Aug. 3, 1943. W. T. POWELL 2,325,877

AUTOMATIC TELEPHONE SYSTEM

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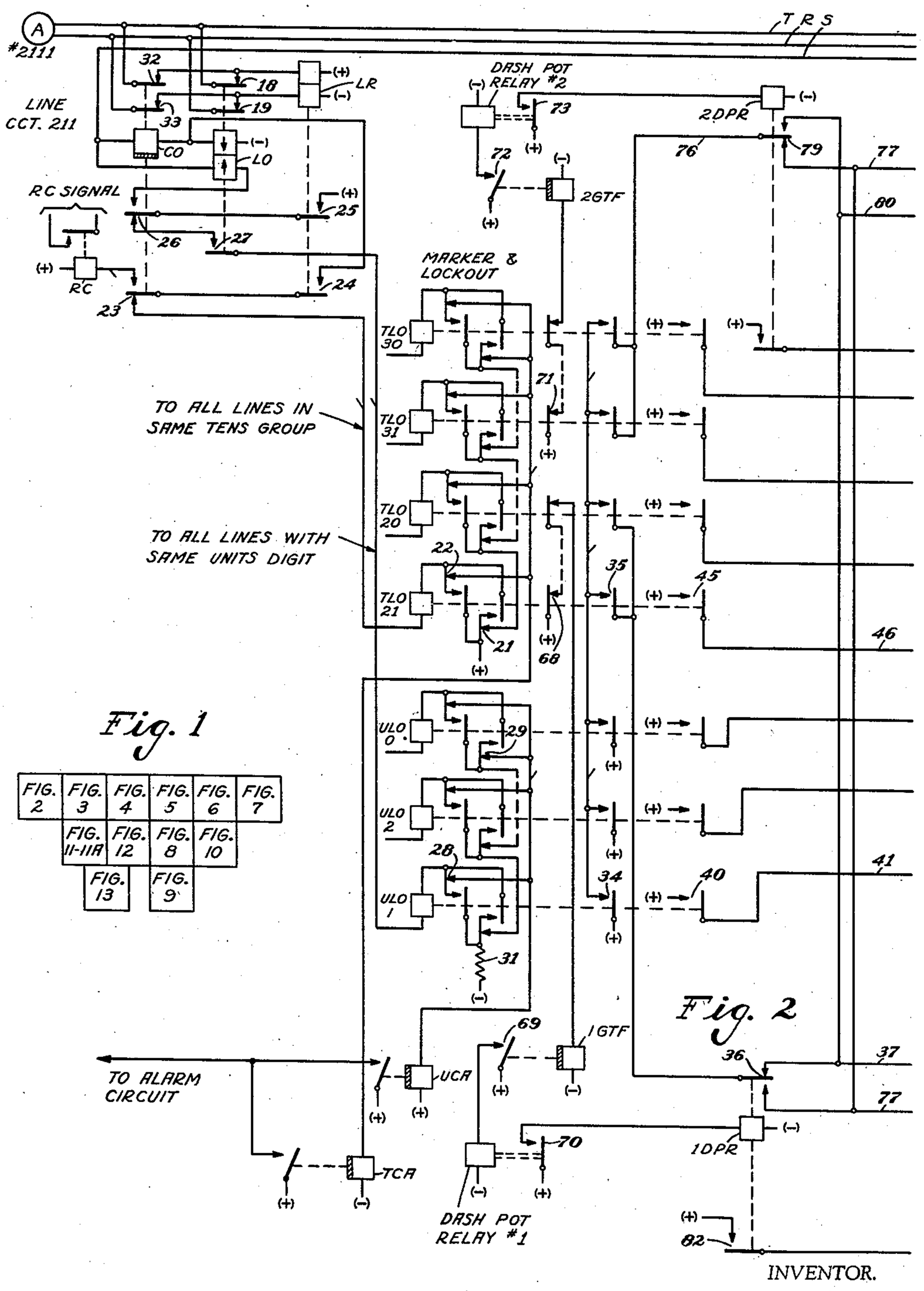

Fig. 1

FIG. 2	FIG. 3	FIG. 4	FIG. 5	FIG. 6	FIG. 7
	FIG. 11-11A	FIG. 12	FIG. 8	FIG. 10	
	FIG. 13		FIG. 9		

Fig. 2

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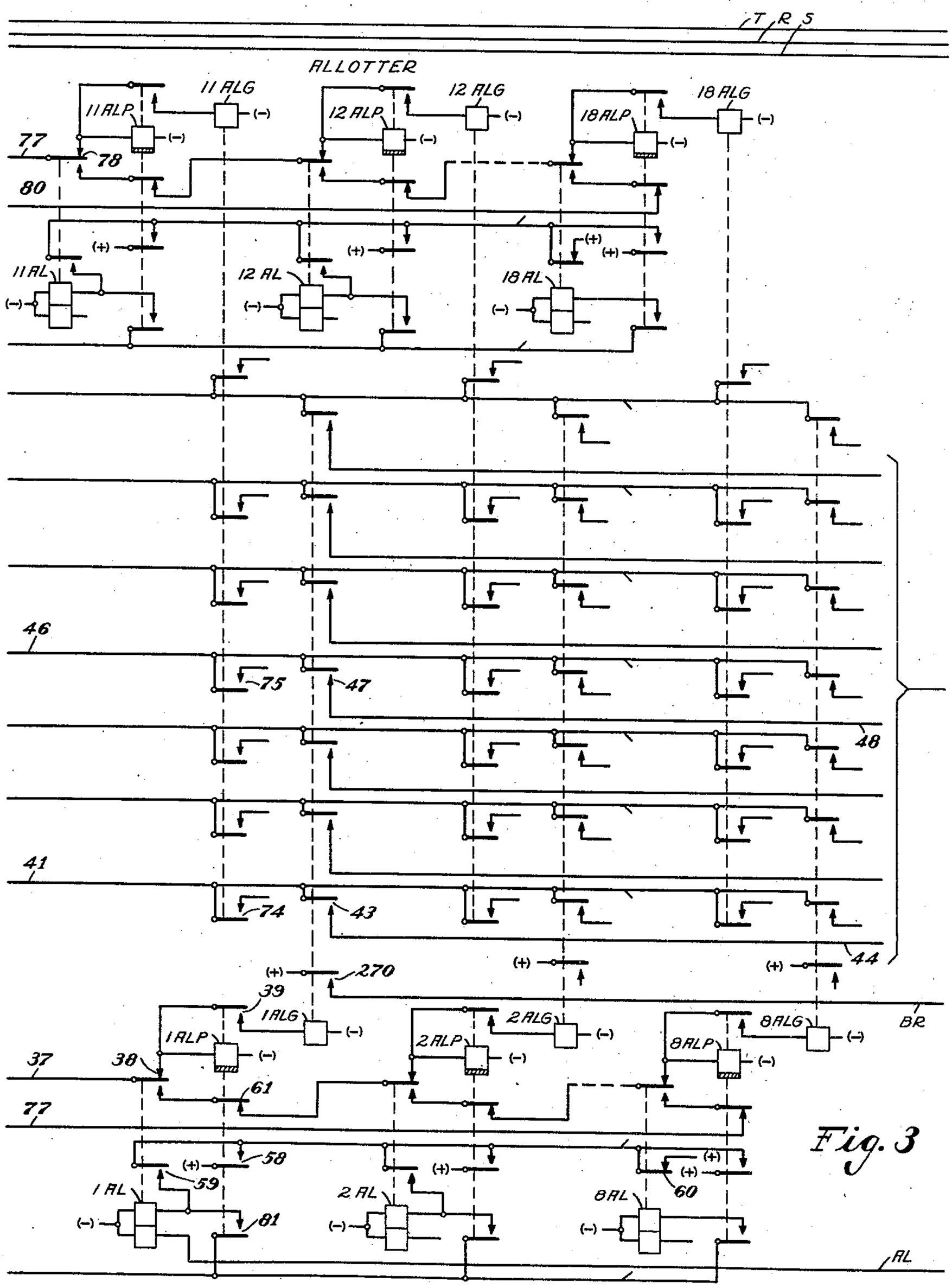

Fig. 3

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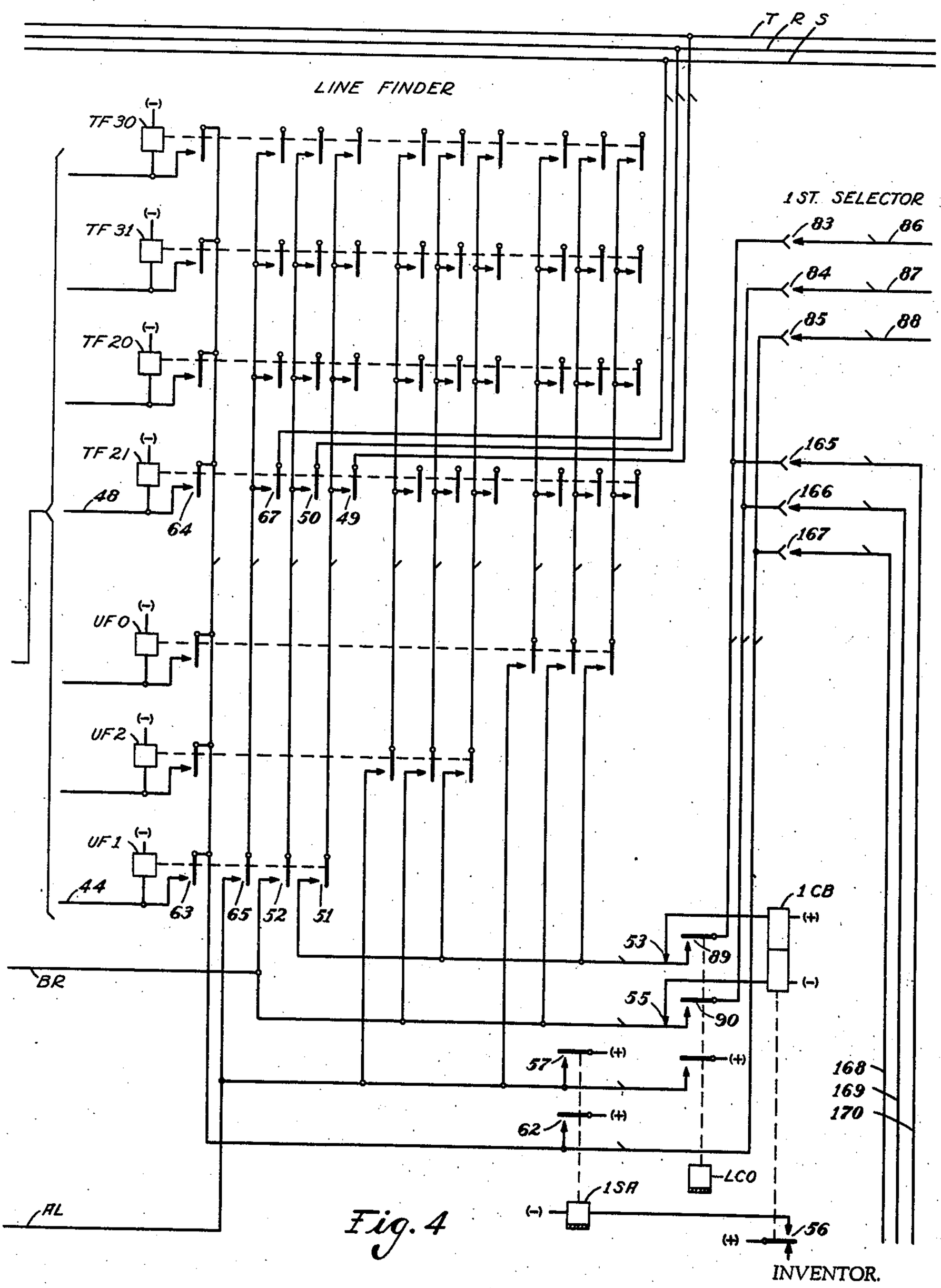

Fig. 4

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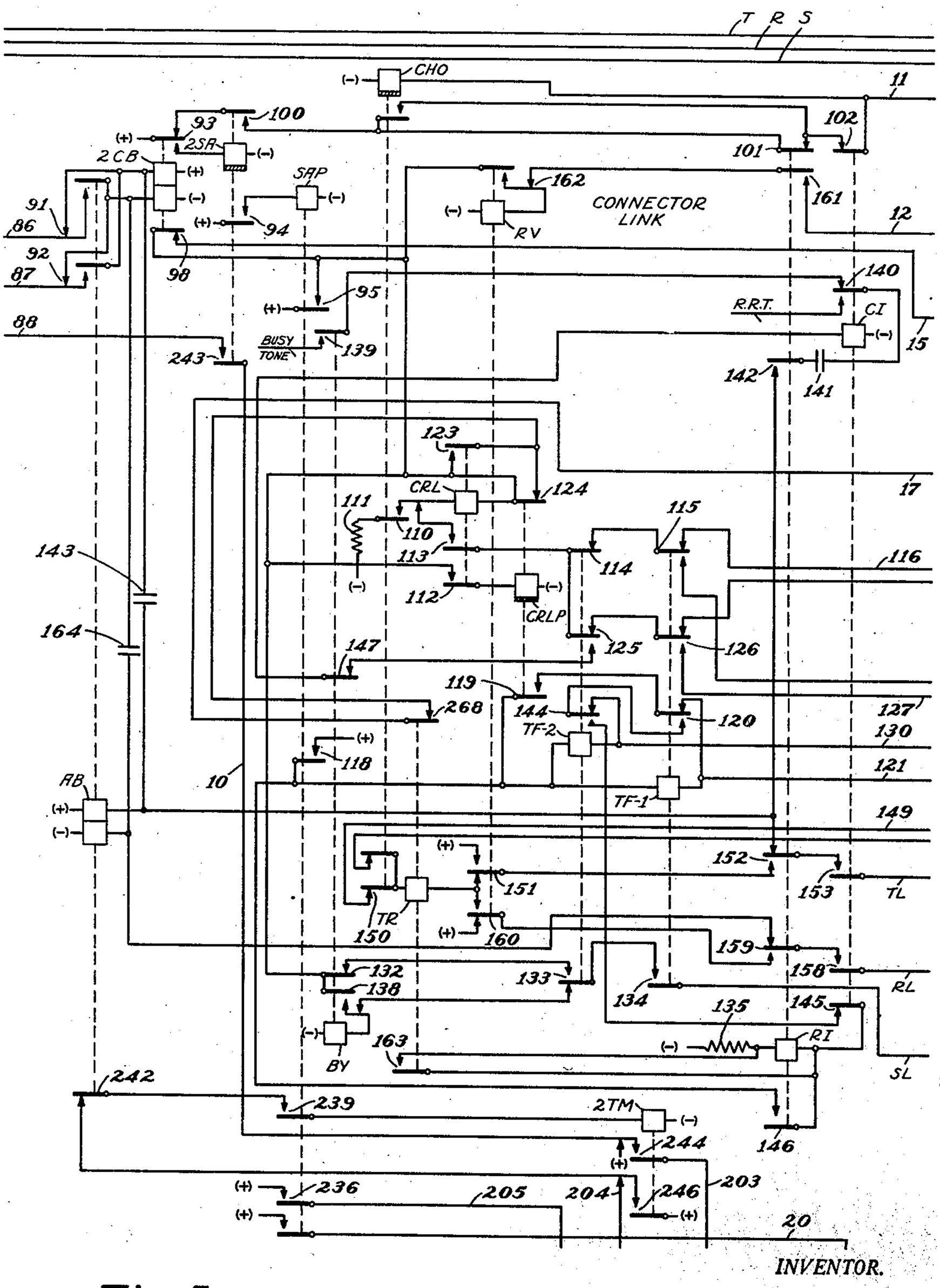

INVENTOR.

Fig. 5

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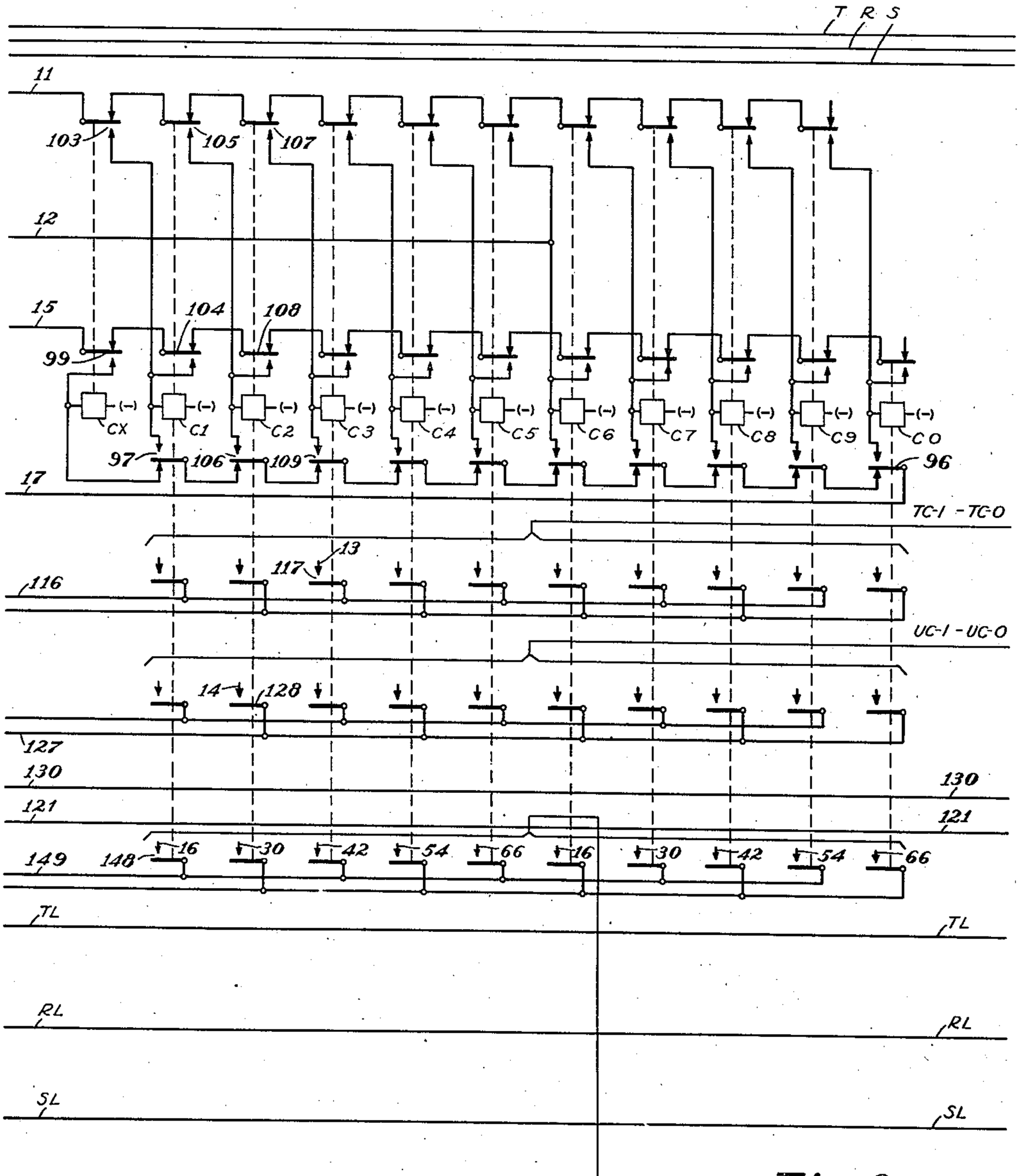

CONNECTOR LINK

Fig. 6

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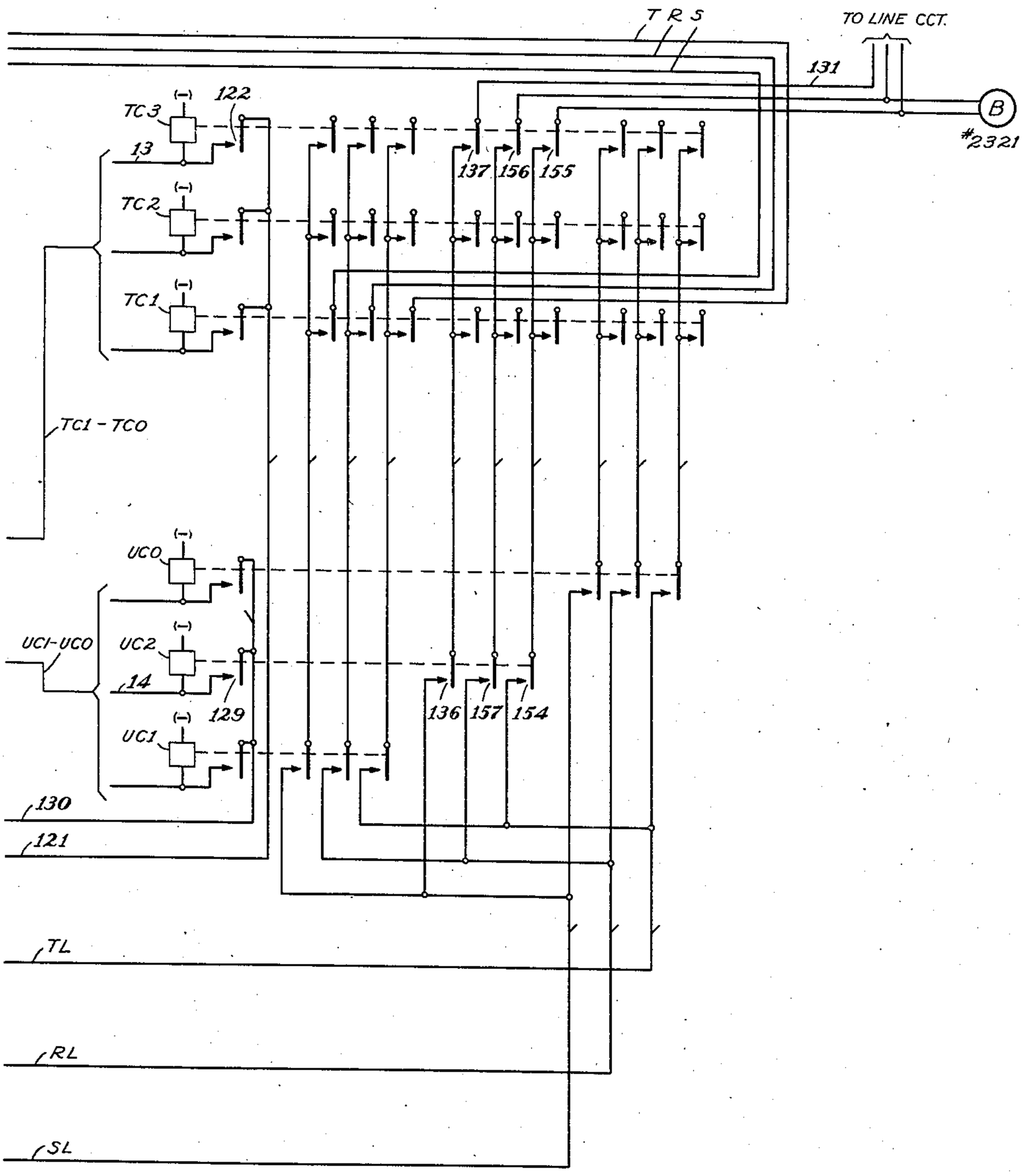

LINE CONNECTOR

Fig. 7

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Fig. 8

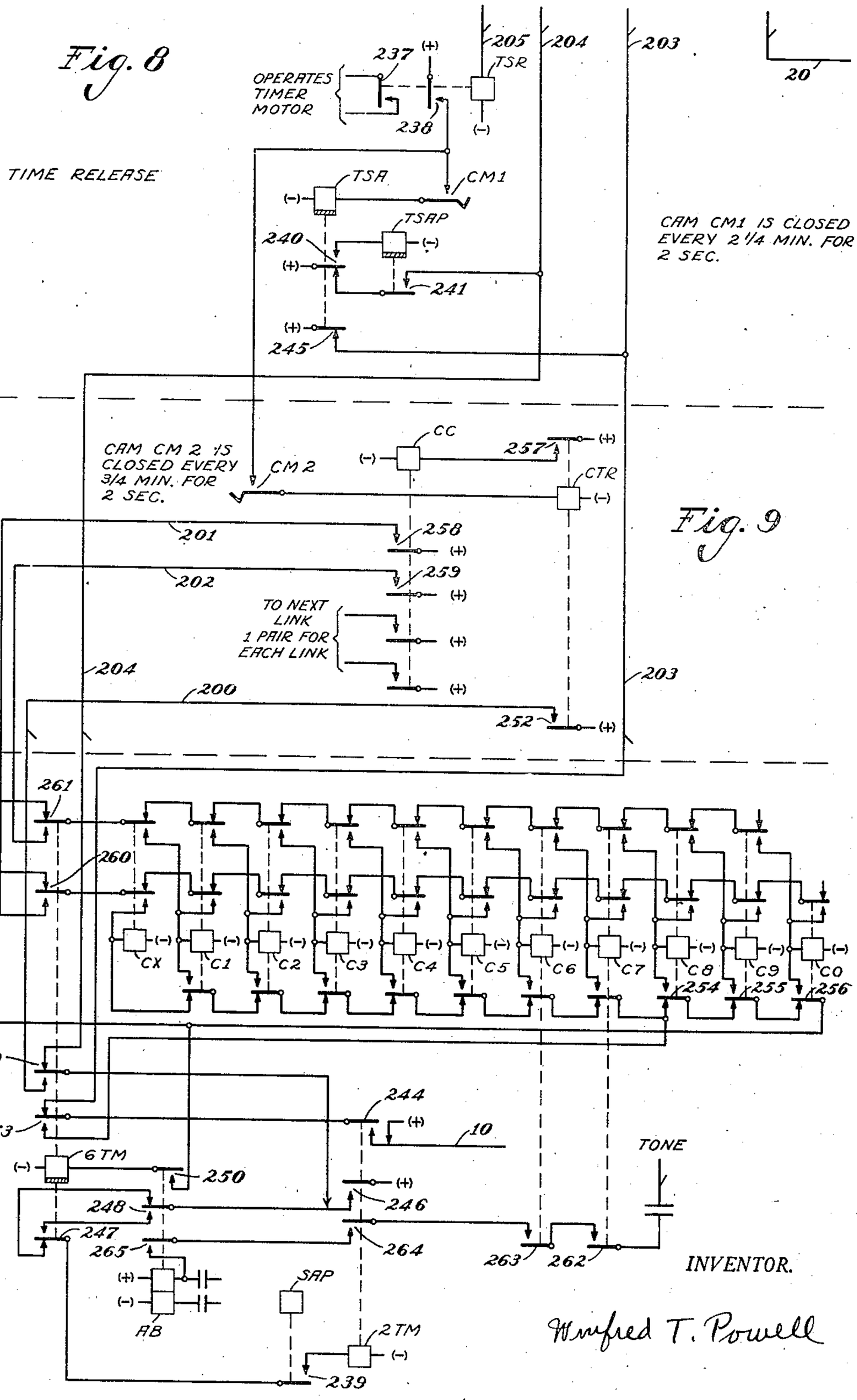

Fig. 9

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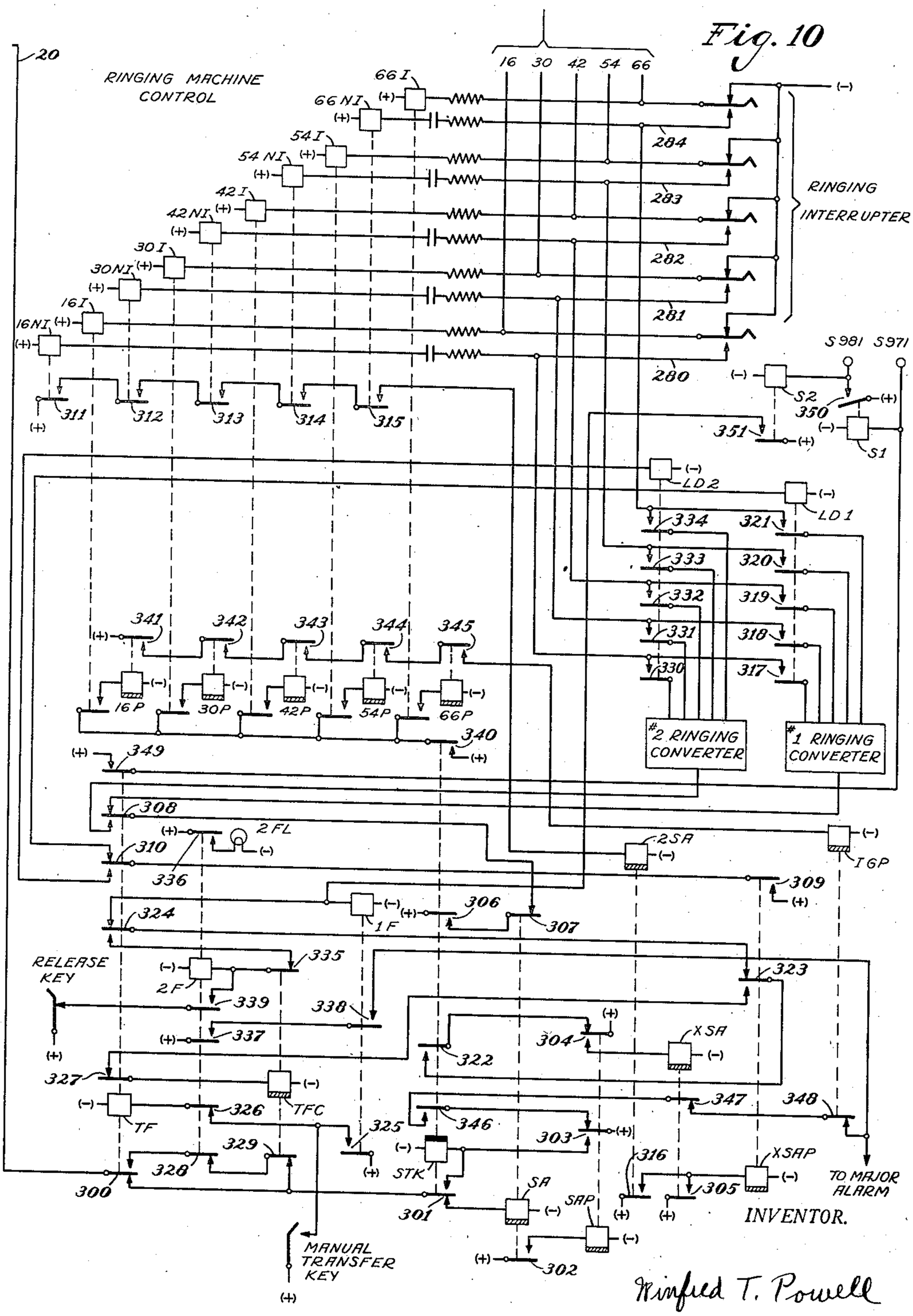
Fig. 10



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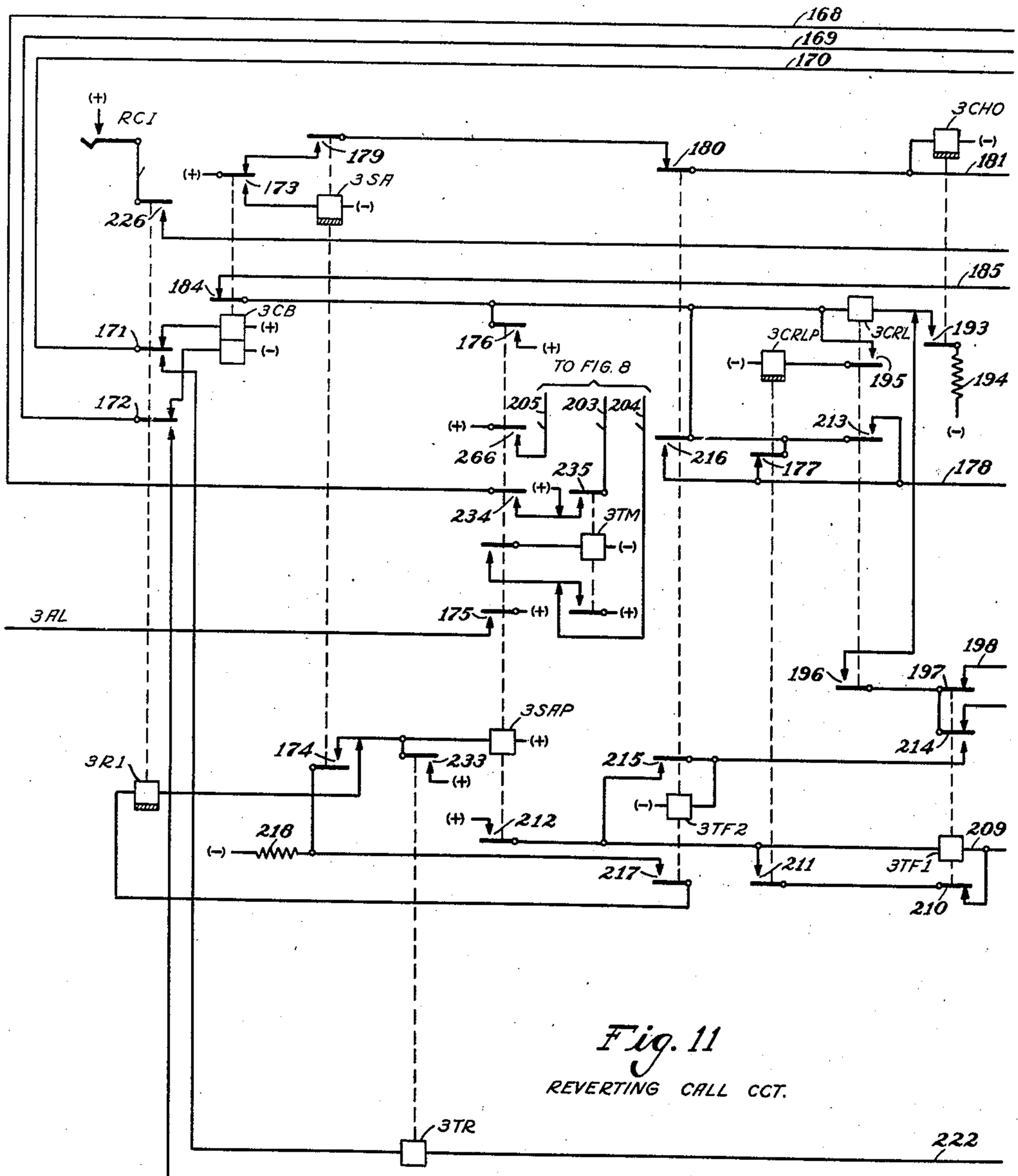

Fig. 11

REVERTING CALL CCT.

IMPULSES TRANSMITTED	1	2	3	4	5	6	7	8	9	10
COUNTING RELAY LEFT OPERATED	1	2	3	4	5	6	1 + 6	2 + 6	3 + 6	4 + 6

Fig. 11A

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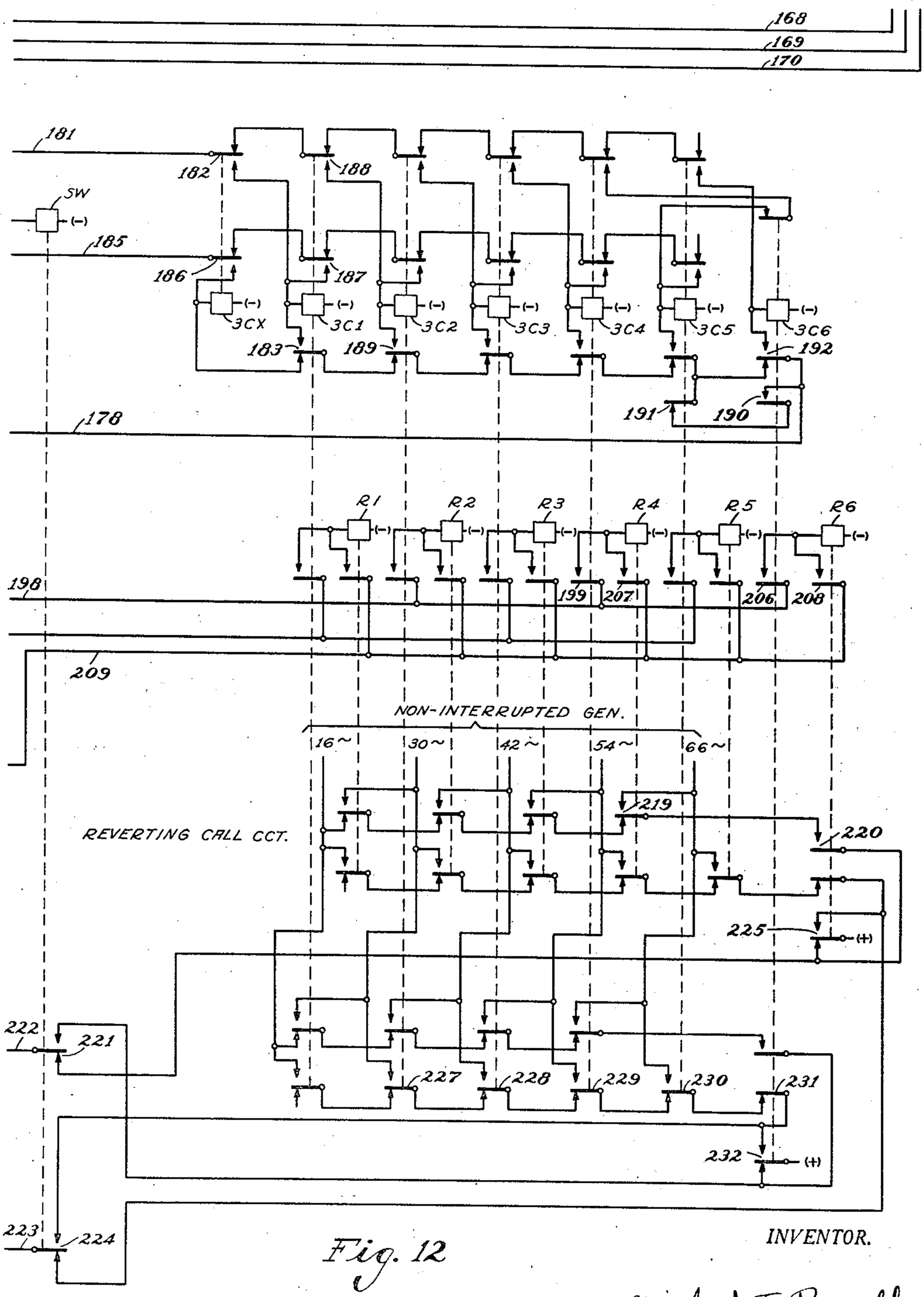

Fig. 12

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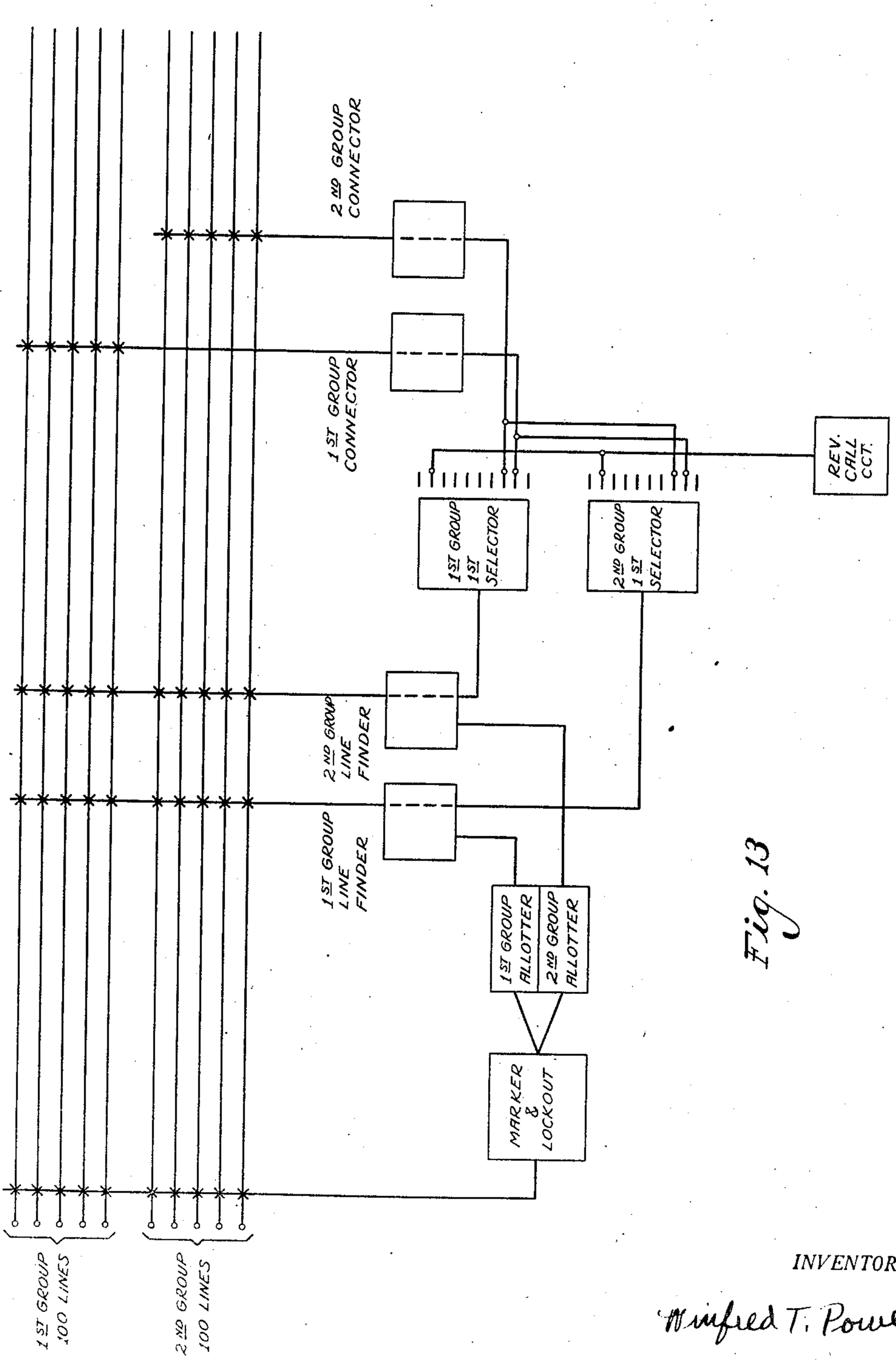

Fig. 13

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Patented Aug. 3, 1943 2,325,877

UNITED STATES PATENT OFFICE

2,325,877

AUTOMATIC TELEPHONE SYSTEM

Winfred T. Powell, Rochester, N. Y., assignor to The Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., a corporation of New York

Application March 11, 1942, Serial No. 434,246

22 Claims. (Cl. 179—17)

This invention relates to automatic telephone systems and particularly to communication facilities furnished by small community dial offices at which a plurality of party telephone lines terminate. An object of the invention is to provide a system of this kind that is economically constructed, simple in operation and easily maintained.

It is a further object of the present invention to provide, for use in a system of the all-relay type, automatic line selecting and connecting equipment which is fully selective in character, and which requires a minimum number of relays for its operation.

It is another object of the invention to provide an improved allotter or distributor arrangement associated with the all-relay finder links, whereby the lines are divided into sub-groups, with the lines in each sub-group being normally served by the line finders of the associated sub-groups and with an automatic group transfer arrangement which is effective to transfer calls from lines of a particular sub-group into the finders of the non-associated sub-group in the case of busy or trouble conditions.

It is a further object of the invention to provide an improved marker and lockout arrangement, which is so arranged that simultaneous calls in a sub-group of lines will not cause faulty operation of the equipment, such as selecting more than one line by a single finder or selecting one line by more than one finder.

It is an additional object of the invention to provide an automatic ringing machine transfer arrangement, whereby a trouble condition in the common ringing or interrupter apparatus is effective to automatically switch over to the other or reserve ringing equipment.

Another additional object of the invention is to arrange the circuits of the common ringing equipment so that a toll operator, or other party having authority to make such connections, can dial special numbers for switching from one ringing machine equipment to the other, but ordinary subscribers in the system cannot connect with these numbers for effecting such a transfer. In this connection, a signal is given to indicate to the operator which machine is in operation.

Further features of the invention pertain to the particular arrangement of the circuit elements whereby the above outlined and additional operating features are attained.

This invention has been illustrated in the accompanying drawings in which:

Fig 1 shows a plan for arranging the various other figures of the circuits;

Fig. 2 shows a line circuit and a portion of the common marking and lockout circuits;

Fig. 3 shows a sufficient portion of the common allotter circuits for each sub-group of lines to obtain an understanding of the present invention;

Fig. 4 shows a portion of a line finder circuit, with the connecting portion of a selector illustrated;

Figs. 5 and 6, when placed together in the order named and with correspondingly numbered lines in alinement, show a connector link circuit;

Fig. 7 shows a portion of the line connector which is associated with each connector link;

Fig. 8 indicates the common time release circuit, which is for the purpose of automatically releasing a "permanent" from the connector link;

Fig. 9 shows the circuit of a modified time release arrangement, for the purpose of automatically releasing a talking connection after a predetermined time interval;

Fig. 10 shows the circuits for controlling the ringing machines in a manner which will be fully described in the following specification;

Figs. 11 and 12 show the relay type reverting call circuit;

Fig 11A is a chart illustrating the counting relays left operated after the various impulses are transmitted;

Fig. 13 is a block diagram and single line layout of the system.

A detailed description will now be made of a call which is assumed to be established from a calling subscriber A to a called subscriber B.

Removing the receiver at the calling station closes a circuit for operating line relay LR, which extends from positive battery, upper winding of relay LR, back contact 18 of lockout relay LO, over the line circuit, by way of back contact 19 of relay LO and lower winding of relay LR to negative battery. Relay LR closes a circuit for operating tens lockout relay TLO21, which extends from positive battery, back contact 21 of relay TLO21 and back contacts of all other tens lockout relays in series, back contact 22 of relay TLO21, winding of relay TLO21, back contact 23 of cut off relay CO, front contact 24 of relay LR and upper winding of relay LO to negative battery. Relay TLO21 operates over this circuit and, at back contact 21 opens the above described series circuit so that no other TLO relay

of the group can operate at this time. Relay LO also operates over the above described circuit and completes a circuit for operating units lockout relay ULO1, which extends from positive battery, front contact 25 of relay LR, back contact 26 of relay CO, front contact 27 of relay LO, winding of relay ULO1, back contact 28 of relay ULO1, back contact 29 of relay ULO0 and all other similar back contacts of other ULO relays, to negative battery through resistance 31.

Tens continuity alarm relay TCA and units continuity alarm relay UCA are connected to the ends of the chain circuits of the TLO and ULO relays respectively and operate to bring in an alarm if one of the associated chain circuits goes open and stays open for an abnormal period of time.

It will be assumed that there are 200 lines in a group and that this group is divided into two sub-groups of 100 lines each. Consequently, there will be 10 ULO relays (ULO1 to ULO0 inclusive) and 20 TLO relays (TLO21 to TLO20 inclusive and TLO31 to TLO30 inclusive). In other words, there is one ULO relay for all lines in the group having the same units digit and there is one TLO relay for every 10 lines in the group. With relay LO operated, contacts 18 and 19 open up the above described circuit of relay LR but another circuit may be traced for this relay through back contacts 32 and 33 of relay CO. With relays TLO21 and ULO1 operated, as above described, a circuit is completed for operating allotter repeater relay 1ALP which extends from positive battery, front contact 34 of relay ULO1, front contact 35 of relay TLO21, back contact 36 of dash pot repeater relay 1DPR, conductor 37, back contact 38 of allotter relay 1AL and winding of relay 1ALP to negative battery. The closure of front contact 39 of relay 1ALP extends this circuit to alloter group relay 1ALG for operating this latter relay.

A circuit is now closed for operating units finder relay UF1 of the line finder, which extends from positive battery, front contact 40 of relay ULO1, conductor 41, front contact 43 of relay 1ALG, conductor 44 and winding of relay UF1 to negative battery. A circuit is also closed for operating tens finder relay TF21 of the line finder, which extends from positive battery, front contact 45 of relay TLO21, conductor 46, front contact 47 of relay 1ALG, conductor 48 and winding of relay TF21 to negative battery.

With relays TF21 and UF1 operated, the tip and ring conductors T and R of the calling line are extended through front contacts 49 and 50 of relay TF21 and front contacts 51 and 52 of relay UF1, back contacts 53 and 55 of link cut off relay LCO and the windings of calling bridge relay 1CB to positive and negative battery, respectively. The closed circuit across the calling line energizes relay 1CB, which closes a circuit at its front contact 56 for operating slow acting relay 1SA.

The operation of relay 1SA closes a circuit, at its front contact 57, to allotter conductor AL and the lower winding of relay 1AL for operating this latter relay. Relay 1AL closes a locking circuit for itself from positive battery, front contact 58 of relay 1ALP, front contact 59 and upper winding of relay 1AL to negative battery. This locking circuit also extends to positive battery by way of back contact 60 of relay 3AL. Since it is assumed that there are 8 line finders in the subgroup and consequently there are 8 allotter relays, this means that when an allotter relay, such as relay 1AL is operated, it locks itself operated until all of the finders are used up to and including the last, when the above described locking circuit, including contact 60 of the last allotter relay, is opened. The purpose of a contact such as front contact 58 applying positive battery to the locking circuit for the associated AL relay is to prevent premature release of this AL relay of a link which is taken for use when the last link of the sub-group is already in use.

The operation of relay 1AL opens up the circuit of relays 1ALP and 1ALG at back contact 38, which effects the release of these two relays, with the closure of front contact 38 of relay 1AL and back contact 61 of relay 1ALP extending the starting wire circuit through to the next group of allotter relays. Since relay 1ALP is slow acting, the closure of this circuit at back contact 61 is delayed slightly to prevent operating the allotter relays of the next link if the lockout relays of Fig. 2 are a little slow in releasing.

The operation of relay 1SA closes a locking circuit for relay UF1, which extends from positive battery front contact 62 of relay 1SA, front contact 63 and winding of relay UF1 to negative battery. A similar locking circuit is also completed for relay TF21 by way of front contact 64 and winding of this latter relay. This locks these two finder relays as long as the connection is maintained by the closed circuit across the calling line.

The closure of contact 57 if relay 1SA extends positive battery through front contact 65 of relay UF1 and front contact 67 of relay TF21 to the sleeve conductor S of the calling line, which extends back through the windings of relays CO and LO to negative battery. This positive battery functions to make the calling line busy and it also operates relay CO of the calling line circuit. It will be noted that, as long as relay LR is operated, positive battery on the sleeve conductor of the calling line is applied to one terminal of the lower winding of relay LO and, with relay CO operated, positive battery is applied to the other terminal of the lower winding of relay LO by way of front contacts 25 and 26. This application of the same potential to both terminals of the lower winding of relay LO prevents current flow in this winding, so that the current in its upper winding maintains this relay operated. With relays CO and LO operated, the calling line is disconnected from relay LR and this latter relay releases.

The operation of relay CO opens up the above described circuit of relays TLO21 and ULO1 for releasing these relays. This opens up the operating circuits of the finder relays, but these relays are locked over the above described locking circuits.

The operation of relay TLO21, or any of the TLO relays in the first sub-group, opens up a series circuit including group transfer relay 1GTF. This circuit, in the above assumed call, is opened at back contact 68 and effects the release of relay 1GTF.

Relay 1GTF closes a circuit at its back contact 69 for energizing the #1 dash-pot relay. This dash-pot relay is adjusted so that it will not close its front contact 70 during the normal operation of the system, consequently relay 1DPR will not be operated during such normal operation. A call in the second sub-group is effective to open up a similar series circuit, including back contact 71 of relay TLO31, which maintains group trans-

fer relay 2GTF normally energized. If the call in this second sub-group is handled in a normal manner, the closure of back contact 72 of relay 2GTF energizes the #2 dash-pot relay but this relay does not have time to close its front contact 73. In the event that, due to some faulty circuit condition, the calling line is not extended through to the 1CB and 1SA relays of the line finder, or the 1SA relay does not extend positive battery back over the sleeve conductor for operating the CO relay of the calling line, then the dash-pot relay has time to operate. In the above example this effects the operation of relay 1DPR and its contact 36 switches the start wire from conductor 37 to conductor 77, which leads through back contact 78 of relay 11AL of the second allotter group to operate relays 11ALP and 11ALG. This connects conductors 41 and 46 by way of front contacts 74 and 75 to finder relays of the first finder in the second sub-group. Then the finder relays and the associated CB and SA relays operate in a manner similar to that above described, with the call being handled by the finder in the second sub-group.

In the event that the call originates in the second subgroup and that the calling line fails to be properly found, the #2 dash-pot relay will operate for effecting the operation of relay 2DPR and this relay in turn switches the start wire 76 of the second group from conductor 77 to conductor 37. This is effected by contact 79 of relay 2DPR and the energization of conductor 37 allots a finder in the first sub-group.

It is believed that the above explanation indicates how calls in each of the two sub groups are normally handled by finders in the associated sub-groups and how, in the event of a faulty condition, a finder of a normally non-associated sub-group will step in and take care of the call. The circuits are also arranged so that, in the event all finders in a sub-group are busy, the start wire will be extended to a finder in the non-associated sub-group. For example, in the case of the above assumed call, if all finders of the first sub-group are busy all of the allotter relays shown in the lower portion of Fig. 3, such as relays 1AL, 2AL and 8AL will be operated. Now when positive battery is applied to conductor 37 as above described, the circuit extends through front contact 38 of relay 1AL, back contact 61 of relay 1ALP and similar front contacts of all other AL relays and back contacts of all other ALP relays to conductor 77, which leads to contact 78 of relay 11AL and thence to the alloter relays of the non-associated subgroup. A similar circuit extends through front contacts of the AL relays and back contacts of the ALP relays of the upper sub-group to conductor 80 and thence to conductor 37, which carries this starter wire from the upper sub-group to the allotter relays of the lower sub-group. It will be noted that there is a circuit completed through front contact 82 of relay 1DPR and front contact 81 of relay 1ALP to the upper winding of relay 1AL. This circuit, and other similar circuits to other AL relays, is for the purpose of operating the AL relay and thus making the associated finder busy in the event that the ALP relay allotts a certain finder and, due to a faulty condition, the connection is not properly handled by this finder. In other words, when relay 1ALP operates and then, due to such a faulty condition, relay 1DPR operates, relay 1AL is operated and locked to make this finder busy to the next call. It will be evident that this particular finder will remain busy until calls have progressed through all the finders in the associated sub-group. It will be understood that relays 1DPR and 2DPR can control alarm circuits if desired.

It will be noted that the operation of relay 1ALG closes a circuit at its front contact 270 by way of booster conductor BR for operating relay 1CB, which circuit is independent of the calling line. This is for the purpose of positively operating the CB relay of the finder, so the allotter and marking relays will be sure to clear out and not lockout succeeding calls in the event of a high resistance leak on some line which would operate relay LR but not operate the CB relay.

It will be assumed that the calling subscriber operates his dial to select substation B of Fig. 7 which is assumed to be #2321. The first turn of the dial operates the first selector (not shown) of the system to select a connector link in the second hundreds group. When this selection is made, in a manner which is well understood by those skilled in the art, contacts 83, 84 and 85 of the selector are closed to extend the tip, ring and sleeve conductors of the calling line to conductors 86, 87, and 88 of the connector link shown in Fig. 5. This extension of the tip and ring conductors is by way of front contacts 89 and 90 of relay LCO of Fig. 4, which relay is the usual "cut-through" relay of the selector and which operates when the first selector operation has been completed.

The extension of the closed circuit of the calling line to conductors 86 and 87 of the connector link completes a circuit, including the calling line, by way of back contacts 91 and 92 of answering bridge relay AB to the windings of relay 2CB, thus operating this relay, which closes a circuit at its front contact 93 for operating relay 2SA. The operation of relay 2SA closes a circuit at its front contact 94 for operating slow acting repeater relay SAP. The counter-preparing relay CX is now operated over a circuit extending from positive battery, front contact 95 of relay SAP, back contact 124 of counter release repeater relay CRLP, back contact 268 of trip relay TR, conductor 17, back contacts in series of all counting relays from CO to C1 inclusive, which includes back contacts 96 and 97, and winding of relay CX to negative battery. The operation of relay CX prepares a locking circuit for itself which is effective to maintain this relay operated at the time of the transmission of the first impulse, this locking circuit extending from positive battery, front contact 95 of relay SAP, back contact 98 of relay 2CB, conductor 15, front contact 99 and winding of relay CX to negative battery. This locking circuit is established to maintain relay CX operated during the transmission of the first impulse of the series and similar locking circuits are provided for the other counting relays to maintain a counting relay operated during the transmission of an impulse which operates the next succeeding counting relay. It was assumed that called sub-station B is selected by dialing #2321. This means that the first digit, #2, operates the selector to select an idle connector in the group, that the second digit, #3, selects the tens connecting relay to which this line is connected, the third digit, #2, selects the units connecting relay for picking out the particular line in the group selected by the tens connecting relay and the fourth digit, #1,

selects the particular frequency for ringing the called station on the selected line.

The transmission of the three impulses, after the connector is selected, effects the release of relay 2CB, once for each impulse, followed by the continued energization of this relay after the three impulses have been transmitted. Recalling that relay CX was operated when the connector was seized, the first impulse closes a circuit for operating relay C1 which extends from positive battery, back contact 93 of relay 2CB, front contact 100 of relay 2SA, back contact 101 of ringing relay RI, back contact 102 of cut-in relay CI, conductor 11, front contact 103 of relay CX and winding of relay C1 to negative battery. Relay C1 opens up the above described operating circuit for relay CX at back contact 97 and extends this circuit through front contact 97 to the winding of relay C1. Relay CX does not release at this time because of the above described locking circuit through back contact 93 of relay 2CB.

When relay 2CB energizes after the transmission of the first impulse, the locking circuit and relay CX, including back contact 93, is opened and relay CX releases. When the 2CB relay releases at the beginning of the second impulse, a locking circuit is closed for relay C1, which extends through back contact 93 of relay 2CB, back contact 99 of relay CX and front contact 104 of relay C1. This prevents the release of relay C1 while the circuit is closed for operating relay C2, which extends from positive battery by way of conductor 11, as above described, back contact 103 of relay CX, front contact 105 of relay C1 and winding of relay C2 to negative battery. Relay C2 operates, opens the first locking circuit above described for relay C1 at back contact 106 and closes a first locking circuit for itself at front contact 106. Relay C1 is released at the end of this second impulse when relay 2CB operates to open back contact 93.

The transmission of the third impulse is effective to operate relay C3 over the above described pickup conductor 11, which now includes front contact 107 of relay C2. Relay C2 is prevented from releasing during the transmission of this impulse because of the second locking circuit, which is completed by way of back contact 93 of relay 2CB, back contacts 99 and 104 of relays CX and C1 and front contact 108 of relay C2. Contact 109 of relay C3 switches the first locking circuit from relay C2 to relay C3. At the end of the third impulse relay C2 is released because its second locking circuit is opened at back contact 98 of relay 2CB. This leaves relay C3 operated and all other counting relays released.

At the beginning of the series of impulses a circuit is closed for operating change over relay CHO which includes the above described pick up conductor 11. Relay CHO, being slow to release, remains operated during the transmission of each series of impulses and releases at the end of the series of impulses. The operation of relay CHO closes a circuit for operating counter release relay CRL, which extends from positive battery, front contact 95 of relay SAP, winding of relay CRL, front contact 110 of relay CHO and resistance 111 to negative battery. Relay CRL closes a circuit for operating relay CRLP which extends from positive battery, front contact 95 of relay SAP, front contact 112 of relay CRL and winding of relay CRLP to negative battery. When relay CHO releases at the end of the series of impulses, a circuit is closed for operating tens connecting relay TC3, which extends from positive battery front contact 95 of relay SAP, winding of relay CRL, back contact of the make-before-break combination 110 of relay CHO, front contact 113 of relay CRL, back contacts 114 and 115 of transfer relays TF2 and TF1, conductor 116, front contact 117 of relay C3, conductor 13 and winding of relay TC3 to negative battery. It will be understood that, if some other number was dialed for the tens digit some other TC relay, such as TC1, TC2 or the like would have been operated in accordance with the selection made by the counting relay left operated in response to the number of impulses in this digit.

Since the above described operating circuit for relay TC3 includes the winding of relay CRL, relay TC3 will be operated and relay CRL will be held operated over this circuit. The operation of relay TC3 closes a locking circuit for itself, which extends from positive battery, front contact 118 of relay SAP, front contact 119 of relay CRLP, back contact 120 of relay TF1, conductor 121, front contact 122 and winding of relay TC3 to negative battery. It will be noted that this circuit to positive battery through front contact 116 of relay SAP applies positive battery to the left hand terminal of relay TF1, while positive battery is applied to the right hand terminal of this relay by way of front contact 119 of relay CRLP. This prevents the operation of relay TF1 at this time. Furthermore, the connection to positive battery on conductor 121 is extended through front contact 122 of relay TC3 and conductor 13, back to the left hand terminal of the winding of relay CRL and, since positive battery is applied to the right hand terminal of this winding at front contact 95 of relay SAP, it is short-circuited and released. The release of relay CRL opens up the circuit of conductor 17 at front contact 123, which allows relay C3 to release. Shortly after this, relay CRLP is released because of open contact 112 and positive battery is again applied to conductor 17 by way of back contact 124 of relay CRLP. This again operates relay CX to prepare the counting relay circuits for the next digit. When relay CRLP releases, the above described short circuit around relay TF1 is opened at contact 119 which allows relay TF1 to operate over a circuit extending from positive battery, front contact 118 of relay SAP, winding of relay TF1, conductor 121, front contact 122 and winding of relay TC3 to negative battery.

The transmission of the third digit (#2) to the connector link is effective to release relay 2CB twice in response to the impulses of this digit. This is effective to operate relays C1 and C2 over circuits above described and, since relay CB remains energized after the second impulse, relay C2 will remain energized while relays CX and C1 are released. Relay CHO will be operated and released as before, relays CRL and CRLP will be operated and released as before and units connecting relay UC2 will be operated over a circuit extending from positive battery, front contact 95 of relay SAP, winding of relay CRL, back contact of the make-before-break combination 110 of relay CHO, front contact 113 of relay CRL, back contact 125 of relay TF2, front contact 126 of relay TF1, conductor 127, front contact 128 of relay C2, conductor 14 and winding of relay UC2 to negative battery. Relay CRL is locked as before until relay UC2 is operated and its locking circuit closed at front contact 129, at which time relay CRL is released as before, followed by the release of relay CRLP.

After relay CRLP releases, following the operation of relay UC2, relay TF2 is operated over a circuit extending from positive battery, front contact 118 of relay SAP, winding of relay TF2, conductor 130, front contact 129 and winding of relay UC2 to negative battery. During the interval between the release of relay CRL and relay CRLP, relay C2 is released and after relay CRLP releases relay CX is energized over its previously described circuit.

Within the interval between the operation of relay UC2 and the operation of relay TF2, which interval is of comparatively long time due to the slow release of relay CRLP, a test is made of the called line. If this line is idle, there is an absence of positive potential on its sleeve conductor 131. Then when relay TF2 operates, positive potential is applied to sleeve conductor 131 from positive battery, front contact 95 of relay SAP, back contact 132 of relay BY, front contacts 133 and 134 of relays TF2 and TF1, conductor SL, front contact 136 of relay UC2, front contact 137 of relay TC3, to conductor 131. This operates the cut-off relay of the called line and also makes this line busy to other calls.

In the event that the called line is busy when this called line test is made, the positive battery on conductor 131 extends through front contacts 137 and 136 of the line connecting relays, conductor SL, front contact 134 of relay TF1, back contact 133 of relay TF2, back contact of the make-before-break combination 138 and winding of busy relay BY to negative battery. This operates relay BY and, at its back contact 132, prevents the application of positive battery to conductor 131 while relay BY is maintained locked over a circuit including front contact 138 of its make-before-break combination and front contact 95 of relay SAP. The busy tone is connected to the calling line over a circuit including front contact 139 of relay BY, back contact 140 of relay CI, condenser 141, front contact 142 of relay RI and condenser 143 to the calling line. The release of the connection will be the same as will be described in connection with a call to a line which is not busy. Relay RI is operated when the station digit is dialed as will be later explained.

Assuming the called line to be idle, then the circuits function as will now be described. Following the transmission of the units digit, as above described, the station digit is transmitted, which in the assumed case is #1. The transmission of the station digit effects the operation of ringing relay RI at the beginning of this station digit transmission, whether the called line is busy or idle. When relay 2CB releases at the beginning of the first station impulse, relay CX is locked operated and relay C1 is operated and locked as previously described. At the end of this impulse, relay CX is released and, since it is assumed that one impulse is transmitted, relay C1 remains operated for selecting 16 cycle ringing current. Relays CHO, CRL and CRLP operate at the beginning of the first impulse, when relay CB is released, in the previously described manner.

Relay RI is operated over a circuit which extends from positive battery, front contact 118 of relay SAP, front contact 119 of relay CRLP, front contact 120 of relay TF1, front contact 144 of relay TF2, back contact 145 of relay CI, winding of relay RI and resistance 135 to negative battery. A locking circuit is closed for relay RI which extends from positive battery, front contact 118 of relay SAP, front contact 146 and winding of relay RI to negative battery through resistance 135. It will be understood that these operating and locking circuits for relay RI are completed when the station digit is transmitted even though the called line is busy. When the called line is idle, the release of relay CHO at the end of the station digit closes a circuit for operating relay CI which extends from positive battery, front contact 95 of relay SAP, winding of relay CRL, back contact of make-before-break spring combination 110 of relay CHO, front contact 113 of relay CRL, front contact 125 of relay TF2, back contact 147 of relay BY and winding of relay CI to negative battery. Since the winding of relay CRL is included in series with the winding of relay CI, both relays are maintained operated and consequently relay CRLP is maintained operated over a circuit including front contact 112 of relay CRL.

It will be understood that other station digits are effective to select other frequencies for application to the called line by the different combinations of impulses in these other station digits operating different combinations of counting relays. With counting relay C1 operated as above described, a circuit is completed for ringing the called station with 16 cycle current which extends from the 16 cycle lead from the ringing converter, front contact of either load relay LD1 or LD2, interrupter 271, to the 16 cycle generator common and thence by way of front contact 148 of relay C1, conductor 149, back contact 150 of relay CHO, winding of trip relay TR, back contact 151 of relay RV, front contacts 152 and 153 of relays RI and CI, conductor TL, front contacts 154 and 155 of relays UC2 and TC3, over the conductors of the called line, front contacts 156 and 157 of relays TC3 and UC2, conductor RL, front contacts 158 and 159 of relays CI and RI, back contact 160 of relay RV to positive battery and thence to the other side of the ringing source.

In the event that the station digit is 6 to 0 inclusive, then relay RV will be operated over a circuit extending from the positive battery which operates relay C6, conductor 12, front contact 161 of relay RI, back contact 162 and winding of relay RV to negative battery. Relay RV is locked operated by means of its make-before-break spring combination to positive battery at contact 95 of relay SAP. The contacts 151 and 160 reverse the connection to the ringing source so that ringing current is sent out over the ring side of the line. This is effective to provide divided circuit ringing by applying ringing current to the tip side of the line when the station digit is 1 to 5 inclusive and by applying ringing current to the ring side of the line when the station digit is 6 or more. In this event, the stations on the line with stations digits 1 to 5 will have their ringers connected between the tip side and ground and those with stations digits 6 to 0 will have their ringers connected between the ring side and ground.

When the called party answers, relay TR is operated and, at its front contact 163, short circuits relay RI for releasing this relay. The release of relay RI opens up the circuit to the ringing current source at front contacts 152 and 159 and extends the circuit of the called line through back contacts 152 and 159 to relay AB. Talking current is supplied to the called line through the windings of relay AB, talking current is supplied to the calling line through the

windings of relay 2CB and these two lines are inductively connected for conversation by way of condensers 143 and 164.

Relay AB reverses the current to the calling line for the purpose of providing supervision, coin box operation and the like. Release of the connection is controlled by the calling party. Opening the circuit of the calling line effects the release of relays 2CB, 2SA and SAP in sequence. Relay SAP disconnects positive battery from the control conductor at contact 85, which effects the release of relays RV (if this relay is operated), CRL, CRLP, C1 (or any other counting relay left operated), the cut-off relay of the called line or relay BY in the event that the called line was found to be busy. The circuits of relays TC3 (or any other tens connecting relay which was operated), UC2 (or any other units connecting relay which was left operated), TF1 and TF2 are opened at front contact 118 of relay SAP for effecting the release of these relays. Relay C1 is released by the opening of front contact 95 of relay SAP and relay AB is released either by the hanging up of the called party or by the release of relay C1 and the consequent opening of its contacts 153 and 158.

Referring to Figure 13, it will be observed that the first selector can select connector groups, after which the selected connector in the selected group is operated as above described to select the called station. It will also be noted that the first selector can, by dialing the proper first digit, select a reverting call circuit. It will be understood that more than one reverting call circuit may be provided to meet the requirements of traffic. It will now be assumed that the calling party desires connection with a station on the same line, which requires the dialing of #9 for the first digit to select the reverting call circuit shown in Fig. 12. It will also be assumed that the calling subscriber first dials the station of the calling telephone (#0), then dials the station of the called telephone (#2) and then hangs up the receiver. In describing the operation of the circuits relating to this feature of the present invention, it will be obvious from the example assumed how other digits corresponding to other calling and called stations may be dialed for selecting other combinations of ringing frequencies.

Referring to Figs. 11 and 12, it will be assumed that the tip, ring and sleeve conductors of the calling line are connected to the tip, ring and sleeve conductors of the reverting call circuit by way of selector contacts 165, 166 and 167 of Fig. 4. This means that the calling line will be extended by way of conductors 168, 169 and 170 to the incoming end of the circuits illustrated in Fig. 11. The closed circuit across the calling line effects the operation of relay 3CB over the line conductors of the calling line which extend through back contacts 171 and 172 of relay 3RI. Relay 3CB closes a circuit at its front contacts 173 for operating 3SA and relay 3SA closes a circuit at contact 174 for operating relay 3SAP. Relay 3SAP at its front contact 175, applies positive battery to conductor 3AL for making this reverting call circuit busy in a manner which will be understood from the previously described operation of the allotter circuit relays.

A circuit is now closed for operating relay 3CX which extends from positive battery, front contact 135 of relay 3SAP, back contact 177 of relay 3CRLP, conductor 178, back contacts of all the counting relays in series, including relays 3C6 to 3C1 inclusive, and winding of relay 3CX to negative battery. When the calling subscriber transmits the 10 impulses corresponding to the station digit of the calling telephone, relay 3CB is intermittently released 10 times, followed by the energization of this relay for a comparatively long time interval. The first release of relay 3CB closes an operating circuit for relay 3C1 which extends from positive battery, back contact of 173 of relay 3CB, front contact 179 of relay 3SA, back contact 180 of relay 3TF2, conductor 181, front contact 182 of relay 3CX and winding of relay 3C1 to negative battery. Relay 3C1 is locked operated over the previously described circuit from positive battery from front contact 176 of relay 3SAP and now by way of front contact 183 of relay 3C1. The release of relay 3CX at this time is prevented because of a locking circuit extending through front contact 176 of relay 3SAP, back contact 184 of relay 3CB, conductor 185, front contact 186 and winding of relay 3CX to negative battery.

At the end of the first impulse this locking circuit for relay 3CX is opened at back contact 184 of relay 3CB is released. At the beginning of the second impulse, the release of relay 3CB establishes a locking circuit for relay 3C1 through back contact 184 of relay 3CB, back contact 186 of relay 3CX and front contact 187 of relay 3C1 to its winding. Relay 3C2 is operated over the above described circuit including conductor 181, back contact 182 of relay 3CX and front contact 188 of relay 3C1. Relay 3C2 closes a locking circuit for itself at front contact 189 and, at this back contact, opens one locking circuit for relay 3C1 but the above described other locking circuit prevents the release of relay 3C1 at this time.

It is not believed necessary to point out in detail the circuit operation for all of these counting relays, since it is the same as that explained in connection with the operation of the counting relays of the connector link, with the exception that 6 counting relays are used in the reverting call circuit to count 10 impulses instead of 10 counting relays as used in the connector link circuit. Consequently, the operation is modified so that relays 3C1 to 3C5 inclusive are used to select channels in response to the first 5 digits, then relay 3C6 is operated and the first 5 relays are used over again to select the second 5 channels in response to digits over 5.

When relay 3CB releases at the beginning of the sixth impulse, relay 3C6 is operated over an obvious circuit including pick-up conductor 191 and at the end of this sixth impulse, relay 3C5 is released. With relay 3C5 released, a circuit is completed for again operating relay 3CX which extends from positive battery on conductor 173, front contact 190 of relay 3C6, back contact 191 of relay 3C5 and over the previously described circuit to the winding of relay 3CX. Relay 3C6 is maintained locked during the transmission of the last 5 impulses over a circuit including conductor 178 and front contact 192. Consequently the transmission of the last 5 impulses is effective to again operate the first 5 counting relays. If only 5 impulses are transmitted, the counting relay operation will be stopped with relay 3C5 operated. If 6 impulses are transmitted, the counting relay operation will be stopped with relays 3C6 and 3CX operated and with relay 3C5 released. With 10 impulses transmitted, the counting relay operation will be stopped with relays 3C6 and 3C1 operated and with the other counting relays released.

After the transmission of the first digit into the reverting call circuit, the record is transferred to the register relays, R1 to R6 inclusive. In the present example, with 10 impulses transmitted and with counting relays C4 and C6 operated, the corresponding register relays R4 and R6 will be operated. The circuit for effecting the operation of these register relays will now be described.

At the beginning of the transmission of the first digit as above described, a circuit is closed for operating relay 3CHO, including conductor 181, which was energized to operate the first counting relay at the beginning of this digit. Relay 3CHO closes a circuit for operating relay 3CRL which extends from positive battery, front contact 176 of relay 3SAP, winding of relay 3CRL, front contact 193 of relay 3CHO and resistance 194 to negative battery. A circuit is now closed for operating relay 3CRLP which extends from positive battery, front contact 176 of relay 3SAP, front contact 195 of relay 3CRL and winding of relay 3CRLP to negative battery.

At the end of the first series of impulses, relay 3CHO is released and a circuit is closed for operating the register relay which was selected by the counting relay left operated. Since it was assumed that ten impulses were transmitted and counting relays C4 and C6 were left operated, register relays R4 and R6 will be operated, the circuit for operating relay R4 extending from positive battery, front contact 176 of relay 3SAP, winding of relay 3CRL, back contact of the make-before-break spring combination 193 of relay 3CHO, front contact 196 of relay 3CRL, back contact 197 of relay 3TF1, conductor 198, front contact 199 of relay 3C4 and winding of relay R4 to negative battery. Since the winding of relay 3CRL is included in this circuit, this relay remains operated until a short time later. The circuit for operating relay R6 includes that above described circuit including conductor 198, by way of front contact 206 of relay 3C6 and winding of relay R6 to negative battery. The closure of front contacts 207 and 208 of relays R4 and R6 completes locking circuits for these two relays which includes conductor 209 and extends by way of back contact 210 of relay 3TF1 and front contact 211 of relay 3CRLP to positive battery at front contact 212 of relay 3SAP. This circuit to positive battery at contact 212 extends back to the right hand terminal of relay 3CRL by way of conductors 209 and 198, and since this relay has positive battery on its left-hand terminal from front contact 176 of relay 3SAP, it is short-circuited and released. The release of relay 3CRL opens its front contact 195 to effect the release of relay 3CRLP. During the interval between the release of relay 3CRL and the release of relay 3CRLP, front contact 213 of relay 3CRL is opened before back contact 177 of relay 3CRLP is closed and this removes positive battery from conductor 178 to effect the release of the operated counting relays. Now when relay 3CRLP releases and closes its back contact 177, positive battery is again applied to conductor 178 for operating relay 3CX to prepare the counting relay circuit for the next digit.

Before relay 3CRLP releases, the above described connection to positive battery on conductor 209 appears on both terminals of the winding of relay 3TF1. When relay 3CRLP releases and opens its contact 211, this positive battery is removed from the right-hand terminal of relay 3TF1 and this relay operates in series with the operated register relays. It will be apparent that any other combination of impulses for the first digit dialed will operate other combinations of counting relays and leave the combination operated which corresponds to the number of impulses in the digit and, at the end of the series of impulses, the combination of register relays will be operated which corresponds to the combination of counting relays left operated. This also applies to the second digit dialed, which digit corresponds to that of the called telephone, and in this example it will be assumed that the station digit of the called telephone is #2.

The transmission of the two impulses effects the operation and release of counting relay 3C1 and the operation of counting relay 3C2 which remains operated after this series of impulses has been transmitted. Relays 3CHO, 3CRL, and 3CRLP are operated and released in sequence as before. When relay 3CHO releases, a circuit is closed from positive battery, front contact 176 of relay 3SAP, winding of relay 3CRL, back contact of the make-before-break combination 193 of relay 3CHO, front contact 196 of relay 3CRL, front contact 214 of relay 3TF1 and winding of relay 3TF2 to negative battery. Relay 3TF2 operates and closes a locking circuit for itself which includes its own front contact 215 and front contact 212 of relay 3SAP. This connection to positive battery also extends back to the winding of relay 3CRL for releasing this relay and the release of relay 3CRL effects the release of relay 3CRLP.

During the interval between the release of relay 3CRL and the release of relay 3CRLP, the counting relay left operated is not released this time because front contact 216 of relay 3TF2 maintains positive battery on conductor 178. Since the station digits corresponding to the calling and called telephones have now been registered, the next operation is for the calling subscriber to hang up the receiver. This effects the release of relays 3CB and 3SA in sequence.

Ringing relay 3RI is now operated over a circuit extending from positive battery, winding of relay 3SAP, back contact of make-before-break spring combination 174 of relay 3SA, winding of relay 3RI, front contact 217 of relay 3TF2 and resistance 218 to negative battery. Since relay 3SAP is included in the above described operating circuit for relay 3RI, the 3SAP relay will be maintained energized for holding the line, finder and selector and for making this reverting call circuit busy.

A circuit is now closed for ringing the telephone of the calling station, which telephone is selectively responsive to the ten impulses and the consequent operation of register relays R4 and R6. This selection by the first ten impulses selects 66 cycle current and applies it to the tip side of the line, the return circuit to positive battery being by way of the ring side of the line. This ringing circuit may be traced from the source of the 66 cycle ringing current, front contact 219 of relay R4, front contact 220 of relay R6, back contact 221 of switching relay SW, conductor 222, winding of trip relay 3TR, front contact 171 of relay 3RI, conductor 170 and thence by way of the selector and finder circuits to the tip side of the line, through the substation ringer, back over the ring side of the line and by way of the selector and finder circuits to conductor 169, front contact 172 of relay 3RI, conductor 223, back contact 224 of relay SW and front contact 225 of relay R6 to positive battery.

It is believed unnecessary to point out in detail all of the combinations of relay operations for selecting other frequencies and for connecting these frequencies over the tip or ring conductors of the line. The chart illustrated in Fig. 11A shows that, when from one to five impulses are transmitted, the corresponding counting relays are left operated and by referring to the contacts of the counting relays, as well as those of the register relays, it will be seen that circuits are extended from the five frequencies 16 to 66 cycles inclusive to the ring side of the line by way of conductor 169. With register relay R5 operated, the 16 cycle generator is connected by way of the back contacts of the first four register relays in series and then by way of front contact 220 of relay R5 and over the remainder of the circuit already described to the tip side of the line. Further, it will be noted that the next four frequencies are selected and applied to the tip side of the line in response to the operation of relays 1, 2, 3 and 4 in combination with relay 6, as indicated in Fig. 11A.

The 66 cycle current, over the above described circuit, rings the bell of the calling station and when the reverting call interrupter contact RCI is closed, a circuit is completed through this contact and by way of front contact 226 of relay 3RI for operating relay SW. This connects the frequency selected in response to the called station digit, which in the above example was #2 and which left counting relay 3C2 operated. Consequently, a circuit is closed from the 30 cycle generator common by way of front contact 227 of relay 3C2, back contact 228 of relay 3C3, back contact 229 of relay 3C4, back contact 230 of relay 3C5, back contact 231 of relay 3C6, front contact 224 of relay SW, conductor 223, front contact 172 of relay 3RI and conductor 169 to the ring side of the line, the return circuit being by way of conductor 170, front contact 171 of relay 3RI, winding of relay 3TR, conductor 222, front contact 221 of relay SW and back contact 232 of relay 3C6 to positive battery.

Since the reverting call interrupter contact is intermittently operated for intermittently operating relay SW, the calling and called station bells are alternately rung. When either party responds, the direct current path across the telephone line is effective to operate relay 3TR which, at its front contact 233, short-circuits and releases relay 3SAP. Relay 3SAP, at its front contact 234, opens the holding circuit to the sleeve conductor, including conductor 168, which extends to positive battery by way of back contact of make-before-break combination 235 of relay 3TM. This effects the release of the selector and finder to which the calling line was connected, as well as the release of the lockout relay LO of this line. When the lockout relay releases, the double wound line relay is connected across the calling line and it operates to maintain the cut-off relay associated with this line in its operated position, before it has had time to release, due to its slow acting characteristics. Talking battery is supplied to the line through the windings of the line relay and, since the finder has been released, no circuit is held in use during a reverting call talking connection, except that of the individual line. Relay LO is maintained deenergized because current flows through its windings in opposition, over a circuit extending from positive battery, front contact 25 of relay LR, front contact 26 of relay CO, lower winding of relay LO, winding of relay CO and upper winding of relay CO to negative battery. This maintains relay CO operated and applies positive battery to sleeve conductor S for making this line busy. When both parties hang up, relay LR releases to restore the line circuit to normal. Common reverting call signal relay RC is operated when one or more lines are locked out on a reverting call, over a circuit extending from positive battery, winding of relay RC, front contact 23 of relay CO, front contact 24 of relay LR and upper winding of relay LO to negative battery. The contacts of relay RC may be used to light a lamp or to control any desired signal circuit.

The release of relay 3SAP removes positive battery from allotter conductor 3AL at front contact 175 for rendering this reverting call circuit again selectable. The opening of contact 212 of relay 3SAP effects the release of relays 3TF2, 3TF1, R4 and R5. The opening of front contact 176 of relay 3SAP effects the release of relays 3C4 and 3C5. Relay 3TR is released when the finder or selector disconnects the line circuit from the reverting call circuit.

The circuits of this invention are arranged for two separate time release features. The first is an arrangement whereby a line with a permanent signal is automatically released from a link circuit, such as the connector link of Figs. 5 and 6, after a predetermined time interval. The second time release feature relates to a conversation time release, that is, after a predetermined interval, say five minutes, a warning tone is given to the subscriber and then after an additional one minute, they are automatically released from the link circuit. The common time release circuit, as shown in Figs. 8 and 9, illustrates the common conversation time release arrangement operating in connection with the counting relays and certain other relays which are assumed to be the same relays shown in Figs. 5 and 6. In other words, when conversation time release is desired it is connected into the circuits of Figs. 5 and 6 in the manner illustrated in Fig. 9.

The first or permanent signal time release arrangement will now be described. When a link is seized, such as the connector link of Fig. 5 or the reverting call circuit of Figs. 11 and 12, positive battery is connected to the timer start conductor 205 by way of a front contact of the SAP relay, such as front contact 236 of relay SAP or front contact 266 of relay 3SAP, and this positive battery on conductor 205 is effective to operate the timer start relay TSR which, at its front contact 237, closes a circuit for operating the timer motor. Positive battery is connected through front contact 238 to cam CM1 which is controlled by the timer motor and which is closed every 2¼-minutes for approximately 2 seconds.

It will be convenient to refer to the connector link of Fig. 5 for describing the method of controlling the release of a line when it is to be released by the 2¼-minute timer. When the connector is first seized and relay SAP operates, a circuit is closed at front contact 239 of relay SAP which connects relay 2TM to conductor 204. At the beginning of each 2¼-minute interval, the interrupter cam closes a circuit for operating relay TSA and this relay closes an obvious circuit at its front contact 240 for operating relay TSAP. Relay TSA releases at the end of the 2¼-minute interval and connects positive battery through its back contact 240 to conductor 204 by way of front contact 241 of relay TSAP.

If the call has not been answered, back contact 242 of relay AB will be closed and relay 2TM will be operated by the application of positive battery to conductor 204. The operation of relay 2TM transfers the holding circuit of the sleeve conductor, including conductor 88, from positive battery at the back contact of make-before-break spring combination 244 of relay 2TM, to conductor 203 which has positive battery connected to it at back contact 245 of relay TSA. Relay 2TM also transfers the circuit extending to its winding from conductor 204 to positive battery at front contact of the make-before-break combination 246 of relay 2TM, for locking this relay when it is once operated. Consequently, when relay TSA releases at the beginning of a 2¼-minute interval, positive battery is applied to conductor 204 for operating relay 2TM, but at this same time positive battery is applied to conductor 203 at back contact 245 for holding the connection to the line. At the beginning of the next 2¼-minute interval, the operation of relay TSA opens up the circuit to positive battery on conductor 203 and this effects the release of the connection. It will thus be seen that, when a connector link or the like is being used without the call being answered at the beginning of a 2¼-minute interval, the associated 2TM relay is operated and locked and the substitute holding circuit is connected to the sleeve or holding circuit by way of conductor 203 and if this condition is maintained, that is, without the circuit of the 2TM relay being opened during the next 2¼-minute interval, then the removal of positive battery from conductor 203 effects the release of the connection. It is believed obvious how the circuits of other connector links, selector links or reverting call circuits, will operate in a like manner by means of the operation of the associated 2TM or 3TM relays. The removal of positive battery from the holding circuit effects the release of relay LO and the energization of relays LR and CO of the line circuit, as long as the permanent condition exists, all in the same manner previously described in connection with the locking out of the line circuit on a reverting call.

It will now be explained how the conversation time release operates. The 2TM relay of Fig. 5 is again illustrated in Fig. 9 and an additional timer relay 6TM is used for the conversation time release. Likewise, the AB, the SAP and the counting relays of Fig. 6 are reproduced in Fig. 9.

When the connector link is seized, the closure of front contact 239 of relay SAP effects the operation of relay 2TM as before, since the winding of relay 2TM is extended through back contact 247 of relay 6TM, back contact 248 of relay AB, back contact of make-before-break spring combination 246 of relay 2TM, back contact 249 of relay 6TM to conductor 204. If the call is answered before relay 2TM is operated over this circuit, the operation of relay AB opens up the above described circuit at its back contact 248 and extends conductor 204 by way of front contact 248 to front contact 247 of relay 6TM. This disables the first time release circuit and brings the conversation time release feature.

The operation of relay AB closes a circuit for operating relay 6TM which extends from positive battery on conductor 17 of the connector link, front contact 250 of relay AB and winding of relay 6TM to negative battery. The holding circuit for the finder and selector, including conductor 10, now extends to positive battery by way of the back contact of the make-before-break spring combination 244 of relay 2TM. Relay 2TM is operated over a circuit extending from positive battery at front contact 252 of relay CTR, conductor 200, front contact 249 of relay 6TM, back contact of the make-before-break combination 246 of relay 2TM, front contact 248 of relay AB, front contact 247 of relay 6TM, front contact 239 of relay SAP and winding of relay 2TM to negative battery. This circuit is closed at the beginning of the ¾-minute interval when the cam CM2 is closed for operating relay CTR. Relay 2TM closes a locking circuit for itself at the front contact of the make-before-break combination 246 and at the front contact 244 of relay 2TM the holding circuit, including conductor 10, is transferred from positive battery to positive battery through the counting relay contacts over a circuit which extends through front contact 253 of relay 6TM, back contact 254 of relay C8, back contact 255 of relay C9, back contact 256 of relay CO and conductor 17, to which positive battery is connected at front contact 95 of relay SAP of the connector link. This means that positive battery will be held on holding conductor 10 until relay C8 is operated to open its back contact 254 and this is accomplished in a manner which will now be explained.

It will be recalled that relay TR of Fig. 5 is momentarily operated when the called party answers. The operation of relay TR effects the release of the counting relay which was left operated to select the ringing frequency. This is accomplished by opening up the locking circuit, including conductor 17, at back contact 268 of relay TR. Then when contact 268 again closes, conductor 17 is again energized and relay CX is operated. When the ¾-minute interrupter cam CM2 closes its contact for operating relay CTR, a circuit is closed at its front contact 257 for operating relay CC. Relay CC, at its front contacts 258 and 259, applies positive battery to conductors 201 and 202 which lead to front contacts 260 and 261 of the 6TM relay associated with the link which is in use. It will be understood that there are enough contacts on the CC relay to apply positive battery to individual conductors similar to 201 and 202 associated with each link.

At each energization of conductors 201 and 202, circuits are completed through front contacts 260 and 261 of relay 6TM for stepping the counting relays in the manner which has already been explained by means of circuits including conductors 11 and 15 and 17. This means that a counting relay will be operated every ¾-minute and at the end of the seventh ¾-minute (5¼ minutes) counting relay C7 will be operated and shortly thereafter counting relay C6 will be released. During this interval, a tone is connected to the conversation circuit by way of front contacts 262 and 263 of relays C7 and C6 respectively and contacts 264 and 265 of relays 2TM and AB respectively, this tone being interrupted when relay C6 releases. If the connection is not released at the beginning of the next ¾-minute interval, the operation of relay C8 opens its back contact 254 to remove positive battery, which is on conductor 17, from the circuit leading through front contact 253 of relay 6TM and front contact 251 of relay 2TM to holding conductor 10. This effects the release of the connection in the previously described manner and the closed circuit across the lines of the released stations being effective to lockout those line circuits by operat-

ing the line and cut-off relays, as previously described.

These circuits are arranged to start the harmonic ringing machines when common start conductor 20 is energized, calling for ringing current. They are arranged for five frequency harmonic ringing and function to automatically transfer the ringing and control circuits from machine #1 to machine #2 if machine #1 fails to deliver all five frequencies when the common start conductor is energized.

The circuits are also arranged to transfer the control circuits from the #2 machine to the #1 machine if the #2 machine fails to deliver all five frequencies. The circuits are further arranged to check the continuity of the ringing interrupter contacts for all five frequencies and will send a major alarm if any of these contacts are open for a predetermined time interval after the common start conductor is energized. In addition to this, when the #1 machine fails to deliver five frequency ringing current, a lamp is lighted and remains lighted until the #1 machine is restored to service by a manual operation of a release key. When both machines fail, a major alarm is sent and also when a contact of any of the ringing interrupters is open for a predetermined time after the common start conductor is energized, a major alarm is sent.

Another feature of this circuit is that the #2 machine may be switched into circuit by the operation of a manual transfer key. With this key operated the #2 machine will function and in the event of failure of the ringing supply from this machine, the #1 machine will be automatically switched into circuit. Furthermore, the circuits are so arranged that an operator can dial a first or a second special number for switching in ringing machine #1 or #2 and an audible indication will be given as to which machine is switched in.

The operation will now be explained for the condition where the #1 machine is started in response to a call and with all circuits functioning properly. When a connector link, or other link requiring ringing current is seized, the common start conductor 20 is energized, which provides sufficient time for the circuit operation of the various relays, before the link or other circuits progress to the position calling for ringing current.

When the common start conductor 20 is energized, a circuit is closed through back contacts 300 and 301 of relays TF and STK for operating relay SA. Relay SA closes a circuit at its front contact 302 for operating relay SAP and relay SAP closes a circuit at its front contact 303 for operating relay STK, the latter relay being slow to operate. Relay SAP also closes a circuit at its front contact 304 for operating relay XSA and relay XSA closes a circuit at its front contact 305 for operating relay XSAP. The operation of relay STK closes a locking circuit for itself at front contact 301 and opens the circuit of relay SA at back contact 301, which effects the release of relays SA and SAP, with relay STK remaining operated. The release of relay SA completes a circuit from positive battery, front contact 306 of relay STK, back contact 307 of relay SA, back contact 308 of relay TF, for energizing the motor magnets of the #1 machine by way of their self-interrupting contacts. Relay LD1 is operated over a circuit extending from positive battery, front contact 309 of relay XSAP, back contact 310 of relay TF and winding of relay LD1 to negative battery.

The release of relay SAP opens front contact 304 which effects the release of relay XSA and it will now be assumed that current of all five frequencies from the #1 machine is supplied to the non-interrupted generator commons 280 to 284 inclusive, with the result that relays 16NI, 30NI, 42NI, 54NI and 66NI will be energized. This completes a circuit through front contacts 311, 312, 313, 314 and 315 for operating relay 2SA and the latter relay, at its front contact 316, energizes relay XSAP before it has time to release after the release of relay XSA. Relay TFC is energized by the release of relay SAP over a circuit extending from positive battery, back contact 304 of relay SAP, front contact 322 of relay STK, front contact 323 of relay XSAP, back contact 327 of relay TF and winding of relay TFC to negative battery. Relay TFC performs no function on this class of call. The operation of relay LD1 connects the five frequencies from the #1 machine to non-interrupted generator commons by way of front contacts 317, 318, 319, 320 and 321. Under this condition, that is, the #1 machine being started and functioning to supply all five frequencies, the alarm or transfer circuits do not function. When all links are released and the common start conductor 20 is deenergized, relay STK is released and this effects the release of relay TFC by opening front contact 322. The release of relay STK and the opening of its contact 306 stops the #1 converter, which in turn releases relays 16NI to 66NI inclusive. This releases relay 2SA and this relay in turn releases relay XSAP. The release of relay XSAP releases relay LD1 for disconnecting the #1 machine five frequencies from the non-interrupted generator commons. The circuits are now in normal condition awaiting the next energization of the common start conductor.

It will now be assumed that the common start conductor 20 is energized and that the #1 machine fails to supply one or more frequencies to the generator commons. The same relay operations as above described are now effected, except that the series circuit through the front contacts of the NI relays is not completed, with the result that relay 2SA is not energized. This effects the release of relay XSAP when relay XSA releases, as an indication of failure of the #1 machine. A circuit is now closed through back contact 304 of relay SAP, front contact 322 of relay STK, back contact 323 of relay XSAP, back contact 324 of relay TF and winding of relay 1F for operating this latter relay. Relay 1F closes a circuit at its front contact 325 and by way of back contact 326 of relay 2F for energizing relay TF and this latter relay opens the locking circuit of relay STK at back contact 300, permitting relay STK to release. The release of relay XSAP, as previously described, effects the release of relay TFC by opening front contact 323 and after relay TFC is released a circuit is closed through front contact 300 of relay TF, back contact 328 of relay 2F and back contact 329 of relay TFC for again operating relay SA to put the circuit through another cycle.

During the next cycle of relay operations, the release of relay SA closes the circuit for running the #2 machine by way of front contact 308 of relay TF. The operation of relay XSAP closes a circuit through front contact 310 of relay TF for operating relay LD2 which connects the five fre-

quencies from the #2 machine to the non-interrupted generator commons by way of front contacts 330 to 334 inclusive. If the #2 machine properly supplies all five frequencies, the series circuit through the front contacts of relays 16NI to 66NI inclusive will be completed for energizing relay 2SA for holding relay XSAP before it has time to release after the release of relay XSA. It will be observed that the operation of the manual transfer key (locking) will energize relay TF for switching the circuits in the same manner as above explained, so that the energization of common start conductor 20 will effect the operation of the #2 machine.

It will now be assumed that the #2 machine fails to deliver its five frequencies when operated as above described. This means that relay 2SA will not be energized for holding relay XSAP when the #2 machine is started. A circuit will now be closed from positive battery, back contact 304 of relay SAP, front contact 322 of relay STK, back contact 323 of relay XSAP, front contact 324 of relay TF, back contact 335 of relay TFC and winding of relay 2F to negative battery. This energizes the 2F relay, which locks and lights the #2 machine failure lamp 2FL at front contact 336. Since both the 1F and 2F relays are now energized, a major alarm is sent over a circuit including front contacts 337 and 338 of relays 2F and 1F. Relay 2F may be released by operating the manual release key after the trouble has been repaired, which operation opens the locking circuit through front contact 339 of relay 2F. The operation of relay 2F opens the circuits for relays TF and STK, which effects the release of these two relays. The energized common start conductor 20 now effects the reenergization of relay SA and the relays go through another cycle, this time trying to start machine #1 again. This is because relay TF is deenergized and the circuits are completed to the #1 machine and its control relays. In the event that the #1 machine functions properly, relay 2SA is energized for holding relay XSAP and the circuits will be released ready for another cycle when common start conductor 20 is deenergized. The major alarm remains in effect because the 1F and 2F relays are both held energized until the manual release key is actuated.

From the above it will be seen that relays 16NI to 66NI check the generator current from all five frequencies and control the change-over from machine #1 to machine #2 in the event that machine #1 fails to function properly. Furthermore, in the event that machine #2 fails to function properly, an attempt will be made to again start the #1 machine each time the circuits call for ringing generator.

It will now be explained how a major alarm is transmitted in the event of an open contact at one or more of the common ringing interrupters, when the circuits call for interrupted ringing current. Relays 16I to 66I inclusive are connected to the interrupted generator commons and will be energized through front or back contacts of the associated interrupter cams. Each one of these relays controls the operation of a slow releasing repeater relay (16P, 30P, 42P, 54P and 66P), the circuits to these latter relays being completed only when relay STK is energized and has its front contact 340 closed. This is for preventing their energization when no link circuits are in use. If, when interrupted ringing current is called for, all of these repeater relays are energized, a circuit is completed through their front contacts 341 to 345 inclusive for energizing relay IGP and this relay opens the circuit to the major alarm. In the event that some interrupter cam contact fails to make, the associated I relay will be deenergized and the associated repeater relay will be released for releasing relay IGP. The major alarm circuit is now closed through back contact 303 of relay SAP, front contact 346 of relay STK, back contact 347 of relay XSA and back contact 348 of relay IGP. This circuit to the major alarm is not prepared until relays SAP and XSA are released, after relay STK is operated. This provides a delay in closing the circuit to the major alarm to give relay IGP time to operate after the ringing interrupter is started.

Relays S1 and S2 are to provide means whereby the toll operator can control and check the ringing machine operation. With machine #1 operating, relay TF is normal and a circuit is closed through back contact 349 of relay TF for operating relay S1. This circuit extends positive battery to the sleeve terminal S971 of #971, so that the operator will get a busy signal when this number is dialed as an indication that machine #1 is operating. With machine #2 operating, relay TF is operated and positive battery is removed from the winding of relay S1 and terminal S971, which releases relay S1 and renders #971 idle. Relay S1 closes a circuit at its back contact 350 for operating relay S2 and for making #981 busy. Relay S2 closes a circuit at its front contact 351 for operating relay 1F, which transfers to machine #2 as above described. The operator now gets a busy signal when dialing #981 as an indication that machine #2 is operating. She may now transfer to machine #1 by dialing #971 and operating relay S1, which places the control relays in normal condition, as shown, by releasing relays S2, 1F and TF.

What I claim is:

1. In a telephone system, a group of lines divided into a first and a second subgroup, a first and a second subgroup of line finders each having access to the lines in said first and second subgroups of lines respectively, a first and a second subgroup of allotter relays individually corresponding to said line finders, means including said allotter relays for normally assigning idle line finders in the associated subgroup, and time delay means for causing the allotter relays in one of said subgroups to assign an idle line finder for use in the other of said subgroups.

2. In a telephone system, a group of lines divided into a first and a second subgroup, a first and a second subgroup of line finders each having access to the lines in said first and second subgroups of lines respectively, a first and a second subgroup of allotter relays individually corresponding to said line finders, means responsive to a calling condition on a line in said first subgroup for causing said allotter relays to normally assign idle line finders in said first subgroup, a time delay device, and means including said time delay device and responsive to a calling condition on a line in said first subgroup for causing said allotter relays to assign idle line finders in said second subgroup.

3. In a telephone system, a group of lines divided into a first and a second subgroup, a first and a second subgroup of line finders each having access to the lines in said first and second subgroups of lines respectively, a first and a second subgroup of allotter relays individually corresponding to said line finders, means responsive to a calling condition on a line in said first sub-

group for causing said allotter relays to normally assign idle line finders in said first subgroup, a time delay device, means including said time delay device and responsive to a calling condition on a line in said first subgroup for causing said allotter relays to assign idle line finders in said second subgroup, and means including the allotter relays of a particular line finder in said second subgroup for causing said allotter relays to re-assign idle line finders in said first subgroup.

4. In a telephone system, a group of lines divided into a first and a second subgroup, a first and a second subgroup of line finders each having access to the lines in said first and second subgroups of lines respectively, a first and a second subgroup of allotter relays individually corresponding to said line finders, means responsive to a calling condition on a line in said first subgroup for causing said allotter relays to normally assign idle line finders in said first subgroup, a time delay device, means including said time delay device and responsive to a calling condition on a line in said first subgroup for causing said allotter relays to assign idle line finders in said second subgroup, means including the allotter relays of a particular line finder in said second subgroup for causing said allotter relays to re-assign idle line finders in said first subgroup, and additional means including said time delay device for rendering a particular finder in said first subgroup non-assignable when said allotter relays have re-assigned idle line finders in said first subgroup.

5. In a telephone system, telephone lines, a line circuit for each line including line, cut-off and lockout relays, means responsive to a calling condition on said line for operating said line relay, marker relays common to a plurality of said lines, means responsive to the operation of said line relay for operating one of said marker relays and said lockout relay, means responsive to the operation of said line and lockout relays for operating another of said marker relays, control means responsive to the operation of said marker relays in combination for effecting the operation of said cut-off relay, means responsive to the operation of said cut-off relay for effecting the release of said line relay, and means including said control means for maintaining said lockout relay operated after the release of said line relay.

6. In a telephone system, telephone lines, a line circuit for each line including line, cut-off and lockout relays, means responsive to a calling condition on said line for operating said line relay, marker relays common to a plurality of said lines, means responsive to the operation of said line relay for operating one of said marker relays and said lockout relay, means responsive to the operation of said line and lockout relays for operating another of said marker relays, control means responsive to the operation of said marker relays in combination for effecting the operation of said cut-off relay, means responsive to the operation of said cut-off relay for effecting the release of said line relay and said marker relays, and means including said control means for maintaining said lockout and cut-off relays operated after the release of said line relay.

7. In a telephone system, telephone lines, a line circuit for each line including line, cut-off and lockout relays, means responsive to a calling condition on said line for operating said line relay, marker relays common to a plurality of said lines, means responsive to the operation of said line relay for operating one of said marker relays and said lockout relay, means responsive to the operation of said line and lockout relays for operating another of said marker relays, control means responsive to the operation of said marker relays in combination for effecting the operation of said cut-off relay, means responsive to the operation of said cut-off relay for effecting the release of said line relay and said marker relays, means including said control means for maintaining said lockout and cut-off relays operated after the release of said line relay, means for releasing said lockout relay and reoperating said line relay, and means responsive to the reoperation of said line relay for maintaining said cut-off relay.

8. In a telephone system, telephone lines, a line circuit for each line including line, cut-off and lockout relays, means responsive to a calling condition on said line for operating said line relay, marker relays common to a plurality of said lines, means responsive to the operation of said line relay for operating one of said marker relays and said lockout relay, means responsive to the operation of said line and lockout relays for operating another of said marker relays, control means responsive to the operation of said marker relays in combination for effecting the operation of said cut-off relay, means responsive to the operation of said cut-off relay for effecting the release of said line relay and said marker relays, means including said control means for maintaining said lockout and cut-off relays operated after the release of said line relay, means for releasing said lockout relay and reoperating said line relay, and means responsive to the reoperation of said line relay for maintaining said cut-off relay operated and for maintaining said lockout relay released.

9. In a telephone system, telephone lines, a line circuit for each line including line, cut-off and lockout relays, said lockout relay being double wound, means responsive to a calling condition on said line for operating said line relay, marker relays common to a plurality of said lines, means responsive to the operation of said line relay for operating one of said marker relays and said lockout relay, means responsive to the operation of said line and lockout relays for operating another of said marker relays, control means responsive to the operation of said marker relays in combination for effecting the operation of said cut-off relay, means responsive to the operation of said cut-off relay for effecting the release of said line relay and said marker relays, means including said control means for maintaining said lockout and cut-off relays operated after the release of said line relay, means for releasing said lockout relay and reoperating said line relay, means responsive to the re-operation of said line relay for maintaining said cut-off relay operated and for maintaining said lockout relay released by differentially energizing its windings.

10. In a telephone system, a line, a line relay associated with said line, a finder link having access to said line, a link line relay associated with said finder link, means responsive to a calling condition on said line for effecting a connection between said line and said link whereby said line relay and said link line relay are connected to said line in multiple, and means for applying a booster potential to said link line relay shortly before said relays are connected in multiple.

11. In a telephone system, a line, a line relay

associated with said line, a finder link having access to said line, a link line relay associated with said finder link, means responsive to a calling condition on said line for effecting a connection between said line and said link whereby said line relay and said link line relay are connected to said line in multiple, means for applying a booster potential to said link line relay shortly before said relays are connected in multiple, and means for removing said booster potential from said link line relay shortly after said relays are connected in multiple.

12. In a telephone system, a line, a line relay associated with said line, a finder link having access to said line, a link line relay associated with said finder link, means responsive to a calling condition on said line for effecting a connection between said line and said link whereby said line relay and said link line relay are connected to said line in multiple, means responsive to the connection between said line and said link for removing the multiple connection between said line relay and said link line relay, and means for applying a booster potential to said link line relay before, during and after the establishment of said multiple connection.

13. In a telephone system, a party line, apparatus for providing currents of a plurality of different characteristics, a reverting call selector, means for connecting said party line to said reverting call selector, a plurality of counting relays associated with said reverting call selector, means controlled over said party line for operating said counting relays in response to the impulses of each of a plurality of series of impulses to record the identity of the calling and called stations on said line, a relay register associated with said reverting call selector, means controlled by the recording of the identity of one of said stations by said counting relays for transferring this record to said relay register, means for releasing said counting relays, means controlled by the recording of the identity of the other of said stations by said counting relays for maintaining this record on said counting relays and for preventing their release, and means for alternately applying currents of a first and a second characteristic to said line from said apparatus in accordance with the identity stored on said relay register and said counting relays.

14. In a telephone system, a party line, apparatus for providing currents of a plurality of different characteristics, a reverting call selector, means for connecting said party line to said reverting call selector, a plurality of counting relays associated with said reverting call selector, means controlled over said party line for operating said counting relays in response to the impulses of each of a plurality of series of impulses to record the identity of the calling and called stations on said line, a relay register associated with said reverting call selector, means controlled by the recording of the identity of one of said stations by said counting relays for transferring this record to said relay register, means for releasing said counting relays, means controlled by the recording of the identity of the other of said stations by said counting relays for maintaining this record on said counting relays and for preventing their release, means for alternately applying currents of a first and a second characteristic to said line from said apparatus in accordance with the identity stored on said relay register and said counting relays, and means controlled by said relay register and said counting relays for selectively ringing over either side of said line to ground.

15. In a telephone system, a party line, a line circuit for said party line including a line relay, a cut-off relay and a lockout relay, a line finder, means for closing and opening said line circuit, means responsive to the closing of said line circuit for operating said line relay, means responsive to the operation of said line relay for operating said lockout relay, means responsive to the joint operation of said line and lockout relays for causing said line finder to seize said party line, a reverting call selector, means controlled over said party line for associating said line with said reverting call selector by way of said line finder, means responsive to the seizure of said party line by said line finder for operating said cut-off relay and for maintaining said lockout relay operated, means responsive to the joint operation of said lockout and cut-off relays for releasing said line relay, means for sending a plurality of station selecting series of impulses over said party line to said reverting call selector, means responsive to said station selecting impulses for causing said reverting call selector to register the identity of a plurality of stations to be rung on said party line, means responsive to the opening of said line circuit for selectively ringing said plurality of stations, means responsive to the subsequent closing of said line circuit for disconnecting said line finder from said party line and for releasing said lockout relay, means responsive to the release of said lockout relay for effecting a second operation of said line relay, and means responsive to the second operation of said line relay for preventing the operation of said lockout relay and for maintaining said cut-off relay operated.

16. In a telephone system, a party line, ringing apparatus comprising first and second ringing current sources of different frequencies, a plurality of common ringing leads, means for selectively connecting said first and second sources to said common leads, means for selectively connecting said common leads to said party line for selectively ringing stations thereon, means responsive to a failure of any of the frequencies when said first sources are connected to said common leads for automatically switching said common leads from said first to said second sources, and means responsive to a failure of any of the frequencies when said second sources are switched to said common leads for automatically switching said common leads from said second to said first sources.

17. In a telephone system, a party line, ringing apparatus comprising first and second ringing current sources of different frequencies, a plurality of common ringing leads, means for selectively connecting said first and second sources to said common leads, means for selectively connecting said common leads to said party line for selectively ringing stations thereon, means responsive to a failure of any of the frequencies when said first sources are connected to said common leads for automatically switching said common leads from said first to said second sources, means responsive to a failure of any of the frequencies when said second sources are switched to said common leads for automatically switching said common leads from said second to said first sources, and means responsive to a second failure of any of the frequencies of said first sources for preventing the switching back to said second sources.

18. In a telephone system, a party line, ringing

apparatus comprising first and second ringing current sources of different frequencies, a plurality of common ringing leads, means for selectively connecting said first and second sources to said common leads, means including ringing interrupter contacts for selectively connecting said common leads to said party line for selectively and interruptedly ringing stations thereon, means responsive to a failure of any of the frequencies when said first sources are connected to said common leads for automatically switching said common leads from said first to said second sources, means responsive to a failure of any of the frequencies when said second sources are switched to said common leads for automatically switching said common leads from said second to said first sources, and means responsive to an open circuit in said interrupter contacts for operating an alarm signal.

19. In a telephone system, a plurality of lines, a switching link, a plurality of counting relays associated with said link, means controlled over one of said lines for operating said counting relays in response to the impulses of each of a plurality of series of impulses, means responsive to the operation of said counting relays in response to said series of impulses for establishing connections between said lines, a timing device, means controlled by said timing device for operating said counting relays, and means controlled by the operation of said counting relays by said timing device for automatically releasing an established connection between said lines.

20. In a telephone system, a plurality of lines, a switching link, a plurality of counting relays associated with said link, means controlled over one of said lines for operating said counting relays in response to the impulses of each of a plurality of series of impulses, means responsive to the operation of said counting relays in response to said series of impulses for establishing connections between said lines, a timing device, means controlled by said timing device for operating said counting relays, and means controlled by the operation of said counting relays by said timing device for automatically releasing an established connection between said lines and for applying a warning signal to said connection shortly before the automatic release thereof.

21. In a telephone system, a plurality of lines, a switching link, means for selectively connecting said lines to said link, a plurality of counting relays associated with said link, means controlled over a line connected to said link for operating said counting relays in response to the impulses of each of a plurality of series of impulses, means responsive to the operation of said counting relays in response to said series of impulses for establishing connections between said lines, a timing device, a supervisory relay controlled over one of said lines, means controlled by said timing device and including said supervisory relay in one position for disconnecting a line from said link within a comparatively short time interval, means controlled by said timing device and including said supervisory relay in another position for operating said counting relays, and means controlled by the operation of said counting relays by said timing device for effecting the release of a line from said link within a comparatively long time interval.

22. In a telephone system, a plurality of lines, a switching link, means for selectively connecting said lines to said link, a plurality of counting relays associated with said link, means controlled over a line connected to said link for operating said counting relays in response to the impulses of each of a plurality of series of impulses, means responsive to the operation of said counting relays in response to said series of impulses for establishing connections between said lines, a timing device, a supervisory relay controlled over one of said lines, means controlled by said timing device and including said supervisory relay in one position for disconnecting a line from said link within a comparatively short time interval, means controlled by said timing device and including said supervisory relay in another position for operating said counting relays, and means controlled by the operation of said counting relays by said timing device for effecting the release of a line from said link within a comparatively long time interval and for momentarily connecting a warning signal to an established connection a comparatively short time interval before said release.

WINFRED T. POWELL.