Feb. 27, 1945. B. A. WALLACE 2,370,335

ALLOTTER

Filed Aug. 3, 1940 3 Sheets-Sheet 1

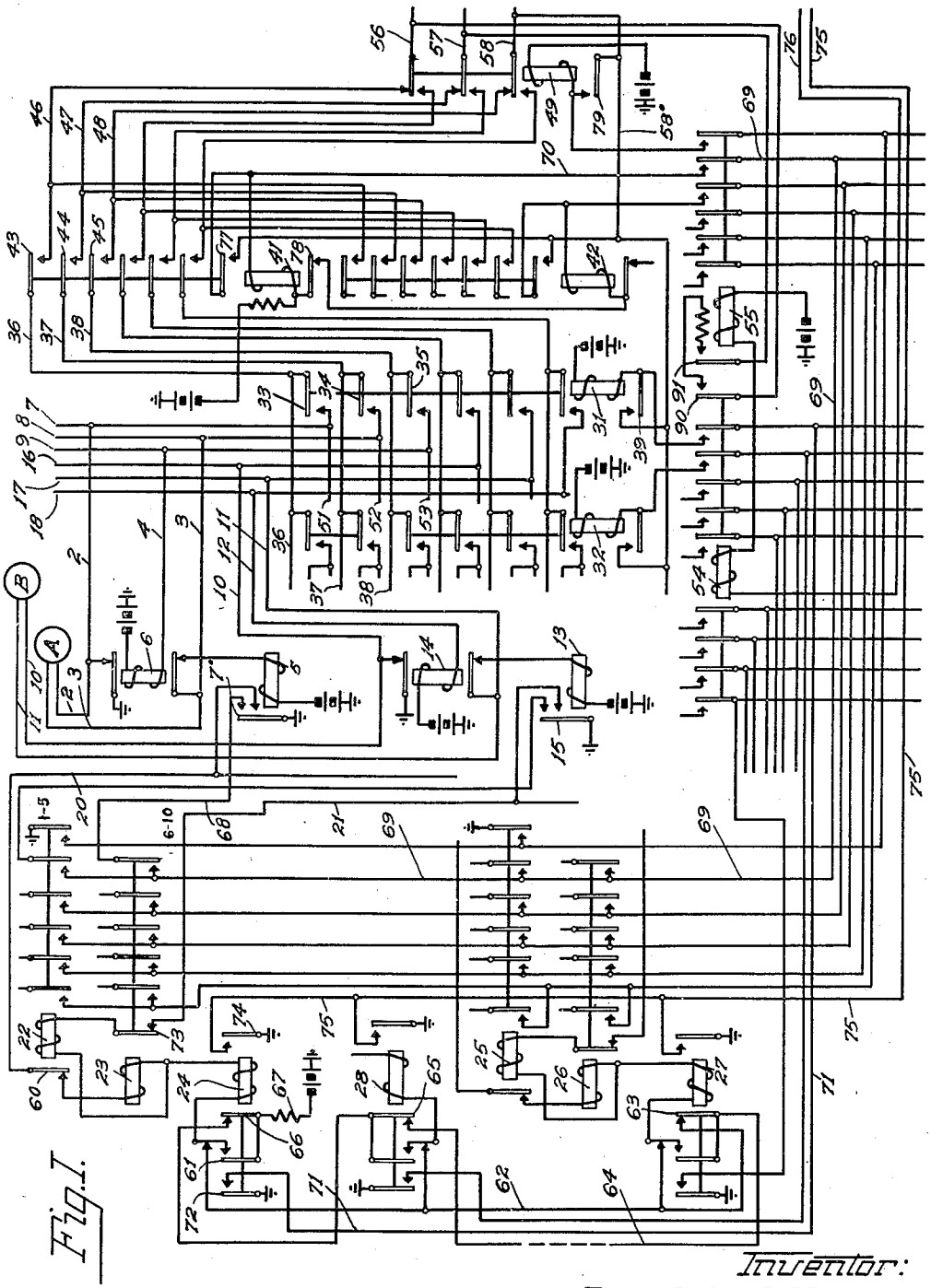

Fig. 1.

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ALLOTTER

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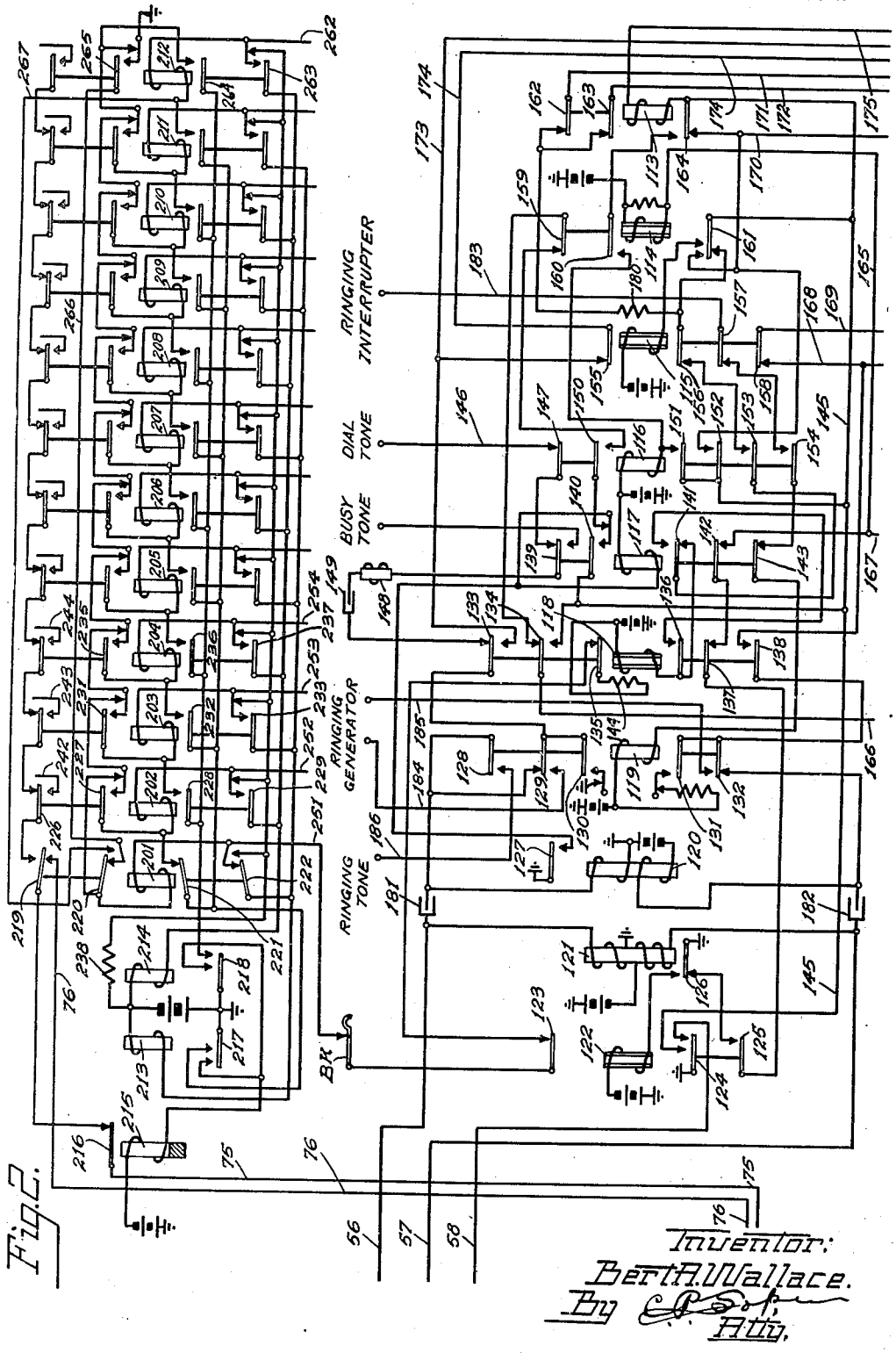

Fig. 2.

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ALLOTTER

Filed Aug. 3, 1940 3 Sheets-Sheet 3

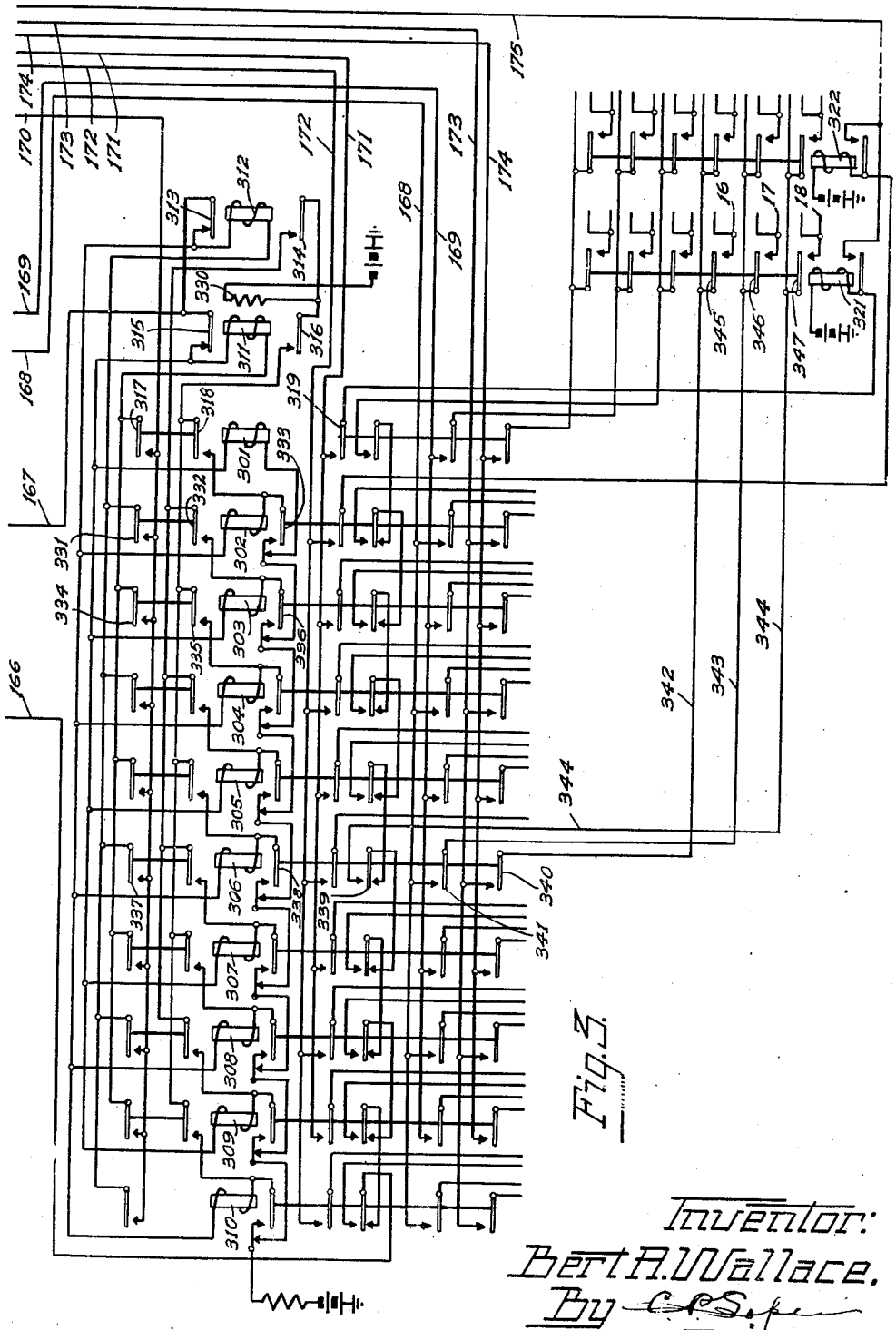

Fig. 2.

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UNITED STATES PATENT OFFICE

2,370,335

ALLOTTER

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Application August 3, 1940, Serial No. 350,222

15 Claims. (Cl. 179—18)

The present invention relates in general to automatic telephone systems, and more in particular to automatic telephone systems of the relay type, in which connections between calling and called lines are established solely by means of relays. The general object of the invention is to provide a new and improved system of this character.

The system disclosed herein is a two-digit system, having a maximum capacity of one hundred lines. Connections are established by means of link circuits, each link comprising a finder which has access to calling lines and a connector which is directively controlled over a calling line which has been connected with by the associated finder to complete the connection to the called line. Since the links are provided on a percentage basis and are common to all the lines, means must be provided for assigning idle link circuits to calling lines in a systematic manner, to the end that any calling line may be given the exclusive use of a link circuit to complete the call, so long as idle links are available.

A device for assigning link circuits as mentioned in the foregoing is commonly referred to as an allotter, and a special object of the invention is to provide a new and improved allotter, consisting entirely of relays, and adapted for use in larger systems as well as in the small system disclosed herein.

Other objects and features of the invention will be brought out in the course of the ensuing description, reference being made to the accompanying drawings, Figs. 1, 2, and 3, which show by means of the usual circuit diagrams sufficient of the apparatus and circuits involved to enable the invention to be explained and understood.

Referring to Fig. 1 of the drawings, the reference character A indicates a subscriber's station, which may be of any suitable automatic type, including a dial or calling device. The sub-station A is connected with the exchange over a line comprising conductors 2 and 3. At the exchange the line is provided with the usual line and cut-off relays 5 and 6.

A second subscriber's station is indicated at B and is connected to the exchange over the line conductors 10 and 11. The line and cut-off relays for the line of station B are indicated at 13 and 14.

As previously mentioned, the maximum capacity of the system is one hundred lines. It is customary, however, to use the digit 0 for calling an operator, which reduces the capacity of the system to ninety subscribers' lines. Although the operator's equipment is not shown herein, it may be assumed that the digit 0 is reserved for the purpose stated and that there are accordingly only ninety subscribers' lines. These lines are divided into nine groups in accordance with the first or tens digits of their telephone numbers. Thus the lines numbered from 11 to 10 constitute the first group, the lines numbered from 21 to 20, the second group, and so on.

The two lines shown in Fig. 1 are both lines of the first group. The line of station A is the first line of the group, and accordingly the telephone number is 11. The line of station B is the sixth line of the first group, and its telephone number is 16.

Associated with the first group of lines are three control relays 22, 23, and 24. Relay 24 may be referred to as a group control relay and is common to all the lines of the group. Relays 22 and 23 may be referred to as subgroup control relays. In explanation of this, it may be stated that each group of lines is divided into two subgroups, one comprising the first five lines of the group, and the other the last five lines of the group. Relay 23 is common to lines 11 to 15, constituting the first sub-group, while relay 22 is common to lines 16 to 10, constituting the second sub-group.

Each of the other groups is provided with a similar set of control relays. The drawings show the group control relay 27 and sub-group control relays 25 and 26, which are associated with the ninth group of lines. The group control relays are interconnected by guard circuits which are not readily understood from the showing of the first and last group control relays, and accordingly the drawings also shows the group control relay of an intermediate group. This is relay 28, associated with the second group of lines.

Fig. 1 also shows a finder which constitutes part of one of the link circuits used for establishing connections. This finder comprises nine tens relays such as relays 31 and 32, five units relays such as 41 and 42, a switching relay 49, and two relays 54 and 55.

The tens relay 31 is associated with the first group of lines, and is provided with ten sets of contacts by means of which the ten lines of the first group may be connected to a set of ten intermediate trunks. The drawings only show two sets of contacts on relay 31, being the sets in which the lines of stations A and B are terminated. The line of station A, for example, comprising line conductors 2 and 3, also the test conductor 4, terminates at the contact set desig-

nated by reference numerals 33, 34, and 35. The line of station A has multiple branches, as shown, the one comprising conductors 51, 52, and 53 leading to the corresponding tens relays of other finders, and the one comprising conductors 7, 8, and 9 leading to the connectors. All the other lines are similarly terminated at contact sets of their respective tens relays and are multipled to the tens relays of the other finders and to the connectors.

The drawings show two of the ten intermediate trunks above referred to, one of them being designated by reference numerals 36, 37, and 38. These trunks are multipled to the contact sets of the nine tens relays, as indicated in the drawings, and extend to contact sets on the units relays. The first and sixth intermediate trunks extend to the first units relay 41, the second and seventh intermediate trunks extend to the second units relay 42, and so on.

Each units relay is adapted to extend the two intermediate trunks terminating therein to a pair of intermediate trunks which terminate in the switching relay 49, one trunk of the pair being the one comprising conductors 46, 47, and 48. The intermediate trunk comprising conductors 46, 47, and 48 is normally connected through contacts of relay 49 to the trunk line comprising conductors 56, 57, and 58, which leads to the connector which is associated with the finder being described. The other intermediate trunk of the pair may be connected to the connector trunk by energization of relay 49.

Relays 54 and 55 are provided for temporarily connecting up the marking conductors over which the tens and units relays and relay 49 of the finder are initially energized during the establishment of a connection.

The connector is shown in the lower half of Fig. 2 and in Fig. 3, and comprises the connector control relays 113 to 122, Fig. 2, the counting relays 301 to 310, Fig. 3, with the two common relays 311 and 312, and nine tens relays of which the first two, relays 321 and 322, are shown in the drawings. Each tens relay gives the connector access to a particular group of ten lines, and for this purpose is provided with ten sets of contacts. Relay 321, for instance, is adapted to establish connections to the ten lines of the first group and has ten sets of contacts, of which only the two sets assigned to the lines of stations A and B are shown in the drawings.

The allotter is shown in the upper half of Fig. 2 and comprises relays 201 to 215. The relays 201 to 212 are individual to the link circuits, respectively, relays 213 and 214 are control relays associated with the odd and even individual relays, respectively, while relay 215 is a common control relay. Since twelve individual relays are shown, it will be understood that twelve link circuits such as the link circuit shown are provided for. The number may, however, be increased or decreased to suit varying traffic conditions.

The operation of the system will now be described, it being assumed for this purpose that the subscriber at station A desires to call the subscriber at station B. The connection is established by removing the receiver at station A and dialling the telephone number 16, which is the number of station B.

When the receiver is removed a bridge is closed across the line conductors 2 and 3 in known manner and a circuit is completed for the line relay 5. Upon energizing, relay 5 grounds the individual marking conductor 68 and also grounds conductor 20, which is common to lines 1 to 5 of the first group. The grounding of conductor 20 completes a circuit for the group control relay 24 of the first group which may be traced from ground by way of contact 7, conductor 20, contact 60, winding of relay 23, winding of relay 24, contacts controlled at 61, conductor 62, contact 63, conductor 64, contacts of all intermediate group control relays such as contact 65 of relay 28, contact 66, and resistance 67 to battery. Relay 24 is energized over the above circuit and locks itself at contact 61. At contact 66 relay 24 disconnects battery from conductor 62, which prevents all the other group control relays such as 27 and 28 from energizing responsive to calls that may be initiated in other groups. At contact 72 relay 24 places ground on the tens marking conductor 71, thus preparing for energizing the first tens relay such as 31 of the finder in the link circuit to be used.

The sub-group control relay 23 is energized in series with relay 24, and at contact 73 disconnects conductor 21, common to lines 6 to 0 of the first group, from the sub-group control relay 22, thus preventing relay 22 from energizing responsive to a call being initiated on one of these lines. Relay 23 also connects the five individual marking conductors such as conductor 68 to five common units marking conductors such as 69. Since conductor 68 is grounded, this operation prepares for energizing the first units relay such as 41 in the finder which will be used for the call.

Attention may now be directed to the allotter which is shown in Fig. 2. The operation of this device will be described in detail later on, but for the present it will be sufficient to state that one of the relays 201 to 212 will be in energized position, thereby assigning the associated link circuit as the one to be used on the next call. It may be assumed that the first link circuit, the one shown in the drawing, is idle and is the next one to be used. Accordingly, relay 201 of the allotter will be in energized position, as shown.

Returning now to the call under consideration, when the group control relay 24 energizes it grounds the common conductor 75 at contact 74, thereby establishing a circuit for relays 54 and 55 which may be traced over said conductor 75 to contact 216 of relay 215 and thence by way of contact 219 of relay 201, conductor 76 (individual to the first link circuit), and windings of relays 54 and 55 to battery. Upon energizing, relays 54 and 55 connect the common marking conductors through to the tens and units relays of the finder of the first link circuit.

As the result of the extension of the marking conductors, as described in the preceding paragraph, the tens relay 31 is energized over the tens marking conductor 71, and the units relay 41 is energized over the units marking conductor 69. These relays prepare locking circuits for themselves at contacts 39 and 77, respectively. Relay 41 also disconnects battery from the other four units relays such as 42 at contact 78, thereby preventing any of these other units relays from energizing in case one of the lines 12 to 15 of the first group is calling at this time.

The energization of relays 31 and 41 extends the line of station A to the line relay in the connector of the first link circuit over a path which includes contacts 33 and 34 of relay 31, intermediate trunk conductors 36 and 37, contacts 43 and 44 of relay 41, conductors 46 and 47, normally

closed contacts of relay 49, trunk conductors 56 and 57, and the upper and lower windings of the line relay 121, these windings being connected to ground and battery, respectively. The line relay 121 is accordingly energized, and at contact 126 closes a circuit for the slow acting release relay 122.

Upon energizing, relay 122 grounds the local holding conductor 145 at contact 124 and also places ground on the holding conductor 58 of the incoming trunk from the finder. The grounding of conductor 58 extends ground over conductor 58' to complete the previously prepared locking circuits for relays 31 and 41. A circuit for the cut-off relay 6 is also completed, said circuit extending from the grounded holding conductor 58 by way of normally closed contacts of relay 49, conductor 48, contact 45 of relay 41, conductor 38, contact 35 of relay 31, conductor 4, and winding of cut-off relay 6 to battery. On energizing, relay 6 disconnects the line conductors 2 and 3 from ground and from the line relay 5, respectively, which causes the line relay 5 to deenergize. The deenergization of the line relay breaks the circuit of relays 23 and 24, and these relays accordingly deenergize also. Ground on conductor 4 is also extended over conductor 9 to the connectors, whereby the line of station A is made busy to incoming calls.

When the release relay 122 energizes, it opens its contact 123 and thus disconnects battery from the conductor 251 leading to the allotter, thereby bringing about certain operations in the allotter, including the temporary energization of relay 215, the deenergization of relay 201, and the energization of another relay such as 202 in order to assign another link circuit for the next calling line. These operations will be described presently, but for the moment it will be sufficient to note that the circuit of relays 54 and 55 is broken at contact 216 of relay 215 and also at contact 219 of relay 201. Relays 54 and 55 accordingly deenergize and disconnect the marking conductors from the finder of the first link circuit. It will be noted that the circuit of relays 54 and 55 is broken at the allotter, even though the group control relay 24 may remain energized due to another call and thus maintain ground on the common conductor 75.

As the result of all the foregoing, the calling line has been extended to the connector, where the line and release relays 121 and 122 are energized. A connection may now be traced from the dial tone source by way of conductor 146, contact 147, contact 139, impedance 148, condenser 149, contact 133, contact 129, and condenser 181, to the trunk conductor 56, whereby a dial tone signal is transmitted to the calling station A, notifying the calling subscriber that dialling of the called number may begin. The number of the called subscriber is 16, and therefore the dial is first operated in accordance with the digit 1.

When the first digit is dialled, a single interruption is produced in the line circuit and the line relay 121 is deenergized momentarily a single time. The release relay 122 does not fall back when its circuit is broken momentarily, due to its slow releasing characteristic. On deenergizing, the line relay transmits an impulse to the slow acting relay 114 over a path extending from ground by way of contact 126, contact 125, contact 137, contact 142, conductor 165, and winding of relay 114 to battery. On energizing, relay 114 closes a circuit at contact 161 for the slow acting relay 115, which energizes also.

When the line relay 121 falls back momentarily, it also sends an impulse to the first counting relay 301, Fig. 3, over a path which extends from ground by way of contact 126, contact 125, contacts 137 and 142, conductor 167, contact 315, winding of relay 301, and through the serially related chain contacts on relays 302 to 310, inclusive, to battery. On energizing, relay 301 prepares a circuit for counting relay 302 at contact 318, and closes a locking circuit for itself at contact 317 which extends from the grounded holding conductor 145 by way of contact 164, conductor 170, contact 317, winding of relay 311, winding of relay 301, and the chain contacts of relays 302 to 310, inclusive, to battery. This locking circuit includes relay 311 but is ineffective to energize said relay until the impulse from the line relay has terminated, whereupon relay 311 energizes. Relay 311 breaks the initial energizing circuit of relay 301 at contact 315 and further prepares the circuit of relay 302 at contact 316. As the digit 1 was dialled, only the counting relay 301 is energized at this time, but the description of the call will not be interrupted, since an opportunity of completing the explanation of the operation of the counting chain will be afforded when the results following the dialling of the second digit are discussed.

A short interval after the line relay has come to rest after the dialling of the first digit, the slow acting relay 114 falls back, followed by relay 115. The function performed by relay 115 during dialling is to prevent two subscribers' lines from being momentarily connected during the operation of the counting relays. It performs this function by disconnecting the talking conductors 173 and 168 from their branches 174 and 169, respectively, at contacts 155 and 158. This operation is, of course, unnecessary when the digit dialled is the digit 1, but is essential on other digits because each counting relay except the first is energized before the preceding relay is deenergized, as will appear from the subsequent description.

Continuing with the call, when relay 114 deenergizes, it places ground on the two marking conductors 171 and 172 and completes a circuit for the first tens relay 321, the circuit extending from ground on conductor 145 by way of contact 161, resistance 180, contact 162, conductor 171, contact 319 on relay 301, and winding of relay 321 to battery. On energizing, relay 321 locks itself over a circuit extending from ground on conductor 145, winding of relay 113, conductor 175, lower contact of relay 321, and winding of relay 321 to battery. In energized position, the tens relay 321 extends connections from contacts of the ten counting relays to the ten lines of the first group.

Relay 113 is energized in series with relay 321 and at contacts 162 and 163 disconnects the two marking conductors 171 and 172. These conductors are separated at this time to prevent the false operation of another tens relay when the next digit is dialled. Relay 113 also disconnects ground from conductor 170, thereby bringing about the deenergization of relays 311 and 301.

The calling subscriber may now dial the second digit of the called number. The second digit is the digit 6, and accordingly a series of six interruptions is produced in the line circuit, causing the line relay 121 to momentarily deenergize six times. At each deenergization the line relay sends an impulse to relay 114, which energizes

and remains in operated position during the series of impulses. Relay 115 is also energized as before. When relay 114 energizes, it replaces ground on conductor 170 at contact 161, thereby promptly preparing the locking circuit for the first counting relay 301. Relay 114 also closes a circuit for relay 116, extending from ground on conductor 145 by way of contact 164, contact 160, and winding of relay 116 to battery. On energizing, relay 116 locks itself at contact 151, and at contact 152 places ground on conductor 170 independent of the contact on relay 114 in order that conductor 170 may be maintained grounded after relay 114 has deenergized. Relay 116 also disconnects dial tone from the calling line at contact 147.

While the line relay is sending impulses to relay 114, it also sends impulses to the counting relays. The first impulse energizes relay 301 over a circuit which includes conductor 167, contact 315, winding of relay 301, and chain contacts of relays 302 to 310, inclusive, to battery. On energizing, relay 301 prepares a circuit for relay 302 at contact 318, and locks itself at contact 317 over a previously traced circuit which includes conductor 170 and relay 311, the latter relay energizing at the termination of the first impulse. Relay 311 disconnects the impulse conductor 167 from relay 301 and other odd counting relays at contact 315, and at contact 316 further prepares the circuit of relay 302.

On receipt of the second impulse from the line relay, the second counting relay 302 energizes over a circuit extending over conductor 167 and by way of contact 313, winding of relay 302, contact 318, contact 316, and resistance 330 to battery. On energizing, relay 302 locks itself in a new circuit which extends from grounded conductor 170 by way of contact 331, winding of relay 312, winding of relay 302, contact 333, and chain contacts on relays 303 to 310, inclusive, to battery. In addition, relay 302 partly prepares a circuit for relay 303 at contact 332 and breaks the locking circuit of relays 301 and 311 at the chain contacts associated with contact 333, whereupon these two relays deenergize. Relay 312 energizes in series with relay 302 at the termination of the second impulse, disconnects the impulse conductor 167 from relay 302 and other even counting relays at contact 313, and completes the preparation of the circuit of relay 303 at contact 314.

In response to the third impulse relay 303 energizes over a circuit extending over conductor 167 and by way of contact 315, winding of relay 303, contact 332, contact 314, and resistance 330 to battery. Relay 303 locks itself over a circuit extending from the grounded conductor 170 by way of contact 334, winding of relay 311, winding of relay 303, contact 336, and chain contacts of relays 304 to 310, inclusive, to battery. Relay 303 also prepares the circuit of relay 304 at contact 335, and breaks the circuit of relays 302 and 312 at 336 by disconnecting these relays from the chain circuit to battery. Relays 302 and 312 accordingly deenergize. Relay 311 energizes in series with relay 303 at the termination of the third impulse and performs its allotted function as previously described.

Counting relays 304, 305, and 306 energize successively in response to the fourth, fifth, and sixth impulses, respectively. The operation of these relays will be apparent from the preceding explanation, and need not be described in detail. It will suffice to say that relay 306 is energized responsive to the last impulse and locks itself in series with relay 312 at contacts 337 and 338, relay 312 energizing at the termination of the impulse. The operation of relay 306 selects the sixth line in the group of ten lines that has been selected by the tens relay 321. Relay 321 is the first tens relay, and accordingly line 16, or the line of station B, has been selected.

When relay 114 falls back after the dialling of the second digit, it completes a test circuit which extends from battery by way of the winding of the test relay 117, normally closed contacts associated with contact 140, contact 150, contact 159, contact 134, conductor 166, serially related contacts of relays 310, 309, 308, and 307, contact 339, conductor 344, contact 347, conductor 18, and thence to the test conductor 12 of the called line, Fig. 1. Relay 114 also breaks the circuit of relay 115, but relay 115 is slow to deenergize and holds up long enough for the called line to be tested over the circuit described.

Assuming that the called line is busy, there will be a ground potential on conductor 12 and the test relay 117 in the connector will energize, locking itself at contact 140. At contact 142 relay 117 breaks the impulsing circuit, and at contacts 141 and 143 it breaks the circuits of relays 118 and 119, respectively, preventing these relays from energizing when relay 115 falls back. Finally, at contact 139, relay 117 connects a source of busy signalling current with the calling line, thus giving the calling subscriber a busy signal. The calling subscriber will then replace his receiver and the equipment in use will be restored to normal in a manner to be presently described.

Assuming now that the called line is idle, there will be no ground potential on the test conductor 12 when the test circuit is completed by the deenergization of relay 114, and the test relay 117 will not be energized. When relay 115 falls back, therefore, a circuit will be completed for relay 118, extending from grounded conductor 145, contact 161, contact 156, contact 153, contact 141, and winding of relay 118 to battery. On energizing, relay 118 disconnects the test circuit from the test relay 117 and connects it to ground at contact 134, thereby grounding conductors 18 and 12 to make the called line busy and completing a circuit for the cut-off relay 14. On energizing, relay 14 clears the called line of its normal battery and ground connections.

In addition to the foregoing, relay 117 breaks the impulsing circuit at contact 137, and at contact 135 it opens another point in the circuit over which battery is normally applied to the conductor 251 extending to the allotter. Finally, at contacts 133 and 138 relay 118 completes the connection to the called line, said connection extending from the incoming trunk conductors 56 and 57, by way of the condensers 181 and 182, contacts 129 and 132 of relay 119, contacts 133 and 138, conductors 173 and 168, contacts 340 and 341, conductors 342 and 343, contacts 345 and 346, and conductors 16 and 17 to line conductors 10 and 11 of the called line.

The ringing interrupter machine connects ground intermittently to the conductor 183, thereby operating the ringing relay 119 at intervals over a circuit extending over said conductor 183 and by way of contact 157, contact 154, contact 143, and winding of relay 119 to battery. On energizing, relay 119 breaks the connection to the called line and connects the called line to the ringing current generator over conductors 184 and 185, thereby ringing the bell at the called

station. At the same time a source of ringing tone signalling current is connected to the calling line by way of conductor 186 and contact 128, thereby notifying the calling subscriber that the ringing operation is proceeding. It should be noted also that each time relay 119 deenergizes it momentarily connects ground and battery to the called line at contacts 130 and 131. These contacts should break later than the ringing contacts 129 and 132, and are effective to dissipate the charge on the line and in the condenser at the called station that may remain after the ringing circuit is broken. The object of this operation is to prevent a false operation of the back bridge relay 120.

When the called subscriber answers, the back bridge relay 120 is energized over the called line in an obvious manner. Relay 120 will energize at once if the receiver at the called station is removed during an interval between ringing periods, or as soon as relay 119 deenergizes if the receiver is removed while the bell is ringing. On energizing, relay 120 closes a circuit for the test relay 117 at contact 127. On energizing, relay 117 functions as a ring cut-off relay, breaking the circuit of the ringing relay 119 at contact 143. Relay 117 also breaks the initial energizing circuit of relay 118 at contact 141 but closes another circuit for said relay including its locking contact 136 before it can deenergize.

The connection between the calling and called lines is now complete and conversation can proceed. The talking circuit includes the condensers 181 and 182. Current for the transmitter at the calling station A is supplied through the windings of the line relay 121 while the transmitter at the called station B is supplied through the windings of the back bridge relay 120.

When the conversation is finished the subscribers will replace their receivers and the connection is released. The circuits are so arranged that the calling subscriber controls the release of the finder while the release of the connector is controlled by either the calling or the called subscriber, depending on which subscriber last replaces his receiver.

When the receiver is replaced at the calling station A the circuit of the line relay 121 is broken and said relay deenergizes, breaking the circuit of the release relay 122. After a brief interval relay 122 deenergizes and removes ground from the holding conductor 58, thereby permitting relays 31 and 41 to deenergize. This restores the finder to normal. The removal of ground from conductor 58 also opens the circuit of the cut-off relay 6, which deenergizes and re-connects the line conductors 2 and 3 to ground and to the line relay 5, respectively, thus placing the line of station A in normal condition.

At the connector the back bridge relay 120 remains energized until the called subscriber hangs up and maintains ground on the holding conductor 145 by way of contact 127 and the locking contact 140 of relay 117. Relay 118 maintains battery disconnected from conductor 251 after relay 122 has restored in order to maintain the link in unselectable condition at the allotter.

When the receiver is replaced at the called station B, relay 120 falls back and breaks the circuit of relay 117, which deenergizes also. The opening of contact 127 on relay 120 removes ground from conductor 145 and from conductor 170. Accordingly, relays 113, 116, 118, 306, 312, and 321 are deenergized and the connector is restored to normal. Ground is also removed from the test conductor of the called line and the cut-off relay 14 is deenergized, thereby placing the called line in normal condition.

The connection described in the foregoing is typical of connections established by calling lines 1 to 5 in all groups. Calls made by lines 6 to 0 in the various groups are the same, except that relay 49 of the finder in use is energized on such calls. For example, if an outgoing call is made from the line of station B, which is the sixth line in the first group, the operation of line relay 13 grounds conductor 21, and the sub-group control relay 22 is energized instead of sub-group control relay 23. Then when relay 55 is energized, assuming that the first link circuit is used for the call, a circuit is completed for relay 49 at the same time that the circuits are completed for relays 31 and 41. Relay 49 energizes and the line of station B, line 16, is connected to the connector trunk instead of the line of station A. It will be noted that whenever relay 49 is energized it becomes locked to the holding conductor 58' at contact 79.

Reference will now be made to Fig. 2 for a more detailed explanation of the allotter. From what has been said before it will be understood that conductor 75 incoming to the allotter is common to all the subscribers' lines and may be grounded by any calling line. Also, conductors 76 and 251 outgoing from the allotter are individual to the first link circuit, conductor 76 extending to the finder and conductor 251 extending to the connector. The allotter is provided with as many pairs of outgoing conductors as there are link circuits. Thus conductors 242, 243, and 244 extend to the finders in the second, third, and fourth link circuits, and there are eight similar conductors which extend to the finders in the other eight link circuits. Conductors 252, 253, and 254 extend to the connectors in the second, third, and fourth link circuits, and there are eight similar conductors extending to the connectors in the other eight link circuits. The conductors such as 76, 242, etc., are control conductors over which the relays such as 54 and 55 are energized to connect the marking conductors to the finders, while conudctors 251, 252, etc., are test conductors by means of which the allotter determines whether the link circuits are busy or idle.

One of the relays 201 to 212, inclusive, of the allotter is normally energized, and for convenience it has been assumed that the energized relay is relay 201. This relay is held up over a circuit which extends from ground through serially related chain contacts on relays 212 to 202, inclusive, winding of relay 201, conductor 251, busy key BK, contact 123, contact 135, and resistance 144 to battery. Relay 201 also has a circuit to battery through contact 222 and the winding of relay 213, but resistance 144 is low enough to prevent relay 213 from energizing. With relay 201 energized, the common conductor 75 is connected to conductor 76 at contact 219, and the first link circuit is thus assigned for use on the next call.

When the next call is made, conductor 75 is grounded in the manner already explained, and relays 54 and 55 are energized over conductors 75 and 76, whereby the marking conductors are connected up and the finder of the first link circuit is operated to connect with the calling line. The line and release relays of the connector are then operated and the latter relay opens at contact 123 the previously traced circuit of relay

201 to battery through resistance 144. This operation removes the shunt from relay 213 and said relay energizes in series with relay 201.

On energizing, relay 213 closes a circuit for relay 215, which energizes and opens conductor 75 at contact 216. Relay 213 also closes a circuit for relay 202 extending from ground by way of contact 217, contact 221, winding of relay 202, and conductor 252 to battery in the connector of the second link circuit, assuming that this link circuit is idle. On energizing, relay 202 closes a locking circuit for itself at contact 227, prepares a circuit for relay 203 at contact 228, and connects up relay 214 at contact 229. Relay 214 is shunted by the circuit to battery over conductor 252 and is not operated. Relay 202 also breaks the circuit of relays 201 and 213 at its chain contacts controlled by contact 227 and said relays are deenergized, the latter relay breaking the circuit of relay 215. Relay 215 should be slow to deenergize in order to afford ample time for the operation of the allotter between successive calls. When relay 215 falls back, it extends the common conductor 75 by way of contact 216, contact 219 of the now deenergized relay 201, and contact 226 of the energized relay 202, to conductor 242. The latter conductor extends to relays such as 54 and 55 in the finder of the second link circuit, which is therefore assigned for use on the next call.

When the next call is made, battery is removed from conductor 252 in the connector of the second link circuit and relay 214 is energized in series with relay 202. On energizing, relay 214 closes a circuit for relay 215, which operates again and opens conductor 75. Relay 214 also closes a circuit for relay 203. Assuming that the third link circuit is busy, there will be no battery potential on conductor 253 in the connector, and the circuit of relay 203 will extend from ground by way of contact 218, contact 228, winding of relay 203, normally closed contacts associated with contact 233, and the resistance 238 to battery. On energizing, relay 203 locks itself at contact 231 and at the associated chain contacts breaks the circuit of relays 202 and 214, which deenergize. Relay 203 prepares a circuit for relay 204 at contact 232, and at contact 233 it substitutes relay 213 for the resistance 238.

Relay 213 accordingly energizes in series with relay 203 and closes another circuit for relay 215, thus maintaining this relay energized. Relay 213 also closes a circuit for relay 204 which extends from ground by way of contact 217, contact 232, winding of relay 204, and conductor 254 (assuming that the fourth link circuit is idle) to battery in the connector of the fourth link circuit. On energizing, relay 204 locks itself at contact 235 and at the associated chain contacts breaks the circuit of relays 203 and 213, which deenergize. Relay 204 also prepares a circuit for relay 205 at contact 236, and at contact 237 it connects up relay 214, which does not energize, however, because it is shunted by the circuit over conductor 254 to battery at the connector.

Following the deenergization of relay 213, relay 215 is deenergized, and the common conductor 75 is extended by way of contact 216, and contacts 219, 226, 230, and 234, to conductor 244. The latter conductor is individual to the fourth link circuit which is thus assigned for use on the next call.

In response to succeeding calls, relays 205 to 212, inclusive, will be energized successively in a manner which will be readily understood from the preceding explanation. When relay 212 is energized, it locks itself at contact 265 and at the associated contacts breaks the circuit of relays 211 and 213. The locking circuit of relay 212 extends from ground by way of contact 265, conductor 266, contacts controlled at contact 220 of relay 201, conductor 267, winding of relay 212, and conductor 262 to battery at the connector in the twelfth link circuit, assuming that this link circuit is idle.

When the twelfth link circuit is taken into use, relay 214 energizes in series with relay 212 and closes a circuit for relay 201, extending from ground by way of contact 218, contact 264, chain contacts of relays 211 to 202, inclusive, and winding of relay 201 to battery on conductor 251, assuming that the first link circuit is idle. On energizing, relay 201 locks itself to ground over a circuit including contact 220, conductor 266, and contact 265 of relay 212. Relay 201 also breaks the circuit of relays 212 and 214, which deenergize. Relay 212 breaks the locking circuit of relay 201 at contact 265, and also breaks the initial energizing circuit of this relay at contact 264, but at the same time it replaces ground on the chain circuit and thus establishes the previously traced circuit over which relay 201 is maintained energized while the first link circuit is waiting for a call.

It will be seen from the foregoing that the link circuits are tested and assigned for use by the allotter in regular rotation, thereby equalizing the traffic between the link circuits. In case all the link circuits become busy, the allotter will operate continuously, testing the link circuits one after the other until one of them is found idle and is assigned for the next call. During such testing operation the relay 215 is maintained energized and is only permitted to deenergize after an idle link circuit has been found and assigned for use.

It will be seen further that no link circuit can be assigned unless there is a battery potential on its associated test conductor. In case a connector fuse is blown, therefore, the link circuit which is thus rendered inoperative for completing calls will test busy to the allotter and will not be assigned for use by calling lines until the fuse is replaced.

The testing arrangement also lends itself with facility to the artificial busying of the link circuits. Each of the test conductors such as 251, 252, etc., is preferably provided with a busy key such as BK, which when operated will remove the connector battery potential from the associated test conductor. The allotter will therefore pass by any link circuit in which the busy key is operated.

In the explanation of the setting up of a connection from station A to station B the allotter was described as being operated to test for another link circuit when the line relay was operated over the calling line, the line relay operating relay 122 and the latter relay removing connector battery from conductor 251 at contact 123. This may be considered as the normal operation of the system. However, it is usually desirable as a precautionary measure to provide the relay 55, Fig. 1, with contacts 90 and 91 by means of which a temporary bridge is closed across the trunk conductors 56 and 57 when relay 55 energizes. The closure of this bridge insures the energization of the line and release relays of the connector even though there may be a defective contact at one of the relays in the finder, which

would prevent the line relay in the connector from energizing over the calling line. The possibility of such a case of trouble is remote, but if it did occur it would tie up the system until the calling subscriber replaced his receiver. The arrangement described prevents such result by insuring the operation of the allotter regardless of whether the calling line is properly extended through to the connector or not.

The invention having been described, that which is believed to be new and for which the protection of Letters Patent is desired will be pointed out in the appended claims.

What is claimed is:

1. In an automatic telephone system, a plurality of connectors, an allotter for assigning said connectors to successive calls, relays in said allotter, individual test conductors extending from the allotter relays to the respective connectors, means in each connector for maintaining a potential on its test conductor while the connector is idle, circuits for the allotter relays whereby one of the relays is held energized by the idle potential on its associated test conductor, means in each connector controlled by the calling subscriber when the connector is taken into use for a call to remove the potential from said test conductor, and means controlled by the called subscriber for replacing the potential on said test conductor.

2. The combination, with a plurality of links, of an allotter comprising a plurality of link selecting relays, two control relays, means for energizing said selecting relays successively in search of an idle link, circuits for the odd and even selecting relays including said control relays, respectively, whereby said control relays are energized alternately during the searching operation, link assignment circuits controlled by said selecting relays and including a common conductor, and means controlled by said control relays for holding said conductor open during the searching operation.

3. In an automatic telephone system, a plurality of link circuits, an allotter comprising a like plurality of link selecting relays, test conductors extending between the selecting relays and their respectively associated links, circuit arrangements whereby one of said relays is normally maintained in energized condition over its associated test conductor, and a circuit prepared by the energized relay for allotting the associated link to the next call.

4. The combination, with a plurality of links, of an allotter comprising a plurality of link selecting relays, means local to the allotter for energizing said relays successively to search for an idle link circuit, and means for preventing the energization of each relay, said means comprising a conductor individual to the preceding relay to which a potential is applied at the associated link if the link is idle.

5. The combination, with a plurality of links, of an allotter comprising a plurality of link selecting relays, means for energizing said relays successively to search for an idle link, said means including two control relays common to the odd and even selecting relays, respectively, and shunt circuits including conductors individual to the links for preventing the energization of the associated control relay when an odd or even selecting relay finds an idle link.

6. In an allotter, a series of selecting relays, a series of test conductors, one for each relay, a normal energizing circuit for each relay including its test conductor, an auxiliary energizing circuit for each relay which is effective in case the normal energizing circuit is inoperative, two relays which are common to the odd and even selecting relays, respectively, for controlling said energizing circuits, and circuit connections for controlling said common relays over said test conductors.

7. The combination, with a plurality of link circuits, of an allotter comprising a like plurality of link selecting relays, test conductors extending between said selecting relays and their respective links, means in each link for maintaining a potential on its associated test conductor while the link is idle, local means in the allotter for energizing said relays successively in search of an idle link until a relay associated with an idle link is energized, a circuit for the last energized relay including its associated test conductor, and a connection to said test conductor which prevents said local energizing means from operating the next selecting relay until the potential on said test conductor is removed.

8. The combination, with a plurality of link circuits, of an allotter comprising a relay individual to each link circuit, a normal energizing circuit for each relay including a conductor individual to the associated link, a common energizing circuit for said relays including a resistance, a locking circuit for the odd relays including a control relay for the even relays, and a locking circuit for the even relays including a control relay for the odd relays.

9. The combination, with a plurality of link circuits, of an allotter comprising a like plurality of link selecting relays, means for energizing each relay over a conductor individual to the associated link if the link is idle, a common circuit for energizing any relay when its associated link is busy, two control circuits common to the odd and even relays, respectively, contacts on each relay for disconnecting it from said common circuit and for connecting it to one of said control circuits, and relays in said control circuits for controlling said energizing circuits.

10. The combination, with a plurality of links, of an allotter comprising a selecting relay individual to each link, means for energizing one of said relays over a circuit extending to the associated link, whereby the associated link is selected for the next call, means in the said selected link for opening said circuit when the link is taken into use, a relay energized in series with the energized selecting relay responsive to the opening of said circuit, and a circuit for the next selecting relay controlled by said last mentioned relay.

11. The combination, with a plurality of links, of an allotter comprising a like plurality of relays, a circuit for energizing a first one of said relays including a branch local to the allotter and a parallel branch which is open if the associated link is busy, means for closing said circuit to energize the said first relay over both said branches or the local branch alone, a third branch of said circuit which is substituted for said local branch upon energization of said first relay, a control relay in said third branch energized in series with said first relay in case said parallel branch is open, and a circuit for the second of said plurality of relays closed by said control relay.

12. In an automatic telephone system, a plurality of link circuits, each comprising a relay type finder and a connector, marking conduc-

tors, a relay individual to each link circuit for connecting said marking conductors to its finder, a common operating conductor for said individual relays, an allotter, relays in said allotter controlled from said connectors, circuits whereby one of said allotter relays is held energized from the connector of an idle link circuit to maintain said common conductor in connection with the individual relay thereof, and means responsive to a call for rendering said common conductor active to energize the individual relay to which it is connected.

13. In an automatic telephone system, a plurality of link circuits, an allotter comprising a like plurality of link selecting relays, test conductors extending between the said selecting relays and their respectively associated link circuits, means including the test conductor of an idle link circuit for maintaining the corresponding selecting relay energized, a circuit prepared by the energized selecting relay for allotting the associated link circuit to the next call, and means responsive to the seizure of such link circuit on the next call for successively energizing the other selecting relays until a selecting relay associated with another idle link circuit is energized.

14. In an automatic telephone system, a plurality of link circuits, an allotter comprising a like plurality of link selecting relays, means for maintaining a random one of said relays energized to assign the associated link circuit to the next call, and means responsive to said call in case the assigned link circuit is the only idle link circuit for successively energizing all said selecting relays in search of an idle link circuit.

15. In an automatic telephone system, a plurality of link circuits, an allotter comprising a like plurality of link selecting relays, test conductors extending from said selecting relays to their respective associated link circuits, means in each link circuit for maintaining a test potential on its associated test conductor when the link circuit is idle, means responsive to a call for operating a plurality of said relays successively to pass by busy link circuits characterized by the absence of potentials on their test conductors, the operation continuing until a selecting relay corresponding to an idle link circuit is energized, and a switch individual to each link circuit for opening its test conductor to make the link circuit busy.

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