selector switch from responding to the impulse output of said generator.

11. 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 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, a trunk line extending to said operator's station and accessible to said one selector switch, a local impulse generator, means included in said one selector switch and operative during the establishing of said link connection for initiating the operation of said generator, a pair of conductors interconnecting said generator and said one selector switch, said generator including means for applying a control pulse to one of said conductors and means for impressing a predetermined series of impulses on the other of said conductors, means included in said one selector switch and responsive to said control pulse for conditioning said one selector switch to respond to the impulses of said predetermined series, means included in said one selector switch and responsive to the impulses of said predetermined series for causing said one switch to extend said link connection by way of said trunk line to said operator's station, and means responsive to impulses transmitted to said one switch by way of said one line for preventing the operation of said last-named means.

12. In an automatic telephone system, a plurality of subscribers' lines, a plurality of subscriber controlled automatic switches, including a group of selector switches, for setting up connections between said lines, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, whereby a connection may be established by way of said trunk line between a calling one of said lines and said operator's station, line lockout means associated with the calling line, and means controllable from said operator's station for causing said lockout means to lock said calling line out of service.

13. 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 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 one of said lines, an operator's station, a trunk line extending to said station and accessible to said one selector switch, a local impulse generator, means included in said one selector switch and operative during the establishing of said link connection for initiating the operation of said generator, means included in said one selector switch and responsive to the impulse output of said generator for causing said

one switch to extend said link connection by way of said trunk line to said operator's station, line lockout means associated with said one line, means controllable from said operator's station for causing said lockout means to lock said one line out of service until said calling condition is terminated, and means responsive to impulses transmitted to said one selector switch by way of said one subscriber's line for preventing said one selector switch from responding to the impulse output of said generator.

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, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, certain of said switches other than selector switches being operative to set up a link connection between one of said subscribers' lines and one of said selector switches when a calling condition is created on said one of said lines, an impulse generator, a pair of conductors interconnecting said one selector switch and said impulse generator, means included in said one selector switch and operative during the establishing of said connection for initiating the operation of said impulse generator, said generator including means for applying a control pulse to one of said conductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be energized in response to the application of said control pulse to said one conductor and being operative to condition said one selector switch to respond to the impulses impressed on said other conductor, means included in said one selector switch and responsive to the impulses impressed on said other conductor for causing said one switch to extend said link connection by way of said trunk line to said operator's station, line lockout means associated with said one subscriber's line, means controllable from said operator's station for causing said lockout means to lock said one subscriber's line out of service until said calling condition is terminated, and means responsive to impulses transmitted to said one selector switch by way of said one subscriber's line for preventing said one selector switch from responding to the impulse output of said generator.

15. 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 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; said one selector switch including bank contacts arranged in levels, wipers for engaging said contacts, a stepping magnet for translating said wipers opposite a desired level and means for automatically moving said wipers into engagement with a particular set of contacts following the translation thereof to a position opposite a desired contact level; an operator's station, a trunk line extending from said station and terminating at one set of bank contacts included in a predetermined level, an impulse generator, a pair of conductors interconnecting said one selector switch and said genera-



tor, means included in said one selector switch and operative during the establishing of said link connection for initiating the operation of said impulse generator, said generator including means  
 5 for applying a control pulse to one of said conductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be  
 10 energized in response to the application of said control pulse to said one conductor and being operative to condition said stepping magnet to respond to the impulses impressed on said other conductor, whereby said wipers are translated op-  
 15 posite said predetermined level and are thereafter rotated into engagement with the set of contacts terminating said trunk line thereby to extend said link connection to said operator's station, line lockout means associated with said one sub-  
 20 scriber's line, means controllable from said operator's station by way of said trunk line and said link connection for causing said lockout means to lock said calling line out of service until said calling condition is terminated, and means re-  
 25 sponsive to impulses transmitted to said one selector switch by way of said one line for preventing said magnet from responding to the impulses impressed on said other conductor.

16. In an automatic telephone system, a plu-  
 30 rality of subscribers' lines, each of said lines being identified by a particular character, a plurality of subscriber controlled automatic switches, including a group of selector switches, for setting up connections between said lines, an operator's  
 35 station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's station, whereby a connection may be established by way of said trunk line between a calling one of said lines and  
 40 said operator's station, a second station remotely located with respect to said operator's station, indicating means located respectively at said stations, and means controllable from said opera-  
 45 tor's station for causing each of said indicating means to indicate the character identifying said one line.

17. In an automatic telephone system, a plu-  
 50 rality 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  
 55 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  
 60 said selector switches when a calling condition is created on one of said lines, an operator's station, a trunk line extending to said station and accessible to said one selector switch, a local im-  
 65 pulse generator, means included in said one selector switch and operative during the establishing of said link connection for initiating the operation of said generator, means included in said  
 70 one selector switch and responsive to the impulse output of said generator for causing said one switch to extend said link connection by way of said trunk line to said operator's station, indi-  
 75 cating means commonly associated with said lines, means controllable from said operator's station for causing said indicating means to indicate the character identifying said one line, and means responsive to impulses transmitted to said one selector switch by way of said one subscriber's line for preventing said one selector switch from re-  
 sponding to the impulse output of said generator.

18. 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, including a group of impulse responsive selector  
 10 switches, for setting up connections between said lines, an operator's station, each of said selector switches including a set of bank contacts terminating a trunk line extending to said operator's  
 15 station, certain of said switches other than selector switches being operative to set up a link connection between one of said subscribers' lines and one of said selector switches when a calling  
 20 condition is created on said one of said lines, an impulse generator, a pair of conductors interconnecting said one selector switch and said impulse generator, means included in said one selector  
 25 switch and operative during the establishing of said connection for initiating the operation of said impulse generator, said generator including means for applying a control pulse to one of said  
 30 conductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be  
 35 energized in response to the application of said control pulse to said one conductor and being operative to condition said one selector switch to respond to the impulses impressed on said other  
 40 conductor, means included in said one selector switch and responsive to the impulses impressed on said other conductor for causing said one switch to extend said link connection by way of  
 45 said trunk line to said operator's station, indicating means commonly associated with said lines, means controllable from said operator's station for causing said indicating means to indicate  
 50 the character identifying said one line, and means responsive to impulses transmitted to said one selector switch by way of said one subscriber's  
 55 line for preventing said one selector switch from responding to the impulse output of said generator.

19. In an automatic telephone system, a plu-  
 45 rality 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  
 50 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  
 55 said selector switches when a calling condition is created on said one of said lines; said one selector switch including bank contacts arranged in levels, wipers for engaging said contacts, a step-  
 60 ping magnet for translating said wipers opposite a desired level and means for automatically moving said wipers into engagement with a particular set of contacts following the translation thereof to  
 65 a position opposite a desired contact level; an operator's station, a trunk line extending from said station and terminating at one set of said bank contacts included in a predetermined level,  
 70 an impulse generator, a pair of conductors interconnecting said one selector switch and said generator, means included in said one selector switch and operative during the establishing of said link  
 75 connection for initiating the operation of said impulse generator, said generator including means for applying a control pulse to one of said con-  
 ductors and means for thereafter impressing a predetermined series of impulses on the other of said conductors, a relay included in said one selector switch, said relay being arranged to be



energized in response to the application of said control pulse to said one conductor and being operative to condition said stepping magnet to respond to the impulses impressed on said other conductor, whereby said wipers are translated opposite said predetermined level and are thereafter rotated into engagement with the set of contacts terminating said trunk line thereby to extend said link connection to said operator's station, indicating means commonly associated with said lines, means controllable from said operator's station for causing said indicating means to indicate the character identifying said one line, and means responsive to impulses transmitted to said one selector switch by way of said one line for preventing said magnet from responding to the impulses impressed on said other conductor.

20. In an automatic telephone system, a plurality of subscribers' lines, said lines being arranged in groups each divided into subgroups and each of said subgroups being divided into smaller subgroups, 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 switches for establishing a connection between a calling one of said lines and said operator's station, indicating means, an auxiliary line finder switch operative to select the group of lines including said calling line and thereafter to select the subgroup of lines including said calling line, means controllable from said operator's station for initiating the operation of said finder switch, a second auxiliary line finder switch operative to select from the selected subgroup of lines the smaller subgroup which includes the calling line and the calling line from the selected smaller subgroup of lines, means included in said first-named finder switch for initiating the operation of said second finder switch, and means controlled jointly by said two finder switches for causing said indicating means to indicate the character identifying said calling line.

21. In an automatic telephone system, a plurality of subscribers' lines, said lines being arranged in groups each divided into subgroups and each of said subgroups being divided into smaller subgroups, 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 switches for establishing a connection between a calling one of said lines and said operator's station, a second station remotely located with respect to said operator's station, an indicating device located at each of said stations, an auxiliary line finder switch operative to select the group of lines including said calling line and thereafter to select the subgroup of lines including said calling line, means controllable from said operator's station for initiating the operation of said finder switch, a second auxiliary line finder switch operative to select from the selected subgroup of lines the smaller subgroup which includes the calling line and the calling line from the selected smaller subgroup of lines, means included in said first-named finder switch for initiating the operation of said second finder switch, and means controlled jointly by said two finder switches for causing each of said indicating devices to indicate the character identifying said calling line.

22. In an automatic telephone system, a plurality of subscribers' lines, said lines being ar-

ranged in thousand line groups each divided into one hundred line groups and each of said one hundred line groups being divided into ten line subgroups, each of said lines being identified by a particular four digit number, a plurality of subscriber controlled automatic switches for setting up connections between said lines, an operator's station, means including a portion of said switches for establishing a connection between a calling one of said lines and said operator's station, recording means, an auxiliary line finder switch operative to select the thousand line group including said calling line and thereafter the one hundred line group including said calling line, means controllable from said operator's station for initiating the operation of said finder switch, means included in said finder switch for causing said recording means to record the first two digits of the number identifying said calling line, a second auxiliary line finder switch operative to select from the selected one hundred line group the ten line subgroup including the calling line and thereafter the calling line from the selected subgroup, means included in said first-named auxiliary finder switch for initiating the operation of said second finder switch following the operation of said recording means to record the first two digits of the number identifying said calling line, and means controlled by said second finder switch for causing said recording means to record the final two digits of the number identifying said calling line.

23. In an automatic telephone system, a plurality of subscribers' lines, said lines being arranged in groups each divided into subgroups and each of said subgroups being divided into smaller subgroups, each of said lines being identified by a particular four digit number, a plurality of automatic switches for setting up connections between said lines, an operator's station, means comprising a portion of said switches for establishing a connection between a calling one of said lines and said operator's station, an auxiliary line finder switch, said finder switch being operative to a position corresponding to the group of lines including said calling line and thereafter to a second position corresponding to the subgroup of lines including the calling line, means controllable from said station for initiating the operation of said finder switch, a relay controlled in accordance with the operation of said finder switch to said one position for causing said recording means to record the first digit of the number identifying said calling line, said relay being controlled in accordance with the operation of said finder switch to said second position to cause said recording means to record the second digit of the number identifying said calling line, a second auxiliary line finder switch, said second finder switch being operative to a first position corresponding to the subgroup of lines including said calling line and thereafter to a second position corresponding to the calling line, means included in said first-named finder switch for initiating the operation of said second finder switch following the operation of said recording means to record the first two digits of the number identifying said calling line, means included in said second finder switch for controlling said relay in accordance with the operation of said second finder switch to its first position, thereby to cause said recording means to record the third digit of the number identifying the calling line, and means included in said second finder switch for con-



trolling said relay in accordance with the operation of said second finder switch to its second position, thereby to cause said recording means to record the fourth digit of the number identifying the calling line.

24. In an automatic telephone system, a plurality of subscribers' lines, said lines being arranged in groups each divided into subgroups and each of said subgroups being divided into smaller subgroups, each of said lines being identified by a particular four digit number, a plurality of subscriber controlled automatic switches for setting up connections between said lines, means comprising a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, recording means, a pair of auxiliary line finder switches, each of said finder switches including bank contacts arranged in levels and a set of wipers adapted successively to be operated step by step in two directions to select a particular contact level and thereafter a particular contact set in a selected level, the contact levels in one of said finder switches respectively corresponding to said groups of lines and the corresponding contact sets of each contact level respectively corresponding to said subgroups of lines, the contact levels in the other of said finder switches respectively corresponding to said smaller subgroups of lines and the corresponding contact sets of each contact level to the individual lines of the smaller subgroups, means controllable from said operator's station for marking in the bank contacts of said finder switches the particular group, subgroup and smaller subgroup each including said calling line and also the particular calling line, means also controllable from said operator's station for initiating the operation of said one finder switch, means comprising a relay, energized once for each step taken by the wipers of each finder switch, for driving the wipers of said one finder switch in one direction to a position opposite the marked level of contacts and for thereafter driving said last-named wipers into engagement with the marked contact set of the marked contact level, said recording means being operative to record the first two digits of the number identifying said calling line in response to the repeated operation of said relay during the operation of said one finder switch, and means comprising said relay for driving the wipers of said other switch in one direction to a position opposite the marked level of contacts and for thereafter driving said last-named wipers into engagement with the marked contact set of the marked contact level following the operation of said recording means to record said first two digits, said recording means being operative to record the final two digits of the number identifying said calling line in response to the repeated operation of said relay during the operation of said other finder switch.

25. In an automatic telephone system, a plurality of subscribers' lines, said lines being arranged in groups each divided into subgroups and each of said subgroups being divided into smaller subgroups, 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 switches for establishing a connection between a calling one of said stations and said operator's station, line lockout means associated with said calling line, indicating means, an auxiliary line finder switch

operative to select the group of lines including said calling line and thereafter to select the subgroup of lines including said calling line, means controllable from said operator's station for initiating the operation of said finder switch, a second auxiliary line finder switch operative to select from the selected subgroup of lines the smaller subgroup of lines which includes the calling line and thereafter the calling line from the selected smaller subgroup of lines, means included in said first-named auxiliary finder switch for initiating the operation of said second finder switch, means controlled jointly by said auxiliary finder switches for causing said indicating means to indicate the character identifying said calling line, and means included in one of said auxiliary finder switches for causing said lockout means to lock said calling line out of service.

26. In an automatic telephone system, a plurality of subscribers' lines, said lines being arranged in groups each divided into subgroups and each of said subgroups being divided into smaller subgroups, 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 switches for establishing a connection between a calling one of said stations and said operator's station, line lockout means associated with said calling line, a second station remotely located with respect to said operator's station, an indicating device located at each of said stations, an auxiliary line finder switch operative to select the group of lines including said calling line and thereafter to select the subgroup of lines including said calling line, means controllable from said operator's station for initiating the operation of said finder switch, a second auxiliary line finder switch operative to select from the selected subgroup of lines the smaller subgroup of lines which includes the calling line and thereafter the calling line from the selected smaller subgroup of lines, means included in said first-named auxiliary finder switch for initiating the operation of said second finder switch, means controlled jointly by said auxiliary finder switches for causing each of said indicating devices to indicate the character identifying said calling line, and means included in one of said auxiliary finder switches for causing said lockout means to lock said calling line out of service.

27. In an automatic telephone system, a plurality of subscribers' lines, said lines being arranged in groups each divided into subgroups and each of said subgroups being divided into smaller subgroups, each of said lines being identified by a particular four digit number, a plurality of subscriber controlled automatic switches for setting up connections between said lines, means comprising a portion of said automatic switches for establishing a connection between a calling one of said lines and said operator's station, recording means, a pair of auxiliary line finder switches, each of said finder switches including bank contacts arranged in levels and a set of wipers adapted successively to be operated step by step in two directions to select a particular contact level and thereafter a particular contact set in a selected level, the contact levels in one of said finder switches respectively corresponding to said groups of lines and the corresponding contact sets of each contact level respectively corresponding to said subgroups of lines, the contact levels in the other of said finder



switches respectively corresponding to said smaller subgroups of lines and the corresponding contact sets of each contact level to the individual lines of the smaller subgroups, a two-step lock-out relay associated with said calling line, said lockout relay being operative to one position to mark in the bank contacts of said finder switches the particular group, subgroup, and smaller subgroup each including said calling line and also the particular calling line, said lockout relay being operative to a second position to lock said calling line out of service, a circuit for partially energizing said lockout relay thereby to cause said relay to operate to its said one position, means at said station for completing said circuit, means comprising said lockout relay for initiating the operation of said one finder switch, means comprising a relay, energized once for each step taken by the wipers of each finder switch, for driving the wipers of said one finder switch in one direction to a position opposite the marked level of contacts and for thereafter driving said last-named wipers into engagement with the marked contact set of the marked contact level, said recording means being operative to record the first two digits of the number identifying said calling line in response to the repeated operation of said relay during the operation of said one finder switch, means comprising said relay for driving the wipers of said other finder switch in one direction to a position opposite its marked level of contacts and for thereafter driving said last-named wipers into engagement with the marked contact set of the marked contact level, said last-named means only being operative following the operation of said recording means to record said first two digits, said recording means being operative to record the final two digits of the number identifying said calling line in response to the repeated operation of said relay during the operation of said other finder switch, and means included in said other finder switch for causing said lockout relay to operate to its said second position following the operation of said recording means to record the final two digits of the number identifying said calling line.

28. An impulse generator comprising, in combination, a pair of output terminals, a start relay, means responsive to the operation of said start relay for impressing a control pulse on one of said output terminals, and means operative following the operation of said last-named means for impressing a predetermined number of impulses on the other of said output terminals.

29. An impulse generator comprising, in combination, a pair of output terminals, a start relay, means responsive to the operation of said relay for impressing a control pulse on one of said terminals, means including a rotary switch operative following the operation of said last-named means for impressing a predetermined series of impulses on the other of said terminals, and means for discontinuing the application of impulses to said other terminal, but not the operation of said switch, in the event said start relay restores before said series of impulses is completed.

30. An impulse generator comprising, in combination, a pair of output terminals, a start relay, a group of cyclically operating relays connected and arranged to operate in response to the operation of said start relay, a control relay arranged to operate during the first cycle of operation of said group of relays, means including

said control relay for applying a control pulse to one of said terminals, a pulsing relay including contacts for impressing impulses on the other of said terminals, a pendulum type relay, a rotary switch including an operating magnet, means including said pendulum relay for energizing said operating magnet and said pulsing relay at spaced intervals, and means including said rotary switch for arresting the operation of said pulsing relay after a predetermined number of impulses have been impressed on said other output terminal.

31. An impulse generator comprising, in combination, a pair of output terminals, a start relay, a group of cyclically operating relays connected and arranged to operate in response to the operation of said start relay, a control relay arranged to operate during the first cycle of operation of said group of relays and including contacts for applying a control pulse on one of said terminals, a pulsing relay for impressing impulses on the other of said terminals, a pendulum type relay energized in response to the operation of said control relay, a rotary switch including an operating magnet, a second control relay operative in response to the operation of said first-named control relay, said operating magnet being arranged momentarily to be energized during the second cycle of operation of said group of relays, said first-named control relay and said pendulum relay being so connected and arranged as to be deenergized in response to the resulting operation of said rotary switch, means including said pendulum relay for energizing said pulsing relay and said operating magnet at spaced intervals following said deenergization of said pendulum relay, and means including said rotary switch for arresting the operation of said pulsing relay after a predetermined series of impulses have been impressed on said other output terminal.

32. An impulse generator comprising, in combination, a pair of output terminals, a start relay, a group of cyclically operating relays connected and arranged to operate in response to the operation of said start relay, a control relay arranged to operate during the first cycle of operation of said group of relays and including contacts for applying a control pulse to one of said terminals, a pulsing relay for impressing impulses on the other of said terminals, a pendulum type relay energized in response to the operation of said control relay, a rotary switch including an operating magnet, a second control relay operative in response to the operation of said first-named control relay, said operating magnet being arranged momentarily to be energized during the second cycle of operation of said group of relays, said first-named control relay and said pendulum relay being so connected and arranged as to be deenergized in response to the resulting operation of said rotary switch, means including said pendulum relay for energizing said pulsing relay and said operating magnet at spaced intervals following said deenergization of said pendulum relay, means including said rotary switch for arresting the operation of said pulsing relay after a predetermined series of impulses have been impressed on said other output terminal, and means including said second control relay for arresting the operation of said pulsing relay, but not the operation of said switch, in the event said start relay restores before said series of impulses is completed.

JOHN ELLIS OSTLINE.