Oct. 23, 1928. 1,688,588

C. E. LOMAX ET AL

AUTOMATIC TELEPHONE SYSTEM

Filed July 2, 1927 6 Sheets-Sheet 1

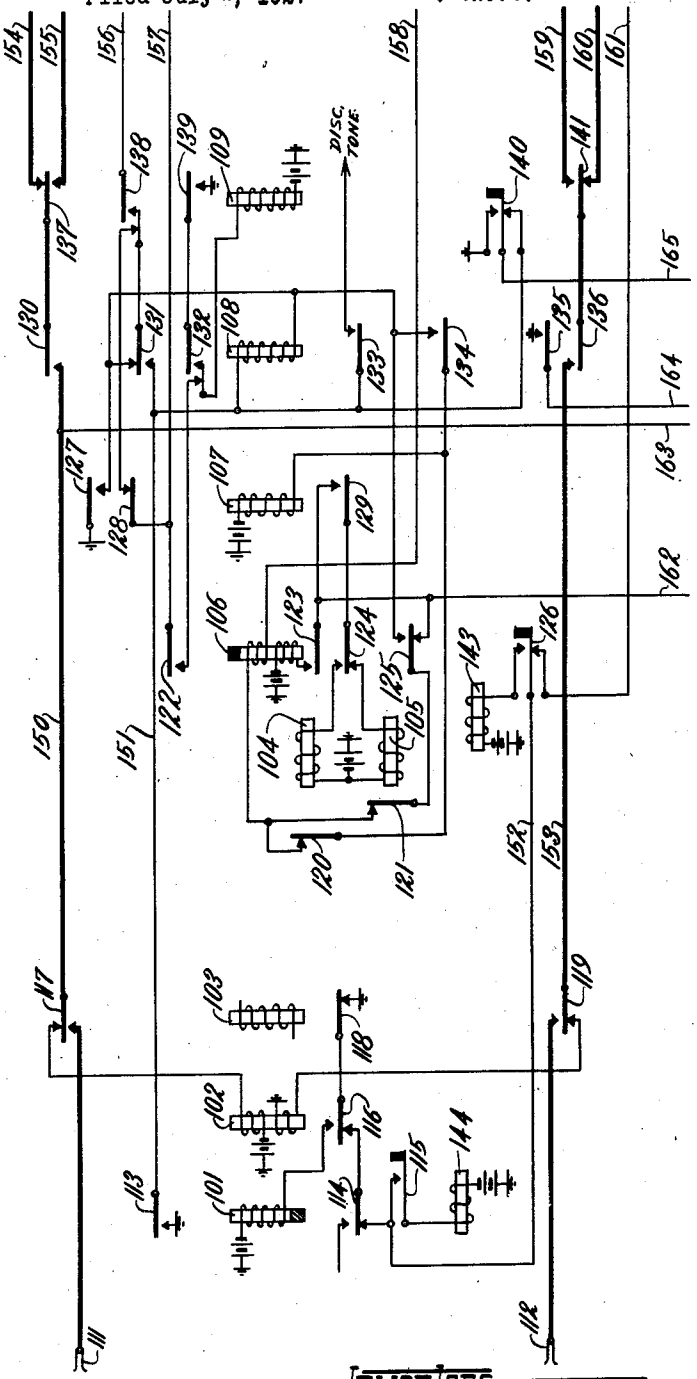


Fig. 1

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AUTOMATIC TELEPHONE SYSTEM

Filed July 2, 1927 6 Sheets-Sheet 2

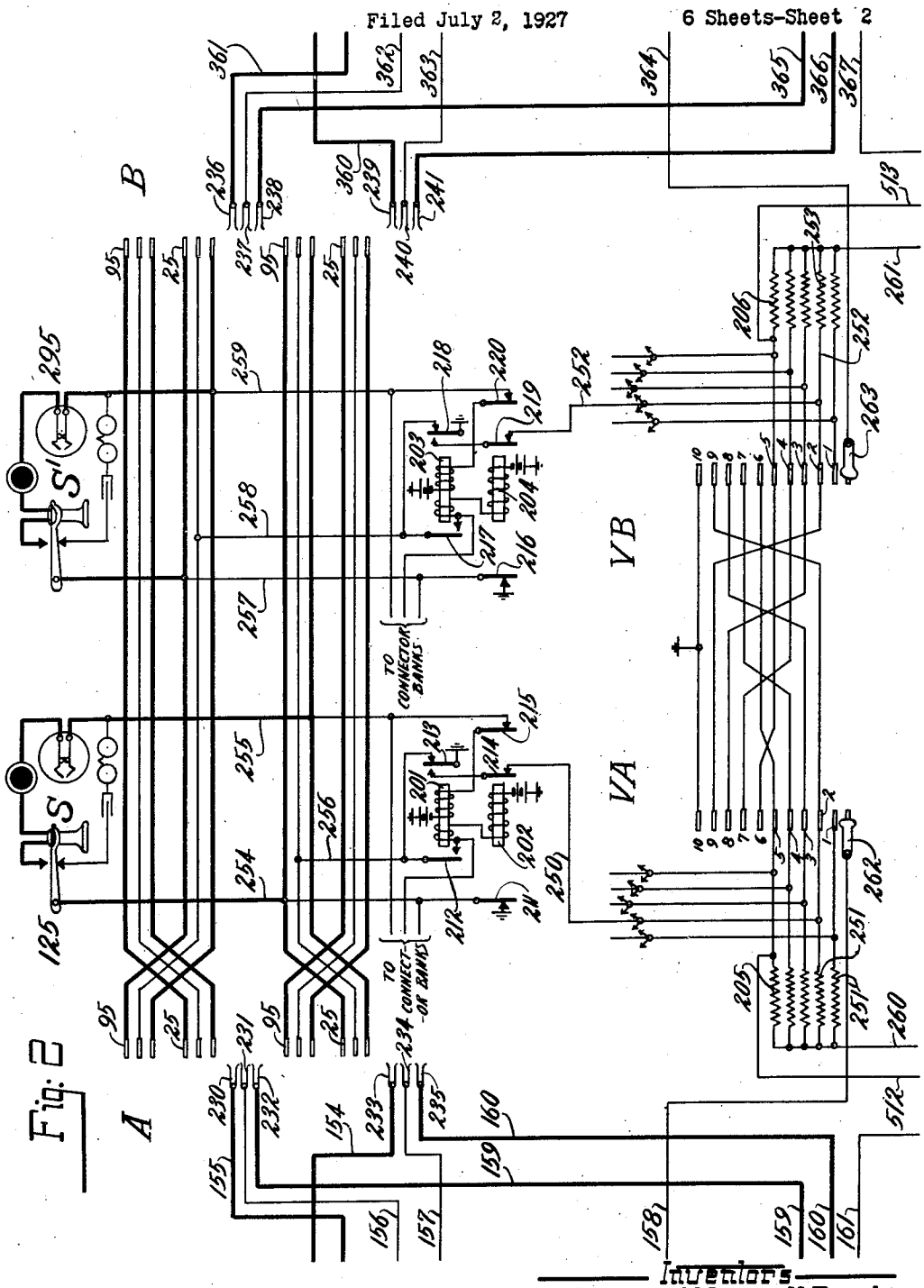


Fig. 2

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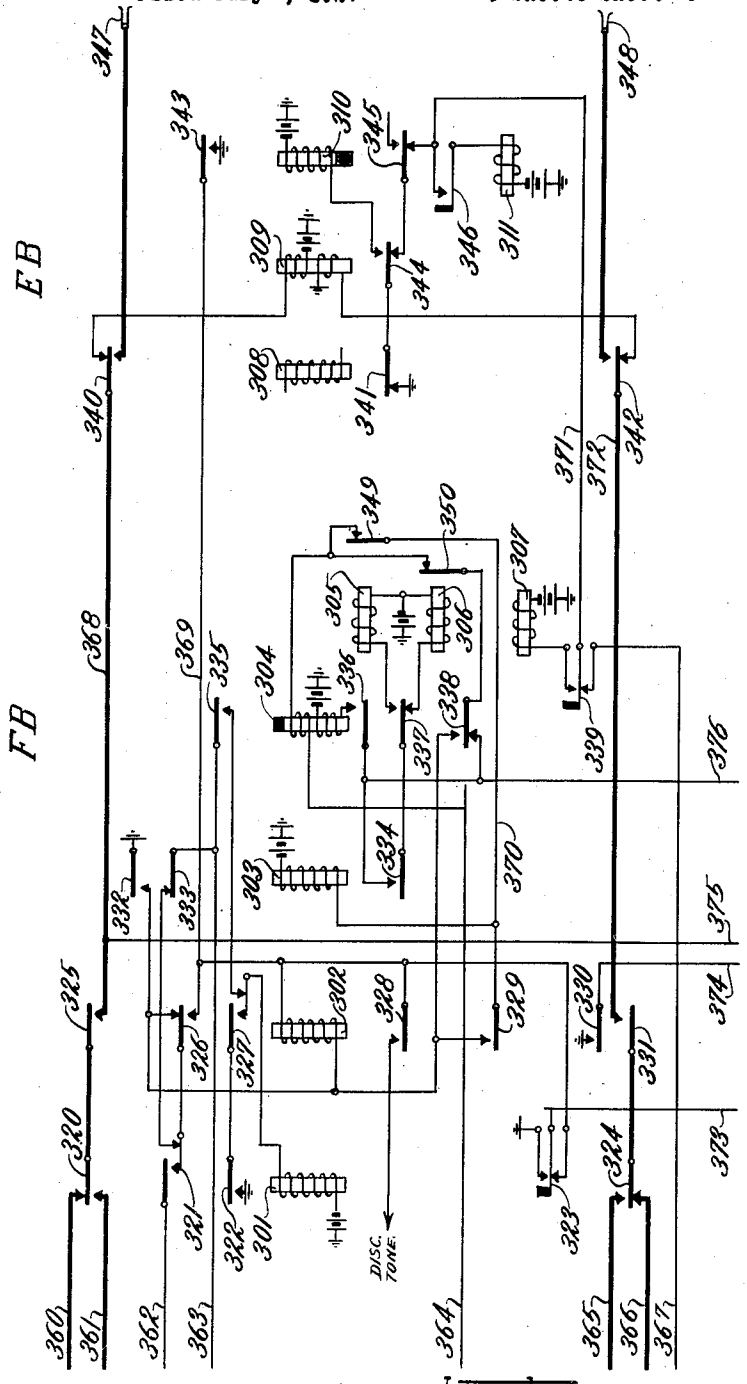
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AUTOMATIC TELEPHONE SYSTEM

Filed July 2, 1927 6 Sheets-Sheet 3

Fig. 3



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AUTOMATIC TELEPHONE SYSTEM

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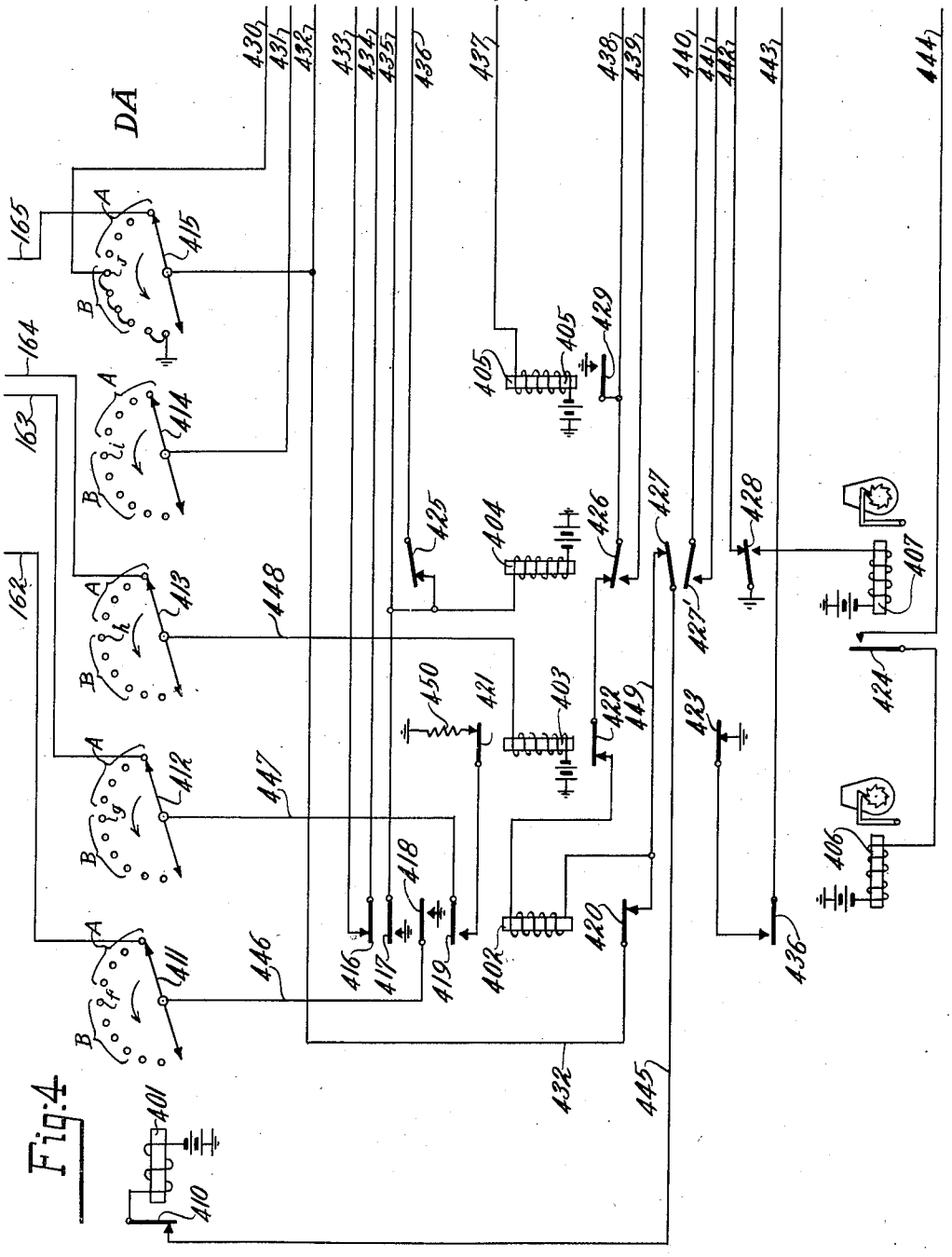


Fig. 4

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AUTOMATIC TELEPHONE SYSTEM

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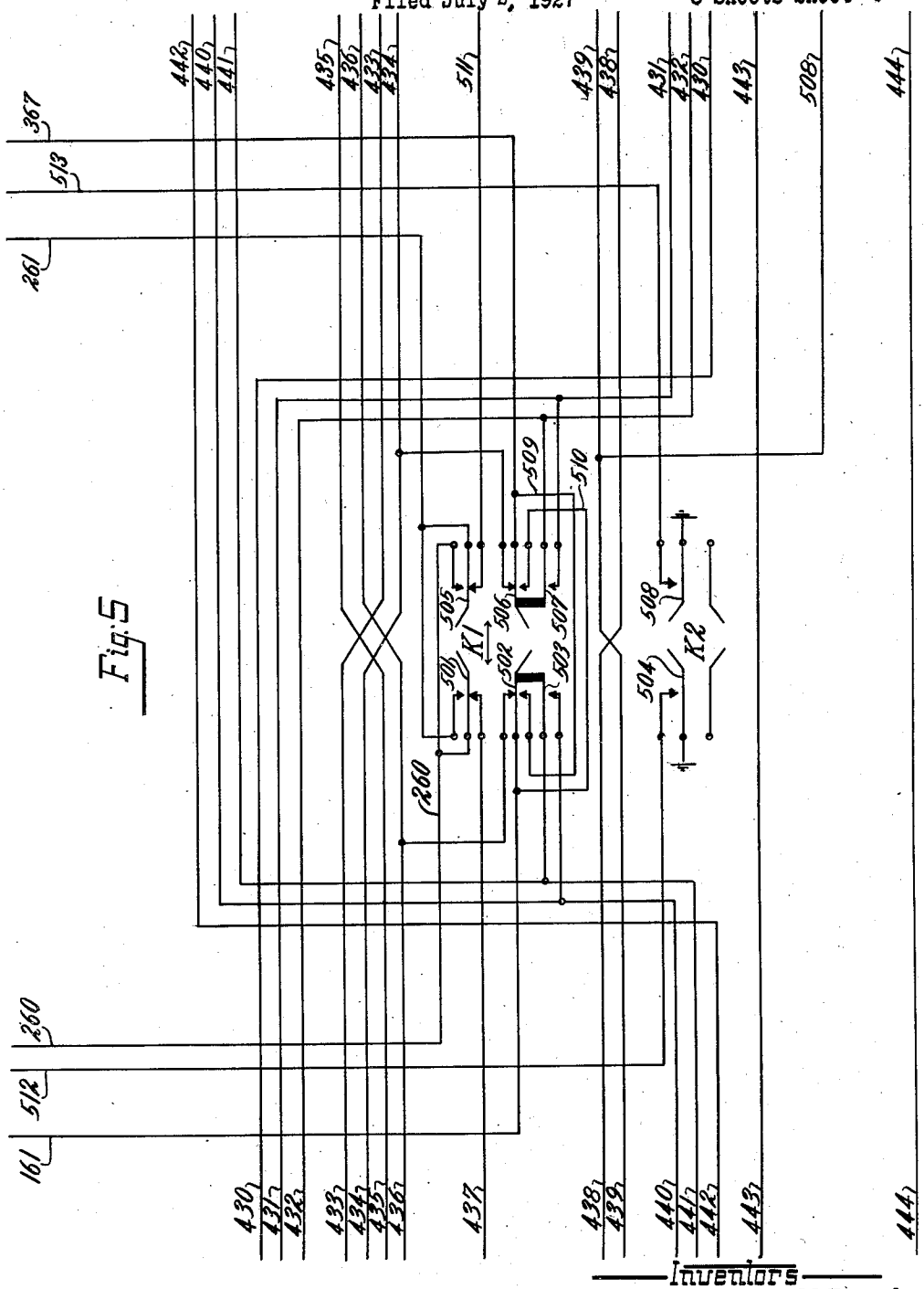


Fig. 5

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AUTOMATIC TELEPHONE SYSTEM

Filed July 2, 1927 6 Sheets-Sheet 6

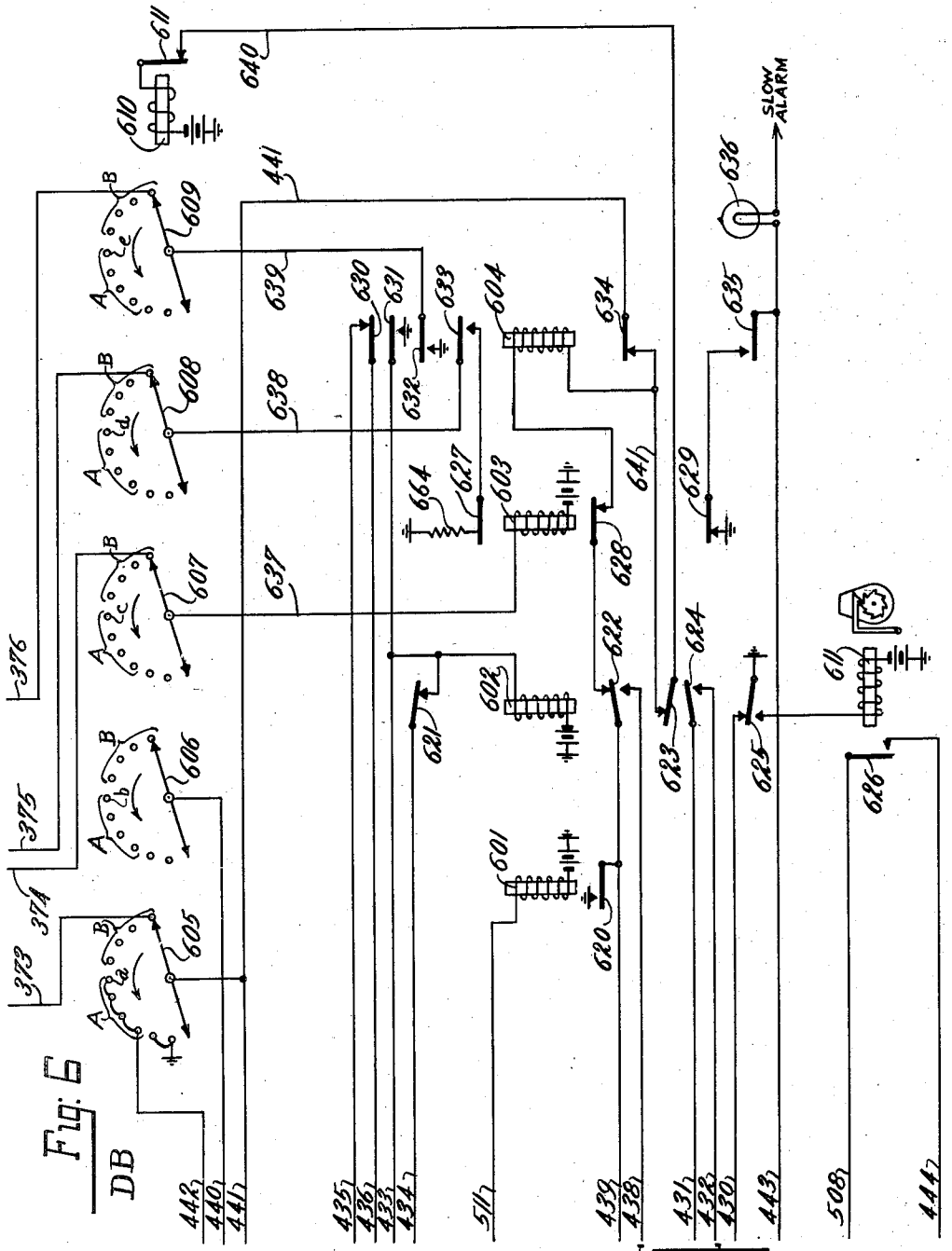


Fig. 6

DB

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By Wallace Davis Atty.

Patented Oct. 23, 1928. 1,688,588

UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed July 2, 1927. Serial No. 203,059.

The present invention relates in general to automatic telephone systems more particularly to such systems in which line finders are employed to connect an idle selecting switch with a calling line; and the principal object of the invention; briefly stated, is the production of a new and improved finder switch system, the improvements tending to make the system more reliable, to give uniform high quality service, and to make it cheaper to install and maintain.

As a further object of our invention we provide a new and improved circuit for simultaneously testing two sets of contacts, the improvement insuring a positive stopping on a set of contacts if one of the lines of the set is calling even though the other is now calling.

As a further object, we provide a new and improved preferential service arrangement, which insures uniform service to all of the subscribers of a line group under all conditions of traffic in the group.

Further objects, not specifically mentioned here will best be understood from reading the detailed description and claims which follow.

The drawings comprising Figs. 1 to 6 inclusive when arranged with Figs. 1, 2 and 3 from left to right in a straight line, with Figs. 4, 5, and 6, placed directly beneath, and with correspondingly numbered lines in alignment, show sufficient details to enable a clear understanding of our invention.

Referring now to Fig. 1 in more detail, we show a finder FA, and a selector EA, the selector being the old and well known type of Strowger selector, forms no integral part of the present invention being shown merely to enable a clearer understanding of the operation of the system. The finder switch FA, is of the Strowger vertical and rotary type, whose wipers 230 to 235 inclusive, are moved first in a vertical direction and then in a rotary direction to select the contacts of a calling line. Since in the present embodiment of our invention we make use of a finder switch of 200 line capacity, the switch FA is provided with two sets of wipers, the wipers 230 to 232 inclusive forming one set and the wipers 233 to 235 inclusive forming the second set. The finder switch FA is also equipped with the vertical wiper 262, shown in Fig. 2, which sweeps over the bank VA to determine the number of digits to be delivered to the vertical magnet of the finder.

In Fig. 2 we show subscribers' lines S and S′, it being assumed for the purpose of illustration that subscriber's line S is line number 125, and subscriber's line S′ is line number 295. Associated with each line are the usual line and cut-off relays, the circuits of which have been modified in accordance with the objects of the present invention. In Fig. 2 we also show the vertical banks VA and VB, which together with the wipers 262 and 263 determine the vertical designation to which the finder switches are to be sent.

In Fig. 3 we show finder FB and the selector EB, the switches being duplicates of those shown in Fig. 1 need not be explained in detail at this time.

In Fig. 4, we show the finder allotter comprising magnet 401 and wipers 411 to 415 inclusive, thru which the finders of group A, that is the group containing finder FA, are allotted for use one at a time. Associated with the finder allotter are the control relays 402 to 405, the purpose of which will be best understood from the detailed description which follows.

In Fig. 5 we show the control keys K1 and K2, thru the operation of which the switch room attendant may cut out a group of finders, and direct all the traffic in the exchange to the other group of finders, in case of a fault in either group.

In Fig. 6 we show a finder allotter comprising wipers 605 to 609 inclusive, and associated relays 601 to 604, which equivalent is a duplicate of that shown in Fig. 4, and thru which equipment the finders of the B group, containing finder FB, are allotted for use one at a time.

Throughout the drawings, we have shown a plurality of batteries to avoid unnecessary complication. In an actual installation there would be but one battery, preferably with its positive pole grounded.

In order to enable a clear understanding of the invention it will now be assumed that the subscriber S initiates a call, and it will be further assumed that the group of finders containing finder FA is in readiness to handle the call. Responsive to the removal of the receiver from the switch hook at the sub-

station S, line relay 201 associated with the line S is energized, to mark that line busy in the connector bank to prevent intrusion on the call by a connection, to mark the line calling in the finder bank to render it selectable by the finder, and to place ground upon the start conductor to start the finder equipment in search of the calling line. The energization of the line relay 201 places the ground upon the level marking conductor 250, which is connected to the second contact in the bank VA, also thru the resistance 251 and the conductor 260 to the start relay 405 associated with the finder allotter shown in Fig. 4. Since the calling line S has a finder bank designation of 125 and since the present call is assumed to be handled by the finder group to which that line is first choice, it will be necessary for the finder to take two vertical steps to reach the level containing the calling line. The placing of ground on conductor 250 and the consequent marking of ground potential on the second bank contact of the bank VA, will cause the finder FA to stop on the second level, at which time its wipers will be rotated into that level to pick out the contacts of the line S. Since the finder FA is a 200 point finder, it is equipped with two sets of wipers, as mentioned hereinbefore. When the wipers are rotated into the level, tests will be made simultaneously by both sets of wipers, that is if the finder is elevated to the second level, and steps into the first contact in that level, the lower set of wipers comprising wipers 233 to 235 will test the line upon which they are resting, in this case line 121, and at the same time the upper set of wipers comprising wipers 230 to 232 inclusive will test the line upon which they are resting, in this case line 221, and if neither one of these lines are calling, both sets of wipers will be stepped on to the next contact, where the test will be repeated. When the line S is encountered, the absence of ground potential on the test contact associated with that line will render it selectable, causing the finder FA to stop thereon and switch thru, so that the calling line will be connected thru to the selector EA, the connection containing no bridges across line, either at the line equipment or at the finder FA.

Referring now to the finder more in detail, responsive to the placing of ground upon the conductor 250, and the consequent energization of the start relay associated with the finder allotter, start relay 107 of the finder is energized, over a circuit including contacts on both the vertical magnet 105 and the rotary magnet 104, and upon energizing relay 107 closes the circuit for the vertical magnet 105 which energizes and opens the circuit of relay 107, in addition to elevating the wipers of the switch one vertical step. The deenergization of relay 107, opens the circuit of vertical magnet 105, causing that magnet to fall back and again close the circuit of relay 107, this intermittent operation of the magnet and relay continuing as long as the vertical wiper 202 of the finder FA encounters battery potential. When the level containing the calling line is reached, in this case the second level, a ground potential picked up by the wiper 262, energizes the relay 106 in addition to holding the relay 107 energized, so that when the vertical magnet opens the circuit of relay 107, that relay does not fall back but is maintained energized over the substitute circuit. The energization of relay 106 transfers the circuit closed by relay 107 from the vertical magnet to the rotary magnet 104, and since the relay 107 is in its energized position at the time this transfer is made, the rotary magnet immediately receives an impulse, and energizes to rotate the wipers one step. The rotary magnet upon energizing, opens the circuit of the relay 107, at a point which also opens the circuit from the vertical wiper 262, permitting the relay 107 to fall back to end the pulse. When the wipers are advanced to the first contact of the level, the first test wiper will pick up a ground, provided the line is not calling, said ground completing a circuit to energize the relay 109, which energizes and transfers the testing circuit to the other set of wipers on the switch. If the other line now engaged by the wipers, is not calling, the other test wiper will pick up another ground, which completes a circuit to again energize with relay 107, to step the wipers of the switch onto the next set of contacts. Thus it will be seen that the change-over from vertical to rotary motion is accomplished positively, without any delay, and that the stepping of the switch in a rotary direction is dependent upon the presence of ground upon the contacts engaged by both of the test wipers.

Assume now that at the time the sub-station S initiated the call, all of the finders in the group containing finder FA, are busy, in which case the call will be handled by a finder in the group containing finder FB, provided no calls from lines to which that finder is first choice are in progress at the time. It will be noted that the placing of ground on conductor 250 and the contact 2 of the vertical bank VA also places ground upon the contact 9 of the vertical bank VB. It will also be remembered that the banks of the finders are slipped between the groups A and B, so that the lines appearing in the lower half of the banks of group A appear in the upper half of the banks of group B. Responsive to the grounding of the conductor 250, the start relay 405 will be energized, and since it is now assumed that all of the finders in the group A are busy, that relay starts a finder in group B, for example finder FB, which operates in

a vertical direction until the vertical wiper 263 encounters the marked bank contact, in this case the 9th contact, at which time the wipers of the finder are stopped and rotated in a horizontal direction into the selected level. In rotating the finder FB tests first for calling lines in the banks over which the lower set of wipers sweep and then in the banks over which the upper set of wipers sweep, the movement of the wipers depending upon the presence of ground upon the contacts engaged by the test wipers of both sets. The operation of the finder FB is identical with that of the finder FA, and need not be explained in detail at this time.

From the foregoing it will be seen that normally calls from the line S are handled by the finder FA, and that in case all the finders in the group A are busy, calls from a line such as S can be handled by the finder FB.

In a similar manner calls from the line S' has as its first choice the finder FB, in which finder it appears in the second level, so that the wipers of FB are moved vertically two steps to engage the level containing the calling line S1. If, however, the group containing the finder FB is busy at the time that F1 makes a call, that call will start the finder FA, provided there are no calls pending in that group at the time, and the line S1 will be picked up by the finder FA, which at this time must take nine vertical steps to reach the level containing the line. It will be noted that the second bank contact in the vertical bank VB is multipled to the 9th bank contact to the vertical bank VA, so that when the conductor 252 is grounded responsive to the energization to the line relay by the initiation of a call on the line S1, level 2 of the bank VB and level 9 of the bank VA are marked calling, so that whichever finder is started to pick up the call will stop on the proper level when reached.

In the normal operation of this system, the finder allotter DA does not have access to the finders of the group B, and similarly the finder allotter DB does not have access to the finders of the group A. It may happen however that because of a fault in one or the other of the control equipments, it is necessary for the dispatcher to cut that equipment out of service for an appreciably long time, during which it will be necessary to employ both groups of finder switches, under the control of one of the finder allotters. Accordingly, the finders of group A, in addition to being multipled into the first half of the bank of the finder allotter DA, are multipled into the last half of the bank of the finder allotter DB, so that when the key K1 is thrown, finder allotter DB may have access to the finders of the group A. Similarly finders of the group B in addition to being multipled into the first half of the banks of the finder allotter DB, are multipled into the second half of the banks of the finder allotter DA, so that when the key K2 is thrown to cut DB out of service, finder allotters DA will have access to the finders of the group B. In order to avoid an unnecessary complication of the drawings, these multiple connections have not been shown, since they will be understood and appreciated by one skilled in the art from the foregoing brief description.

Having thus described our invention in general, we will now proceed with a detailed description of its operation:

Line S initiates a call.

Assume now that the line S initiates a call, a circuit may be traced from ground at springs 211, conductor 254, through the hook switch, receiver, transmitter and calling device of the substation S, conductor 255, springs 215, through the right hand winding of the relay 201 to battery, energizing the relay 201. Relay 201 upon energizing, at spring 213 and its break contact, removes ground from the private conductor 256, associated with the line S in the banks of the finder switches, to render the line calling. Relay 201 also closes at spring 213 and its make contact a circuit from ground thru that spring and springs 214 to the start conductor 250, thereby placing ground potential upon the second bank contact of vertical bank A, and upon the ninth bank contact of the vertical bank VB, for a purpose which will be brought out hereinafter. Ground placed upon conductor 250 by the springs 213 of the relay 201, also completes a circuit thru the resistance 251, conductor 260, thru springs 501 of the key K1, conductor 437, thru the winding of relay 405 to battery, energizing the relay 405. Relay 405 upon energizing, closes a circuit from ground thru springs 429, spring 426 and its make contact, springs 422, thru the winding of relay 402, thru spring 427 and its make contact conductor 445, interruptive springs 410. thru the winding of magnet 401 to battery. Relay 402 energizes over this circuit, but because of the high resistance of the winding of the relay 402, magnet 401 does not energize at this time. The energization of relay 402 prepares the start circuit, to start the finder FA, in search of the calling line S.

The first vertical step.

The energization of relay 402, at springs 417 closes a holding circuit for the all finders busy relay 404, to prevent that relay deenergizing when the finder FA moves off normal, if that finder should happen to be the last idle finder of the group. Relay 402 at springs 416 opens a point in the circuit of the relay 602 of the finder distributor DB, the opening of that circuit being without particular effect at this time. Relay 402 at springs 420 opens a point in the test circuit

of the finder allotter DA, to prevent that allotter searching for an idle finder at this time. Relay 402 at springs 418 closes a circuit from ground thru those springs, conductor 446, wiper 411 now engaging the contact to which conductor 162 is connected, spring 125 and its break contact, spring 121, springs 120, thru the winding of relay 107 to battery, energizing the relay 107. Relay 107 upon energizing closes a circuit from grounded conductor 162, thru springs 129, spring 124 and its break contact, thru the winding of the vertical magnet 105 to battery, energizing the vertical magnet which elevates the shaft containing wipers 230 to 235 inclusive one vertical step, and bringing the vertical wiper 262 into engagement with its first bank contact. The energization of the vertical magnet 105 opens the circuit of relay 107 at springs 121, permitting that relay to fall back to open the circuit of the vertical magnet at springs 129. This interaction of relay 107 and the vertical magnet 105 will continue until the wiper 262 encounters a grounded contact, the continuation of this action operating the vertical magnet to elevate the shaft containing the wipers of the finder FA in a vertical direction a number of steps depending upon the number of energizations of the magnet 105. When the vertical magnet 105 is energized and springs 121 are open, circuit may be traced from grounded conductor 250 to resistances 251 and 251′ in series, vertical wiper 262, conductor 158, thru the upper winding of relay 106, thru springs 120, thru the winding of relay 107 to battery. Because of the high resistance of the resistances 251 and 251′ in series, this circuit is ineffective either to energize relay 106 or to hold the relay 107 in its energized position.

The last vertical step.

Since the calling line has a finder bank number of 125, it appears in the second level of the banks of the finder FA, and consequently, when the vertical magnet 105 has energized the second time, to elevate the wipers of the switch FA opposite the second level of the bank and the vertical wiper 262 into engagement with its second bank contact, the switch over circuit will be completed when the magnet 105 is energized and the springs 121 broken. At this time the wiper 262 engages direct ground potential from the conductor 250 and the second bank contact, completing a circuit thru the wiper 262, conductor 158, upper winding of relay 106, springs 120, thru the winding of relay 107 to battery. This circuit will be completed as soon as the vertical magnet 105 has energized sufficiently to move the wiper 262 into an engagement with the second bank contact. The circuit will, therefore, be completed prior to the opening of springs 121, so that the opening of those springs will not open the circuit of relay 107, it being maintained energized from the ground on conductor 158 as explained above. As soon as the springs 121 are open, relay 106 energizes, locking itself through its lower winding and spring 123 to the grounded conductor 162, independent of the energizing circuit thru its upper winding. The energization of relay 106 opens the circuit of magnet 125, which at this time has completed its stroke and opened springs 121, and closes in its place a circuit for the rotary magnet 104, energizing that magnet immediately from ground on conductor 162 thru the springs 129, spring 124 in its make contact thru the winding of the magnet to battery. The energization of rotary magnet 104 rotates the wipers, 230 to 235 inclusive, one rotary step into engagement with the first contact of the second level of their banks. The rotation of the shaft also disengages wiper 262 from its vertical bank, that disengagement being without effect at this time since relay 106 is maintained energized independent of the circuit thru that wiper. The energization of rotary magnet 104 opens at springs 120 the circuit of relay 107, permitting that relay to fall back and open the circuit of the rotary magnet of springs 129. The interaction of relay 107 and magnet 105, having completed the first rotary step, has positioned the wipers of the finder FA onto the first bank contact, in which position they are prepared to determine whether or not the first line in the level is a calling line.

Rotary testing.

It will be noted that the line equipment comprising relays 201 and 202 for the line S and 203 and 204 for the line S1, normally places a ground upon the private contacts associated with that line in the finder bank, at springs 213 and 218 respectively, so that if the line is in an uncalling position, that is with its line relay 201 or 203 normal, the private contact will be maintained at ground potential. When the wiper set 230 to 232 engage its bank contacts, the private wiper 231, will encounter ground potential if the first line in the level happens to be an uncalling line, as it is assumed to be in this case. Similarly the wiper set 233 to 235 inclusive, will be positioned on the first contact if its banks, and private wiper 234 will encounter a ground potential if the first line of the level is not calling. Since it is assumed that the line S, which is the calling line in the present case, has a finder bank number of 125, it will be necessary for the wipers to be rotated five steps to encounter the contacts of the line. The positioning of wiper 234 upon the first private contact of its bank, closes a circuit from ground on that contact, thru the wiper, conductor 157, thru springs 122, thru the normally closed contacts controlled by spring

132, thru the lower half of the winding of relay 109 to battery, energizing that relay which at springs 137 and 141 transfers the talking conductors from the lower to the upper set of wipers, this transfer being without particular effect at this time. At spring 139, relay 109, prepares a locking circuit for itself, that circuit being held open at the time by spring 132 of the relay 108. At springs 138, relay 109 connects the upper test wiper 231, thereby closing a circuit from the grounded contact upon which that wiper is now resting, thru conductor 156, spring 138 and its make contact, thru spring 131 and its break contact, thru spring 125 and its make contact, thru springs 121, springs 120, thru the winding of relay 107 to battery. Relay 107 energizes over this circuit, closing the circuit to the rotary magnet 104 as before, energizing that magnet to advance the wipers another step and to open the circuit of relay 107 and springs 120. As long as wipers 231 and 234 encounter grounded contacts, relays 109 and 107 will be energized, the former to shift from one wiper set to the other and the latter to close the circuit of the rotary magnet preparatory to taking another step. It should also be noted that while the wipers 231 and 234 are engaging grounded contacts, switch thru relay 108 is short circuited, having ground from release trunk conductor 151 connected to its upper terminal, and having ground from wiper 234 connected to its lower terminal over a circuit thru conductor 157, spring 128, during the interval that relay 107 is deenergized, thru spring 138 and its break contact, spring 131 and its break contact, to the lower terminal of relay 108. When relay 109 has energized, preparatory to energizing relay 107, relay 108 is short circuited from wiper 231, over conductor 156, spring 138 and its make contact, spring 131 and its break contact, to the lower terminal of the relay 108. It should also be noted that when the wiper 234 passes over a plurality of contacts all of which are grounded, that wiper bridges from one grounded contact to another during its movement, and the circuit of relay 109 is, therefore, maintained, so that that relay does not fall back at each step. However, relay 107, whose circuit is opened at springs 120, falls back at each step so that the stepping action of the finder FA in a rotary direction is dependent upon the finding of ground upon both of the private wipers. In the instant call since the line S is assumed to be finder bank number 125, five rotary steps will be taken by the finder FA to connect with the calling line, each step being a duplicate of the one just described need not be repeated at this time.

Finder FA switches through.

At the end of the said five steps, when the wipers 233 to 235 engage the bank contacts to which conductors 254, 255 and 256 are attached, the circuit of relay 107 is opened at spring 120, that relay falls back to the ends of pulse. Since wiper 234 now engages an ungrounded contact, the circuit of 109 is opened, permitting that relay to fall back. The deenergization of relay 109 prevents a further energization of relay 107, even though the upper test wiper 231 may be engaging a grounded contact at the moment. As soon as relay 109 falls back, the short circuit is removed from the winding of switch thru relay 108, that relay energizes over a circuit traceable from ground on spring 113 of the release relay of the selector EA, release trunk conductor 151, through the winding of switch thru relay 108, through spring 125 and its make contact, spring 121, springs 120, relay 107 having fallen back and opened the circuit of the rotary magnet to permit that magnet to fall back, through the winding of relay 107 to battery. Relay 108 energizes in the circuit, however, because of the high resistance of the winding of relay 108 relay 107 does not energize. Relay 108 upon energizing, switches thru the finder, connecting the selector EA to the calling line S, over a circuit traceable from ground to the lower winding of line relay 102, thru spring 119 and its break contact, conductor 153, springs 136, spring 141 and its break contact, conductor 160, wiper 235, conductor 255, thru the substation S, conductor 254, wiper 233, conductor 154, through spring 137 and its break contact, springs 130, conductor 150, spring 117 and its break contact, through the upper winding of the line relay 102 to battery. At springs 131, relay 108 connects the release trunk conductor 151 through the normally closed contact controlled by spring 138, through springs 128, conductor 157, wiper 234, now engaging conductor 256, through the springs 212, the left hand winding of relay 201, through the winding relay 202 to battery. The ground placed upon release trunk conductor 151 by the springs 113, completes the circuit for relays 201 and 202, the latter to energize and remove all attachments from the calling line S, and the former to be maintained energized by its left hand winding. The calling subscriber now has a clear line through from his substation to the selector EA, dial tone being audible to him over a circuit connected in the ground side of the lower winding of relay 102, this call tone generator being old and well known to those skilled in the art is not shown in the drawings. The calling subscriber upon hearing the dial tone manipulates the calling device in accordance with the number of the called station to which he desires to extend a connection, that operation being old and not forming an integral part of the present invention will not be repeated herein.

Finder allotter DA seeks another finder.

Returning now to the energization of switch through relay 108 of the finder FA, the closing of springs 135 places a ground through those springs to conductor 164, through the wiper 413 now engaging that conductor, conductor 448, thru the winding of relay 403 to battery, energizing the relay 403. Relay 403, upon operating springs 421, disconnects the ground placed on the negative line conductor 150 through those springs and resistance 450, to permit the calling subscriber to manipulate his calling device and operate the selector. Relay 403, at springs 422, opens a previously traced circuit for relay 402, permitting that relay to fall back. At springs 423, relay 403 opens a point in the supervisory circuit, permitting the signals controlled thereby to restore to normal. The deenergization of relay 402, at springs 418 removes ground from the conductor 162, thereby releasing the relay 106, of the finder FA, which was locked thereto through springs 123. The deenergization of relay 402 closes springs 420, thereby completing the circuit from ground through off-normal spring 140 of the finder FA, conductor 165, wiper 415 now engaging that conductor, conductor 432, springs 420, conductor 449, springs 427, conductor 445, interrupter springs 410, through the winding of the rotary magnet 401 to battery, energizing this magnet, preparatory to advancing the wipers 411 to 415 of the finder allotter DA one step. Magnet 401 upon energizing opens its own circuit at interrupter springs 410, and falls back to advance the wipers onto the next bank contact. If the next finder of the group is busy, wiper 415 will again encounter a grounded contact, and the above traced circuit will again be completed, the magnet operating to advance the wipers another step. The magnet 401 will therefore operate in a buzzer like fashion as long as the wiper 415 engages grounded contacts, coming to rest upon the first ungrounded contact, which is associated with the first idle finder of the group.

All finders busy in group A.

Assume now that the finder FA was the last idle finder in the group, consequently when it was operated in the manner described, all the finders in the group A will be engaged, and it will be useless for the finder allotter DA to hunt for another idle finder. It will be noted that all finders busy relay 404 is maintained energized normally over circuits traceable from ground at springs 115 of the selector EA, springs 116 and 114 and their respective break contacts, conductor 152, off normal springs 126, conductor 161, normally closed contacts 502 of the key K1, conductor 436, springs 425, through the winding of relay 404 to battery. When the selector EA and the finder FA were taken for use, this circuit is opened at springs 116 of the line relay 102 of the selector, and later opened again at off normal springs 126 when the finder is moved out of its normal position. Relay 404 is maintained energized during the setting of the call by the ground placed on conductor 435 by springs 417 of relay 402. When the relay 402 falls back after the finder FA has switched thru, the circuit of relay 404 is therefore opened, permitting that relay to fall back. The deenergization of relay 404, at springs 426 extends the start circuit away from relay 402 and towards relay 604 of the group B, so that if the start relay 405 is energized group B relay 604 will be energized in the manner described hereinafter. The deenergization of relay 404 at springs 427 opens a point in the testing circuit of the finder allotter DA, so that if wiper 415 is standing on a grounded contact, the magnet 401 is not energized, since there would be no object gained by moving the wipers of the allotter DA at this time. The deenergization of relay 404 closes spring 428 and its break contact, closing the obvious circuit for the magnet 407 of the meter to record that an all trunks' busy condition exists in group A. With an all trunks' busy condition existing in the group A, calls originating therein will be handled by the group B control equipment and finders, in a manner which will be pointed out in detail hereinafter. As soon as one of the finder selector links of the group A becomes idle, the above traced circuit for relay 404 will be closed, energizing that relay, to close the testing circuit of the finder allotter DA, thereby operating that allotter to pick out the idle finder, in a manner which has been hereinbefore pointed out.

The foregoing description shows how a call originating in the group A is handled by the group A control equipment and finders, and a call will now be traced thru the group B control equipment.

Line S' initiates a call.

Assume now that the line S' whose finder bank number is assumed to be 295, initiates a call. The removal of the receiver from the switch hook closes a circuit from ground on springs 216, through the conductor 257 thru the substation to the conductor 259, through springs 220, through the right hand winding of the relay 203 to battery, energizing that relay which at springs 218 opens the ground circuit from the private contact associated with line S' in the finder banks, and closes the circuit thru the make contact of spring 218 and springs 219 to conductor 252. This ground on conductor 252 places ground potential upon the second bank contact of the vertical bank VB of the finder FB, and also upon the ninth bank contact of the bank

VA of the finder FA. The ground on conductor 252 completes a circuit thru resistance 253, conductor 261, spring 505 and its break contact, conductor 511, thru the winding of relay 601 of the control equipment DB. Relay 601 energizes over this circuit, closing its springs 620 to close circuit for the relay 604 from ground at spring 620 and its make contact, spring 622 and its break contact, springs 628, through the winding of relay 604 through springs 623, through the interrupter springs 611, through the winding of the magnet 610 to battery. Relay 604 energizes over the circuit, but because of the resistance of that relay, magnet 610 is prevented from energizing.

Vertical impulsing.

The energization of relay 604 closes a circuit from spring 633, conductor 639, wiper 609, conductor 376, spring 338 and its break contact, springs 350, springs 349, conductor 370, through the winding of relay 303 to negative battery. Relay 303 energizes, and at spring 334 closes a circuit from grounded conductor 376, spring 337 and its break contact through the winding of vertical magnet 306 to battery. Vertical magnet 306 energizes, elevating the wipers 236 to 241 inclusive and vertical wiper 263 one step, the former wipers standing opposite the first level and the latter wiper engaging the first contact of its bank, and at the end of the energization of magnet 306, interrupter springs 350 are opened, to open the circuit of relay 303, which falls back opening springs 334 to open the circuit of the vertical magnet. Vertical magnet 306 and the relay 303 interact in this manner until the vertical wiper 263 encounters ground, which in this case will be at the end of the second impulse.

Switch over to rotary.

After the vertical magnet has elevated the shaft containing the wipers, two steps, to bring the vertical wiper 263 into engagement with the second bank contact, the circuit for relay 304 is completed from ground on conductor 252 now engaged by the wiper 263, conductor 364, through the upper winding of relay 304, through the rotary interrupter springs 349, through the winding of relay 303, maintaining that relay energized independent of the interrupter springs 350. Relay 304 energizes over the above circuit, transferring the circuit through springs 337 from the vertical magnet 306 to the rotary magnet 305, and locks itself to grounded conductor 376 at spring 336. The rotary magnet 304 is energized over this circuit to rotate the wipers one rotary step into engagement with the first contact set in the selected level.

Rotary testing.

Since the calling line S′ is assumed to be number 295, five rotary steps must be taken before the wipers engage the contacts of that line. When the wipers are advanced to the first contacts of the selected level, private wiper 240 of the lower wiper set encounters ground, completing a circuit through conductor 363, springs 335, springs 327, through the lower winding of relay 301 to battery, energizing the relay 301. Relay 301 upon energizing connects the private wiper 237 and conductor 362 thru to the relay 303, energizing that relay from the ground picked up by the wiper 237 over circuit including conductor 362, springs 321, spring 326 and its break contact, springs 338, interrupter springs 350, interrupter springs 349, through the conductor 370 the winding of relay 303 to battery. The relay 303 energizes and again completes the circuit of the rotary magnet, since both of the private wipers of the finder FB have encountered grounded contacts. Switching relay 302 is short circuited at this time, the upper terminal being connected to grounded release trunk conductor 369, and the lower terminal being connected first through spring 326 and its break contact and the normally closed contacts controlled by spring 321 through spring 333, conductor 363 to the ground picked up by wiper 340 and then after relay 301 has energized relay 302 is short circuited over the circuit through spring 326 and its break contact, 321 and its break contact, conductor 362 to the ground picked up by the private wiper 237. Finder FB switches through after the fifth step has been taken, at which time the wiper 237 encounters the contact to which conductor 258 is connected, and since that contact is ungrounded, the circuit of relay 303 is not completed and that relay stays deenergized to prevent the finder FB from taking another step. Since the line S′ is the only calling line at this instant, the contact on which wiper 240 is resting is grounded, and relay 301 is maintained energized by that ground. The control of the finder is therefore under the control of wiper 237, which is engaging an ungrounded contact. The absence of ground on this wiper removes the short circuit from switch through relay 302 which energizes over circuit from grounded conductor 369, through the winding of relay 302, spring 338 and its make contact, interrupter springs 350, interrupter springs 349, through the winding of relay 303 to battery. Relay 302 energizes in this circuit, but because of the high resistance of that relay relay 303 cannot energize. Relay 302 upon energizing completes the loop circuit from the calling station S′ to the first selector EB, that circuit being traceable from ground through the lower winding relay 309 of the selector EB, through the spring 342 and its break contact, conductor 372, spring 331 and its make contact, spring 324 and its make con-

tact, conductor 365, wiper 238, now engaging the contact to which conductor 259 is connected, through the substation S1, conductor 257, wiper 236, conductor 361, spring 320 and its make contact, springs 325, conductor 368, spring 340 and its break contact, through the upper winding of relay 309 to battery. The energization of relay 302 also connects the private conductor 362 to the release trunk conductor 369. The ground on the release conductor 369 traverses a circuit through spring 326 and its make contact, spring 321 and its make contact, conductor 362, wiper 237, bank contact to which conductor 258 is connected, conductor 258, springs 217, through the left hand winding of relay 203, through the winding of relay 204 to battery, maintaining the relay 203 energized independent of its initial circuit and energizing the relay 204 to clear the calling line S′ of attachments. Dial tone is supplied to the calling subscriber over the usual dial tone circuit connected to the ground side of the lower winding of relay 309, that connection being old and well understood by those skilled in the art is not shown in the drawings. The subscriber upon hearing dial tone manipulates his calling device to transmit the digits of the wanted party.

Finder distributor DB seeks another finder.

The energization of relay 302 of the finder FB closes springs 330, placing a ground upon conductor 374, completing a circuit from that conductor through wiper 607, conductor 637, through the winding of relay 603 to battery. Relay 603 upon energizing opens spring 627 to remove the ground placed on the negative line conductor 368, through resistance, to permit the calling subscriber to operate the line relay of the selector EB. Relay 603 opens springs 628 to open a point in the circuit of relay 604, permitting that relay to fall back. Relay 604 upon falling back closes spring 634, thereby closing a circuit from ground on off normal spring 323 of the finder FB, conductor 373, wiper 605 now engaging the contact to which that conductor is connected, conductor 441, spring 634, conductor 641, spring 623, interrupter spring 611, through the winding of magnet 610 to battery, energizing the magnet 610 which prepares to advance the wipers 605 to 609, inclusive, one step, and to open interrupter springs 611 to open its own circuit. Magnet 610 thereupon falls back, advancing the wipers 605 to 609, one step and reclosing its own circuit at interrupter spring 611. If the next finder in the group is busy, wiper 605 will again pick up ground potential, closing the above traced circuit for magnet 610 which will again be energized preparatory to advancing the wipers another step. Magnet 610 will operate in a buzzer like fashion, advancing the wipers 605 to 609 step by step as long as the wiper 605 encounters grounded contacts associated with busy finders. When the wipers encounter the contacts of an idle finder, wiper 605 will fail to pick up ground, and the switch will come to rest upon those contacts, thereby selecting that finder for use.

All finders busy in group B.

In the event that the finder FB happens to be the last idle finder of the group, when it is taken for use in the manner just described, and moves off normal, the circuit for all finders busy relay 602 is opened first at springs 344 of selector EB and later at springs 339 of the finder FB, that circuit including also conductor 367, spring 506 in its break contact, conductor 434, spring 621, and the winding of relay 602. Relay 602 does not fall back immediately, because of the multiple holding circuits closed by the energization of relay 604 and including spring 631, that circuit being maintained as long as relay 604 is in its energized position. When relay 604 deenergizes, as pointed out above, relay 602 deenergizes, and at springs 623 opens a point in the testing circuit of the allotter magnet 610, to prevent the finder allotter DB from needless rotation. At springs 622 and 624, relay 602 extends the start circuit from the lines in group B to the group A control equipment, so that during the interval that all finders in group B are busy, calls originating in that group will be handled in group A in the manner pointed out hereinafter.

Operation of the key K1.

The operation of the key K1 in such a direction as to close springs 501, 502 and 503, serves to cut out the control equipment comprising finder FA and finder allotter DA, and extends the start circuit from the group A lines to the group B control equipment. The operation of the system under this circumstance is the same as it is in case all of the finders in group A are busy, that is all of the calls originating in both groups of lines, are handled by the group B control equipment and finders. Calls from the group A line are handled by the group B finders, which have to take more than five steps to reach the contacts of those lines. Calls from the group B lines are handled by the group B finders which take not more than five steps to connect with the contacts of those lines. It will, therefore, be appreciated that the operation of the system when the key 1 is thrown in the direction indicated, is the same as it would be if the all finders busy relay 404 were to become deenergized because of an all finders busy condition in the group A. The operation of the spring 501, to break its break contact and make its make contact, connects the conductor 260, leading from the resistance units associated with the vertical bank VA,

to the conductor 261, which is the corresponding conductor from the vertical bank VB In the event that the line S now initiates a call, the ground placed on the conductor 250 in the manner hereinbefore described traverses a circuit through resistance 251, conductor 260, spring 501 and its make contact, conductor 261, spring 505 and its break contact, conductor 511, through the winding of start relay 601 to battery, energizing that relay preparatory to starting a group B finder in search of the group A calling line. The operation of the spring 502, connects the busy common lead 161 of the group A to the busy common lead 367 of the group B, so that the all finders busy relay 602 of the group B is maintained energized over parallel circuits, the one leading from ground on spring 118 and its break contact of the selector EA, through springs 116, springs 114, off normal spring 126, conductor 161, spring 502 and its make contact, conductor 509, conductor 367, spring 506 and its break contact, conductor 434, spring 621 and its make contact, through the winding of relay 602 to battery, the other parallel path being the one originating at spring 341 of the selector EB and extending over the previously traced path to the relay 602. Thus it will be seen that an idle finder in either group will maintain this circuit of relay 602 closed, so that that relay will remain energized, and control equipment DB will be in a position to preselect that finder in readiness for a call. The operation of spring 502 away from its break contact, disconnects the ground upon conductor 161, conductor 436, spring 435 and the all finders busy relay 404, so that relay 404 deenergizes even though there may be an idle finder in the group A at the time. The operation of springs 503, shorts conductors 440 and 441 together, in multiple with the short spaced across these conductors by springs 427′ of the all finders busy relay 404. This additional short placed across these conductors by springs 503 guards against the possibility of faulty operation should the relay 404 fail to deenergize when its circuit is open as explained above. It will be remembered that a multiple circuit for relay 404 is closed thru springs 417 of the relay 402, so that in the event that the control equipment DA was stuck and the relay 402 did not deenergize, relay 404 would not be energized and consequently springs 427 would not be closed, however, springs 503 would accomplish their purpose. The deenergization of relay 442, responsive to the operation of the key as explained above, removes ground from the left hand half of the bank over which wiper 605 of the distributor DB rotates, to permit that distributor to select a finder in the group A. It will be noted that the banks of the distributor DB are divided in two halves, the left hand being marked as A and the right hand as B. The finders of the group A, such as finder FA, are multipled to the left hand bank of the distributor DB, those multiples being omitted to avoid an unnecessary complication of the drawings. In this multiple, conductor 165 would be connected to the bank contact *a* over which the wiper 606 rotates, conductor 164 to the bank contact C over which conductor 607 rotates, conductor 163 to the bank contact *d* over which wiper 608 rotates and conductor 162 to the bank contact *e* over which wiper 609 rotates. Assume now that all the finders in the group B are busy, and that the finder FA is idle. The circuit of magnet 610 will be completed as hereinbefore described from ground picked up by wiper 605 in the group B of its bank, to rotate the wiper set 605–609 inclusive, over the group B of contacts. When the wiper 605 reaches the contact *a*, it has passed out of the group B and is entering the group A. Since relay 404 has deenergized and removed ground from conductor 442, contact *a* will not be grounded. If the finder FA were busy, wiper 606, which is now engaging contacts *b* to which conductor 165 of the finder FA is connected, would pick up a ground on that conductor, closing the circuit through that wiper, conductor 440, spring 503 of the key K1 and springs 427′ of the relay 404, in multiple, to conductor 441, spring 634, spring 623, conductor 640, interrupter spring 611, through the winding of magnet 610 to battery, energizing that magnet which prepares to advance the wipers and interrupt its own circuit at spring 611 in the manner pointed out hereinbefore. Thus it will be seen that the wiper 606 of the distributor DB tests for finders in the group A, after the wipers of that switch have encountered the contacts associated with that group. It is now assumed that finder FA is idle, wiper 606 when it encounters contact *b* will not pick up ground, and the finder DB will come to rest upon that contact set, to preselect the finder FA for control by the control equipment DB. Responsive to the energization of relay 601 by the line S, as pointed out hereinbefore, relay 604 is energized over the previously traced circuit, ground from spring 632 closes the circuit through conductor 639, wiper 609, now engaging the contact *e*, conductor 162, to the finder FA, that ground serving to operate the finder in the manner hereinbefore pointed out. When the finder FA switches through, spring 135 places ground on conductor 164, which is connected to the contact *c* on which wiper 607 is resting, that ground completes a circuit thru that wiper, conductor 637 to the relay 603, energizing that relay to release the distributor DB from the finder FA, and to start it in search of another idle finder in the manner hereinbefore pointed out. The distributor DB will then search over the contacts of the

group A, under the control of ground picked up by wiper 606, stopping on the first ungrounded contact to preselect that finder for use.

It will be noted that the last two contacts of the banks over which wiper 605 rotates are permanently connected to ground. In other words the capacity of the banks of the distributor DB is greater than the total number of finders in groups A and B. Unused contacts are connected to permanent ground, so that when the wiper 605 encounters that contact, circuit of magnet 610 will again be closed and the finder DB will speed past those contacts in search of an idle finder. If it is necessary to add more finders to either group, this ground is removed, and the new finders are connected to the contacts associated with that set.

Operation of key K1 to close springs 505 to 507 inclusive.

In a similar manner the operation of the key K1 to the right, to operate springs 505, 506 and 507, removes the control equipment DB from service and diverts all calls originating in both line groups into the control equipment DA. The operation of spring 505 to close its make contact, connects the conductor 261 to the conductor 260, so that ground placed upon conductor 252 by calling lines such as S1 completes a circuit through the resistance 253, conductor 261, spring 505 and its make contact, conductor 260, spring 501 and its break contact, conductor 437, through the winding of relay 405 to battery, energizing that relay preparatory to starting the control equipment DA to handle the call. The operation of spring 506, connects the busy common conductor 367 of the group B through conductor 510, to the busy common conductor 161 of group A, so that a ground placed on the busy common conductor 367 by an idle finder in the group B maintains the all finders busy relay 404 energized over circuit from conductor 161 through spring 502 and its break contact, conductor 436, spring 425, through the winding of the relay 404 to battery. The operation of springs 507 closes a short between conductors 431 and 432, for purposes to be hereinafter pointed out. The disconnection of spring 506 from its break contact, removes busy common conductor 367 from conductor 434, thereby permitting the all finders busy relay 602 to deenergize. The deenergization of relay 602, removes ground from conductor 430, thereby removing ground from the B group of contacts in the bank over which wiper 415 rotates, to permit the distributor DA to select a finder in the group B for use. The operation of the equipment DA is responsive to the energization of the relay and is the same as has been hereinbefore pointed out. When the wiper 415 encounters the contact J, to which contact set the finder FD is assumed to be connected, it no longer finds ground, however, if the finder FD is busy, wiper 414 will encounter a grounded contact. A multiple connection is made between the left hand group of contacts of the banks over which the wipers of DA rotate and the finders of group B similar to that explained in connection with the distributor DB, it being sufficient at this time to point out that the conductor 373 and the finder FB is connected to contact *i* in the bank over which wiper 414 rotates, conductor 474 is connected with contact *h* over which the wiper 413 rotates, conductor 475 is connected with bank contact *g* over which wiper 412 rotates and the connector 376 is connected to the bank contact *f* over which wiper 411 rotates. If finder FB is busy at the moment, wiper 414 will pick up the ground from the off normal spring 323 of the finder FB, conductor 373, contact *i*, wiper 414, conductor 431, through springs 507 of the key K1 and springs 624 of the relay 602 and multiple, conductor 432, through springs 420, springs 427, conductor 445, interrupter springs 410, through the winding of magnet 401 to battery, energizing the magnet which interrupts its circuit at springs 410 and advances the wipers of DA one step. When the finder FB is switched through, relay 302 pulls up and places ground on conductor 374, that ground completing the circuit through contact *h*, wiper 413, conductor 448, relay 403 to battery, energizing the relay 403 to release the control equipment and causes the distributor DA to preselect another idle finder in the manner hereinbefore pointed out.

Operation of key K2.

In order that the equipment may be maintained in proper working order, it is necessary to frequently routine it, that is to cause the equipment to perform a cycle of operations identical with the cycle performed during the process of setting a call. In the present case, the finder FA and control equipment DA must be maintained in proper adjustment if it is to perform its function properly. For this purpose there is provided the key K2, which may be termed an exercising key. When key K2 is thrown to close contacts 504, ground from those contacts completes a circuit over conductor 512, resistance 205 associated with the fifth contact in the bank VA, conductor 260 the winding of relay 405 to battery. Relay 405 energizes over this circuit to start the finder equipment in a manner hereinbefore pointed out. Finder FA, assuming that that finder has been preselected by the distributor DA, therefore, starts stepping in a vertical direction. Since these exercising tests are usually performed at the time of light traffic, it is correct to assume that there will be no calling lines in the group A, and that, therefore, the finder will take

five vertical steps before the vertical wiper 462 encounters the grounded contact. The ground on conductor 512 places the fifth contact of VA at ground potential, so that when the wiper 262 encounters it, the finder FA will be changed over from vertical to rotary movement, and the rotary stepping will take place in the manner hereinbefore described. Since it is assumed there are no calling lines in the group, all of the private contacts in the fifth level will be grounded and the finder FA will accordingly take eleven rotary steps, at the end of which time the wipers of FA will be rotated off of their respective banks. Private wipers 234 and 231 will, therefore, fail to pick up ground, finder FA will be switched through, the distributor DA will preselect another finder, and the control equipment will be released and restored to normal as before. The finder switch after switching through, will not complete a loop circuit, consequently relay 102 of the selector will not be maintained energized, and it will restore and release the selector and finder by removing ground from the release conductor 151. The finder FA will, therefore, return to its normal position, and the next finder of the group, having been preselected by the distributor DA, will be started as soon as relay 403 restores. The next finder of the group, will be put thru the same test, its wipers operated five vertical steps and eleven rotary steps and then released. If a call should come in during this exercising test, the vertical wiper 262 will encounter a grounding contact prior to its arrival upon the fifth contact of the bank VA, consequently the finder will rotate into that level, and stop upon the ungrounded private contacts associated with the calling line. The distributor will preselect another finder and the test will continue just as if no interruption had occurred.

In a similar manner, the operation of key K2 to close spring 508, closes a circuit for the relay 601 of the distributor DB, causing that distributor to start the preselected finder, assumed to be the finder FB, which goes through a similar test. In this manner, the switch room attendant can place an exercising test upon all of the finders in the group, by simply throwing the exercising key first to close spring 504 and then to close spring 508, he may watch the operation of the finders and note the troubles which may appear.

Supervision.

It will be noted that the energization of relay 402 of the control equipment DA, responsive either to the initiation of a call by a line in the group A, or by the operation of the exercising key, closes circuit from grounded springs 423, springs 430, conductor 443, through the lamp 636 and to the slow alarm set indicated at the right of Fig. 6. This slow alarm set may be any well known timing device, which energizes after a definite interval responsive to ground upon the conductor 443, to bring in a suitable alarm to call attention to the fact that something is wrong in the finder equipment. In the normal course of operation of the system, relay 403 is energized responsive to the switching through of the finder, before the slow alarm set has had time to bring in the signal. The lamp 636 is lighted each time a call is in progress in the group A or the group B, serving to supervise those calls. The attendant upon noting that the slow alarm set has operated, is called to the equipment, makes note of the trouble and takes temporary or permanent steps to remove it. Similarly the energization of relay 604 of the control equipment DB, closes the obvious circuit through springs 629 and 635 for the lamp 636 and the slow alarm set, the operation being identical with that just pointed out.

It will also be noted that the deenergization of all finders busy relay 404 closes a circuit through springs 428 for the all finders busy meter 407, energizing that meter to register that all the finders of the group have been busy. Similarly the deenergization of all finders busy relay 602 closes a circuit through spring 625 for all finders busy meter 611, to register that all the finders in group B have been busy. The energization of all finders busy meter 407 prepares at spring 424 a circuit for the lost call meter 406. Similarly the energization of all finders busy meter 611 prepares another point in the circuit of the lost call meter 406. If a call should be attempted during the time that both of the control equipments have an all finders busy condition, ground upon the start conductor would energize either relay 405 or relay 601. Assume that relay 601 is energized, a circuit is then traceable from ground to springs 420, conductor 439, conductor 508, spring 626, conductor 444, spring 424, winding of meter 406 to battery, energizing that meter to register a lost call. The readings registered upon the meters 407 and 611 and upon the lost call meter 406, are valuable to a traffic department in determining whether or not the groups served by the finders FA and FB are overloaded, whether it is necessary to rearrange some of the lines or to supply more finders to the groups to handle the excessive traffic.

Supervision of the condition of the trunk lines from the finders to the first selector, is provided in the following manner. It will be remembered that in the detailed description of the operation of finder FA, after the wipers of that finder had been positioned upon the contacts of the calling line, relay 108 was switched through from a ground placed upon the release trunk conductor 151 by the first selector EA. In the event that the first selector EA is at fault, and is not energized responsive to the placing of the ground upon

conductor 163, as pointed out hereinbefore, this ground will not be present upon the release trunk conductor 151 when it is needed to energize relay 108. Relay 403 of the control equipment DA cannot be energized until relay 108 of the finder has energized and the circuit to the slow alarm set will accordingly be maintained for a sufficiently long period to bring in an alarm. The attendant upon responding to the alarm, will determine which finder is in operation at the time and will note that the wipers are positioned upon the contacts of a calling line, and note that the finder is not switched through, and thereby locate the trouble, either in the negative line conductor, in the line relay of the selector, or in the release circuit.

Having thus described our invention, what we consider new and desire to have protected by Letters Patent is pointed out in the appended claims.

What is claimed is:

1. In an automatic telephone system, a group of subscribers' lines divided into a plurality of subgroups, a start wire for each subgroup, a resistance for each start wire, a relay common to said group of lines, two groups of finders having access to said lines, means including a distributor for each group for preselecting an idle finder in each group, an auxiliary start relay in each distributor, means responsive to the initiation of a call on one of said lines for energizing said common relay over a circuit including the start wire and resistance individual to the subgroup containing said line, means controlled by said common relay for energizing the auxiliary start relay of the first of said distributors if that distributor has preselected an idle finder and for energizing the auxiliary start relay of the other distributor if all the finders of the first group are busy, and means responsive to the energization of an auxiliary start relay for starting a preselected finder to find said calling line.

2. In an automatic telephone system, a group of subscribers' lines, two groups of finders having access to said lines, the order of access of the finders of one of said groups to said lines being the reverse of the order of access of the finder of the other groups to the lines, means including a distributor for each group for preselecting an idle finder in that group, two relays for said lines, one of said relays being associated with each of said distributors, means responsive to the initiation of a call on one of said lines for energizing one of said relays, means controlled by said energized relay through the associated distributor for starting a finder of the group having first access to said line if there is an idle finder in that group and for controlling the other distributor to start a finder of the other group if all of the finders of said first group are busy.

3. In an automatic telephone system, a group of subscribers' lines divided into subgroups, two finder switches having access to said lines, said switches having levels of contacts in which said lines terminate, means including multiple connections between said levels for giving the first of said switches access to said subgroups and lines in the subgroups in one order and for giving the second of said switches access to said subgroups and lines therein in the reverse order, and means responsive to the initiation of a call on one of said lines for starting the finder having first access to the subgroup containing that line to connect with the line if that finder is idle and for starting the other finder if said first finder is busy.

4. In an automatic telephone system, two groups of subscribers' lines each divided into ten subgroups, two finder switches having access to said lines, each finder switch having two sets of wipers, said switches having levels of contacts over which said wipers sweep and in which said lines terminate a start wire for each finder, the start wire of the first finder extending to the first five subgroups of both of said line groups and the start wire of the second finder extending to the second five subgroups of both of said line groups, a relay for each start wire, means responsive to the initiating of a call on one of said lines for energizing one of said relays over the associated start wire to start the finder associated therewith to find that line if that finder is idle and to start the other finder if said first finder is busy, and means in the started finder for determining the wiper set to be used by that finder.

5. In a telephone system, a group of lines divided into sub-groups, a plurality of finder switches having access to said lines, each finder having a plurality of contacts arranged in levels terminating said lines, said levels of one of the finders being connected to said subgroups of lines in a definite order and the levels of another of the finders being connected to said sub-groups in a reversed order, and said contacts in each level being connected to the sub-groups of said lines in a definite order in said first finder and in the reverse order in said second finder.

6. In a telephone system, a plurality of subscribers' lines divided into groups each of which is divided into two sub-groups, a pair of finder switches having access to all of said lines, a wiper set on said finders for each of said sub-groups a starting relay individual to each group of lines, each relay responsive to a call from any line in its group to start either of the finders, to select the line, means in the finder operated after said line is selected for selecting the wiper set corresponding to said group containing the line, and means for establishing a connection through said wipers to said line.

7. In an automatic telephone system, a group of subscribers' lines divided into a plurality of subgroups, a start wire for each subgroup, a resistance for each start wire, two groups of finders having access to said lines, means including a distributor for each group for preselecting an idle finder in each group, an auxiliary start relay in each distributor, means responsive to the initiation of a call on one of said lines and controlled over a circuit including the start wire and resistance individual to the subgroup containing the calling line, for energizing the auxiliary start relay of the first of said distributors so that distributor has access to an idle finder, and for energizing the auxiliary start relay of the second distributor if all the finders of the first group are busy, and means responsive to the energization of an auxiliary start relay for starting a preselected finder to find said calling line.

8. In an automatic telephone system, a group of subscribers' lines divided into subgroups, a plurality of levels of contacts in each subgroup, a plurality of contacts in each of said levels, two coordinate finder switches, banks for said switches, multiple connections between said banks for giving the second finder access to said levels and to the contacts in each level in reverse of the order of access of the first finder, means responsive to the initiation of a call on one of said lines for registering a level digit and a contact digit in the bank of each of said finders, means controlled by said means for starting the finder having the lowest level digit registered in its bank if the finder is idle and for starting the other finder if said first finder is busy, and means in said started finder for counting the level and contact digits in sequence to bring that finder into engagement with said calling line.

In witness whereof, I hereunto subscribe my name this 30th day of June, A. D. 1927.

CLARENCE E. LOMAX.

In witness whereof, I hereunto subscribe my name this 30th day of June, A. D. 1927.

NORMAN H. SAUNDERS.