March 19, 1946. H. D. MacPHERSON 2,396,797

TROUBLE LOCK-OUT ARRANGEMENT

Filed Aug. 18, 1944 2 Sheets-Sheet 1

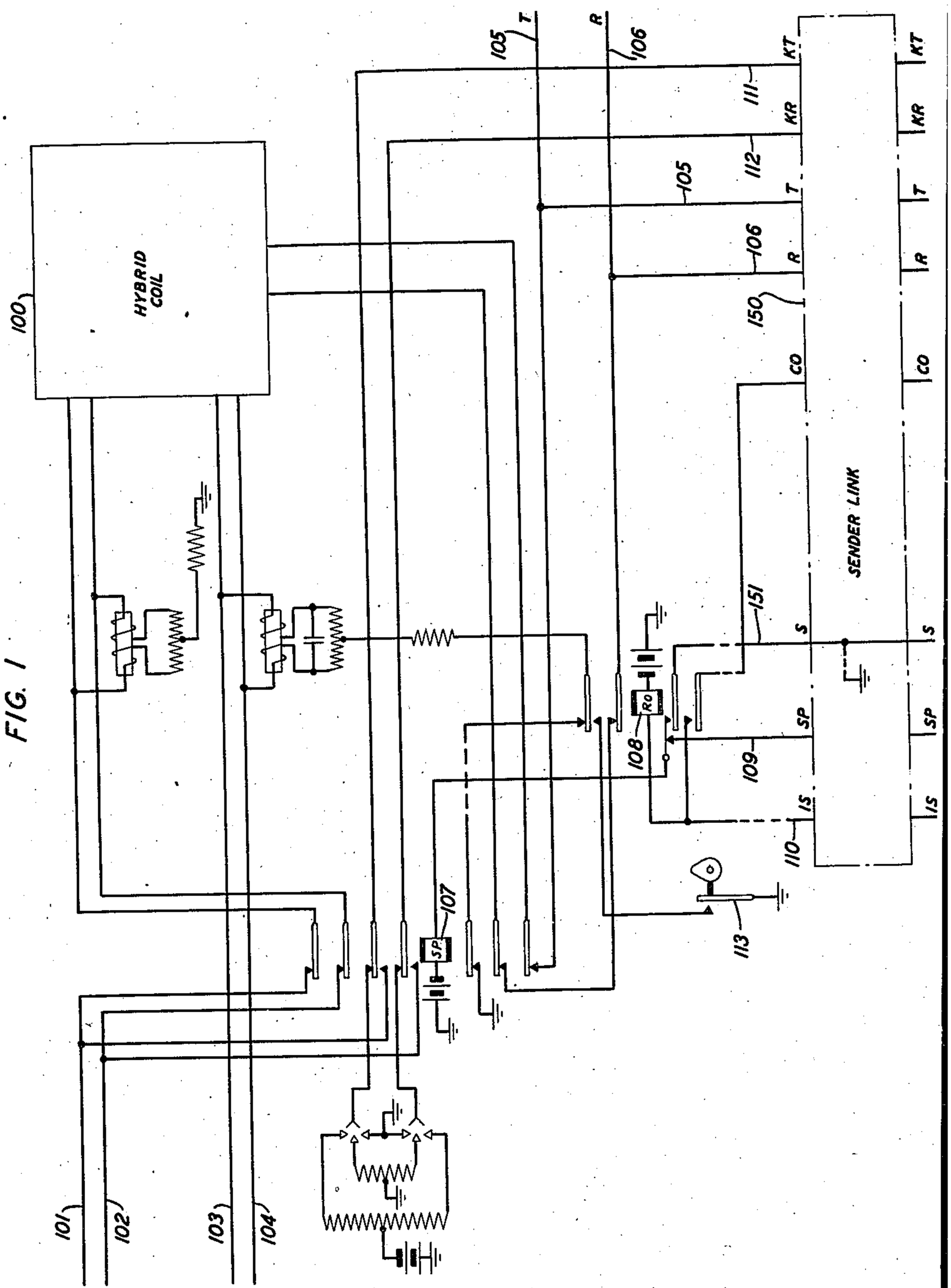

FIG. 1

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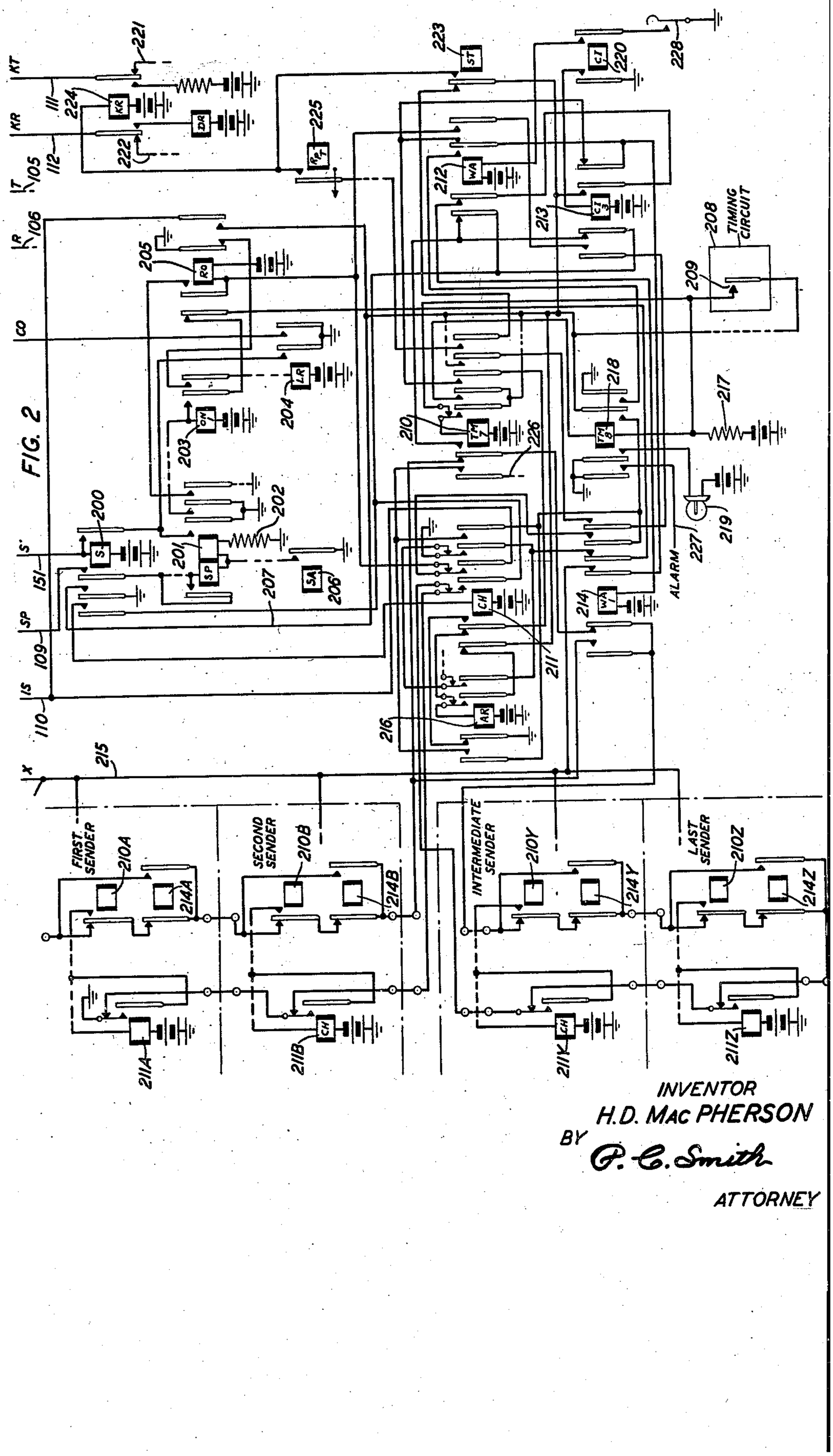

FIG. 2

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TROUBLE LOCKOUT ARRANGEMENT

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8 Claims. (Cl. 179—27)

This invention relates to automatic telephone systems and has for its object to facilitate the removal of trouble conditions in such systems.

In many automatic telephone systems the operation of the automatic switches in the establishment of a connection is performed under the control of common control equipment, called senders, markers, etc. Such common control equipment normally completes its functions with any one call in a short time and is then released for use with a subsequent call. To guard against troubles which might prevent the release of the control equipment and the switches with which it has been associated, each control circuit is provided with timing means which is started when the control circuit is seized and restored to normal when the control circuit is released. Such timing means is arranged, on completing its operation, to sound an alarm so that the maintenance force may be informed that a trouble condition exists.

Heretofore such timing means has also been arranged to automatically release the associated control circuit or, by means of an operated key or plug and jack arrangement, to lock the control circuit and the associated switches.

In accordance with the present invention, means is provided, associated with a group of similar control circuits, for causing the first timing means, which completes its operation, to always lock the associated control circuit and also to prevent any other timing means from locking its control circuit while the first one remains locked.

To this end each control circuit is provided with two relays, a time-out relay, operated when the timing means completes its operation, and an auxiliary relay under the control of the time-out relay which are interconnected by a chain circuit including in series a contact on each auxiliary relay. Therefore, the first operation of one auxiliary relay opens the circuit for operating any other auxiliary relay.

This auxiliary relay supplies ground to hold the control circuit busy and to prevent the release of the link by which the control circuit is connected to the trunk circuit over which the call originated.

In addition the first auxiliary relay, when operated, provides a circuit whereby the operation of any other time-out relay causes the immediate release of the associated control circuit and the transmission of a reorder signal to the calling trunk.

These and other features of the invention will be made apparent by a consideration of the following description read in connection with the drawings in which Fig. 1 shows portions of a trunk circuit and a diagrammatic link circuit and Fig. 2 shows portions of a plurality of sender circuits.

In the present disclosure, the invention has been illustrated as applied to outgoing senders in a cross bar telephone system, but it is equally applicable to any other type of control circuit or to any other telephone system employing control circuits. For an understanding of the relative position of an outgoing sender in a telephone system and for a disclosure of the complete details of such a sender, reference may be made to United States Patent 2,293,191, granted to A. J. Busch and F. J. Scudder on August 18, 1942.

Briefly, the outgoing sender, to which the present invention has been applied, is employed in a cross bar toll office. A call comes into the office over an incoming toll trunk, which is connected to an incoming sender or an operator's position and sender according to the nature of the originating office. The designation of the wanted line is recorded in the incoming sender or operator's sender and a marker controls a set of cross bar switches to connect the incoming trunk to an outgoing trunk. In the case of most calls to be completed at a local office, the services of an outgoing sender are required and the outgoing trunk is arranged to connect with such a sender by means of a link circuit. The numerical designation of the called line is then transmitted by the incoming sender to the outgoing sender and the latter controls the completion of the connection to the called line.

Referring to the drawings, the outgoing trunk of Fig. 1 provides a talking connection by means of the hybrid coil 100, between the four incoming conductors 101 to 104 and the two outgoing conductors 105 and 106. When the outgoing trunk was selected by the marker, a start circuit was completed for the sender link which operated to connect the trunk of Fig. 1 to the outgoing sender of Fig. 2. The control circuit of the sender link grounds conductor 151 to operate the hold magnets of the link and also to operate start relay 200. Relay 200 closes a circuit connecting the splitting relays of the trunk and sender which may be traced from battery through the winding of relay 107, normal contacts of relay 108, conductor 109, front contact of relay 200, through equipment not shown to the winding of relay 201, resistance 202 and ground. Relay 201 operates but relay 107 cannot operate due to the resistance included in the circuit. Relay 201 locks to

its operating circuit independent of the equipment not shown and closes a locking circuit for relay 200, and a holding circuit for the link hold magnets in place of the ground supplied by the control circuit which now releases. Relay 201 also operates off normal relay 203, which in turn closes a circuit from battery through the winding of relay 204, front contact of relay 203 to ground at the back contact of relay 205. Relay 204 also connects ground to the locking circuit of relay 200.

As indicated in Fig. 1, with relay 107 normal, direct ground, ground through a resistance or battery through a resistance is connected to conductors 111 and 112 in different combinations to transmit an indication to the sender of the class of the trunk. When this indication has been received, relay 206 is operated, thereby short-circuiting the right winding of relay 201 and resistance 202 and permitting relay 107 to operate. Relay 107, on operating, disconnects incoming conductors 101 and 102, from the hybrid coil 100 and connects them to conductors 111 and 112, and also disconnects outgoing conductors 105 and 106 from the hybrid coil. Conductors 105 and 106 are directly connected to the sender link and by the link to the sender. Relay 107 also opens the circuit extending to the simplex circuit over conductors 103 and 104, which is under the control of the terminating office, to prevent the premature closure of this circuit.

The numerical designation of the wanted line is transmitted in code over conductors 101 and 102, and conductors 111 and 112 to conductors 221 and 222 of the sender and thence to registers, not shown, where it is recorded.

When all of the digits have been recorded, relay 223 operates, in turn operating relay 224 which connects both conductors 111 and 112 to battery through a high resistance as a signal to the incoming sender that it may release. The outgoing sender then either retransmits the designation over conductors 105 and 106 to the terminating office or uses the record to control automatic equipment over these conductors. When the sender of Fig. 2 has completed its functions, relay 206 is released, in turn releasing relays 201, 203, 204, 200 and 107. Relay 107 on releasing again connects the incoming and outgoing conductors to the hybrid coil and prepares the circuit over conductors 103 and 104 for indicating response by the wanted subscriber.

The operation of the sender in case of trouble will now be described.

When relay 200 operated, following the seizure of the sender, it connected ground to conductor 207 supplying a general off-normal ground to various circuits of the sender. Ground on conductor 207 extends to the timing circuit 208. This circuit has been represented as a single contact but actually may comprise a plurality of relays which interact to measure a number of time intervals and close a number of control circuits. If the sender operates properly none of these control circuits become effective and the release of relay 200 with the release of the sender restores the timing circuit 208 to normal.

If, however, the sender fails to complete its functions within a predetermined time, contact 209 of the timing circuit 208 will be closed, and a circuit completed from grounded conductor 207, over contact 209, normal contacts and winding of time-out relay 210 to battery. Relay 210 operates and locks to ground on conductor 207.

For the purpose of the lockout arrangement, forming the subject of the present invention, all of the outgoing senders included in the same group with the sender of Fig. 2 are regarded as arranged in a predetermined order and contacts of the time-out relays such as relay 210 and the auxiliary relays such as relay 211 are wired through all of the senders in accordance with that order. To give a clearer indication of this wiring the relays similar to relays 210, 211 and 214 of the first, second, last and next to last senders have been indicated in the dotted rectangles at the left of Fig. 2, the sender forming the major part of Fig. 2 representing any one of the intermediate senders.

Therefore, when relay 210 operates, it closes a circuit from battery through the winding of auxiliary relay 211, contact of relay 200, back contact of relay 212 or of relay 213, front contact of relay 210, back contact of relay 214, back contacts of relays similar to relays 210 and 214 in each of the later intermediate senders, back contacts of relays 210Y and 214Y in the next to the last sender, back contacts of relays 210Z and 214Z in the last sender and then over the normal contacts of the auxiliary relays 211Z, 211Y, 211, and of corresponding relays in intermediate senders to the normal contacts of relay 211B in the second sender, normal contacts of relay 211A in the first sender and ground.

Relay 211 operates in this circuit, opening at its inner right normal contacts the chain circuit above traced, thereby preventing the operation of any other auxiliary relay. Relay 211 also locks over a circuit from battery, through its winding, contact of relay 200, inner right alternate contacts of relay 211 to ground over the normal contacts of the auxiliary relays in all of the prior senders in the chain.

Relay 211 in operating closes a holding circuit for relay 203 which may be traced from battery through the winding of relay 203, front contact of relay 203, back contact of relay 205, back contact of relay 214, front contact of relay 211 to ground. With relay 203 locked, relay 204 is held operated and maintains ground on the locking circuit of relay 200 and on conductor 151 to hold the link circuit hold magnets operated and prevent the release of the sender and link from the trunk.

Relay 211 also immediately connects ground to conductor 215, the circuit extending from ground at the left back contact of relay 216, front contact of relay 211, front contact of relay 210, back contact of either relay 212 or relay 213, back contact of relay 214, to conductor 215 for a purpose to be described hereinafter.

If relay 210 is operated prior to the operation of relay 223, relay 210 closes circuits (not shown) which cause the temporary operation and release of relay 225. During the time that relay 225 is operated a circuit is closed from grounded conductor 207, back contact of relay 223, front contact of relay 210, front contact of relay 225 to the winding of relay 224 and battery, thereby transmitting a signal to the originating sender, causing it to be released.

In addition relay 211 closes a circuit from ground, connected to conductor 226 by various means in accordance with the stage of operation at which relay 210 operated, front contact of relay 210, front contact of relay 211, back contact of relay 214, alternate contacts of relay 211, conductor 110 through the sender link 150 to the winding of relay 108 and battery. Relay 108 locks under the control of relay 204 in the sender,

disconnects relay 107 from conductor 109 and connects it to conductor 151, so that relay 107 remains operated under the control of the sender link holding circuit, but relay 201 of the sender releases. Relay 108 also connects interrupted ground from interrupter 113 to the simplex signaling circuit over conductors 103 and 104 thereby transmitting a reorder signal to the originating operator.

It is therefore apparent that, when the first of a group of senders times out, the sender with its associated link and trunk circuit are prevented from releasing, to enable the maintenance force to determine whether the trouble was in the sender, in the trunk or in the link and to remove the faulty equipment from service.

In the foregoing description, when relay 211 operated, ground was connected to conductor 215 which is connected in multiple to all of the senders of the group. Assuming that conductor 215 was grounded by some other sender, for example the first sender of the group, if the time-out relay 210, of the sender shown, operates during the handling of a call the auxiliary relay 211 cannot operate, since the chain circuit was opened by relay 211A of the first sender but a circuit will be completed which may be traced from ground on conductor 215, back contact of relay 214, back contact of relay 213 or relay 212, front contact of relay 210, back contact of relay 211 to the normal contacts and winding of relay 216 and battery. Relay 216 closes a locking circuit for itself from battery through its winding and alternate contacts, back contact of relay 211, to grounded conductor 207. Relay 216 also closes a temporary holding circuit from battery through the winding and front contact of relay 203, back contact of relay 205, back contact of relay 214, alternate contacts of relay 216, normal contacts of relay 211 to ground, holding the connection until relay 218 operates as described hereinafter. With relay 216 operated, and relay 211 unoperated, a circuit is closed from battery through the winding of relay 205, normal contacts of relay 211, back contact of relay 214, front contact of relay 216, front contact of relay 210 to ground over conductor 226. Relay 205 locks under the control of relay 201, opens the locking circuit of relay 203, and opens the operating circuit of relay 204 thereby leaving relay 200 and the link circuit under the control of relay 201. Relay 205 also closes a circuit from ground on conductor 207 to conductor 110, operating relay 108 in the trunk circuit. Relay 108 opens the circuit of relay 201 and permits the sender and link to release. It also transmits a reorder signal to the originating operator who releases the incoming trunk, in turn releasing the outgoing trunk and relays 107 and 108.

When relay 210 operates, it closes a circuit from battery through resistance 217, winding of relay 218, front contact of relay 210 to grounded conductor 207, but relay 218 cannot operate as long as contact 209 is closed since a shunt is closed around its winding from ground over contact 209. If the reorder signal is not transmitted or the sender released promptly, ten seconds after relay 210 operated contact 209 opens and relay 218 operates, lighting lamp 219 to identify the sender which has experienced trouble and grounding alarm conductor 227.

Relay 218 connects ground from conductor 207 to the back contact of relay 214, thereby providing supplementary means for grounding conductor 110 or operating relay 205, according as relay 211 or relay 216 is operated, in order to transmit a reorder signal in case it was not successfully transmitted previously.

Relays 212, 213, 214 and 220 function in connection with calls to be completed by an operator, who is to receive her instruction by means of call indicator pulsing. Relay 220 is a class relay indicating that the sender is serving such a call. Relay 213 operates under the control of relay 220 when a connection has been extended to the terminating office and relay 214 operates from relay 213, provided relay 212 has not been operated. Therefore, relays 213 and 214 are operated during the time that the sender is waiting for the operator at the terminating office to connect her call indicator apparatus to the trunk. Since this time may vary according to the density of traffic, relay 214 opens the circuit for operating relay 211, the circuit for operating relay 216, the circuit for operating relay 205 and the holding circuit for relay 203 so that the timing circuit is ineffective to release or lock the sender during the time that it is waiting for response by the terminating operator. However, the operation of relay 214 does not prevent the operation of the auxiliary relay in some other sender, for relay 214 when operated closes a substitute link in the chain circuit.

If it is desired to cancel this unlimited wait for the terminating operator, key 228 is operated so that whenever class relay 220 is operated, relay 212 will also be operated. With relay 212 operated, relay 214 cannot operate following the operation of relay 213, but with both relays 212 and 213 operated the circuits for operating relays 216 and 211 are opened. However, if the time-out relay 210 operates, while relays 212 and 213 are operated, a circuit is closed from ground on conductor 207, front contact of relay 210, back contact of relay 214, front contacts of relays 213 and 212 to the winding of relay 205 which gives a reorder signal and releases the sender as previously described. If the sender should fail to release, the operation of relay 218 connects ground over its front contact, front contact of relay 212, back contact of relay 214 to conductor 215 to cause other senders which time out to release.

What is claimed is:

1. In a telephone system a plurality of control circuits, each control circuit including timing means, a time-out relay under the control of said timing means and an auxiliary relay normally under the control of said time-out relay, and means for operating the auxiliary relay in one and only one control circuit in response to the operation of the time-out relay in said control circuit comprising a chain circuit including a normally closed contact on the auxiliary relay in each of said plurality of control circuits and a normally closed contact on the time-out relay in certain of said control circuits.

2. In a telephone system a plurality of control circuits, each control circuit including timing means, a time-out relay under the control of said timing means and an auxiliary relay normally under the control of said time-out relay, means for operating the auxiliary relay in one and only one control circuit comprising a chain circuit including a normally closed contact on each auxiliary relay and a normally closed contact on a plurality of time-out relays, and means under the control of said auxiliary relay to prevent the release of the associated control circuit.

3. In a telephone system a plurality of control

circuits, each control circuit including timing means, a time-out relay under the control of said timing means and an auxiliary relay normally under the control of said time-out relay, means for operating the auxiliary relay in one and only one control circuit comprising a chain circuit including a normally closed contact on each auxiliary relay and a normally closed contact on a plurality of time-out relays, and means under the control of said operated auxiliary relay to prevent said time-out relay in other control circuits from operating the associated auxiliary relay.

4. In a telephone system a plurality of control circuits, each control circuit including timing means, a time-out relay under the control of said timing means and an auxiliary relay normally under the control of said time-out relay, means for operating the auxiliary relay in one and only one control circuit comprising a chain circuit including a normally closed contact on each auxiliary relay and a normally closed contact on a plurality of time-out relays and means under the control of said operated auxiliary relay to render the time-out relays in the others of said control circuits effective to release said control circuits.

5. In a telephone system a plurality of control circuits arranged in a predetermined order, each control circuit including timing means, a time-out relay under the control of said timing means and an auxiliary relay normally under the control of said time-out relay, means for operating the auxiliary relay in one and only one control circuit comprising a chain circuit including a normally closed contact on each of said auxiliary relays and a normally closed contact on each of the time-out relays in the control circuits later in said series, and a locking circuit for said auxiliary relay including a normally closed contact on each of the auxiliary relays in the control circuits earlier in said series.

6. In a telephone system a plurality of control circuits, each control circuit including timing means, a time-out relay under the control of said timing means and an auxiliary relay normally under the control of said time-out relay, an automatic release relay, means for operating the auxiliary relay in one and only one control circuit comprising a chain circuit including a normally closed contact on each auxiliary relay and a normally closed contact on a plurality of time-out relays, means under the control of said operated auxiliary relay in said one control circuit to place the automatic release relay under the control of the associated time-out relay in each of the other control circuits, and means under the control of an operated automatic release relay to restore the associated control circuit to normal.

7. In a telephone system a plurality of control circuits, each control circuit including timing means, a time-out relay under the control of said timing means, an auxiliary relay and an automatic release relay, means responsive to the first operation of a time-out relay in one of said control circuits to operate the associated auxiliary relay, means under the control of said auxiliary relay to prevent the restoration of said control circuit to normal and means also under the control of said auxiliary relay to cause the operation of other time-out relays to operate the associated automatic release relay, said automatic release relay being effective to restore the associated control circuit to normal.

8. In a telephone system, trunk circuits, reorder signaling means in said trunk circuits, link circuits, control circuits, means responsive to the seizure of said trunk circuits for operating said link circuits to connect said trunk circuits with said control circuits, timing means, a time-out relay, an auxiliary relay and an automatic release relay in each of said control circuits, means common to said control circuits for causing said time-out relay to operate the associated auxiliary relay in one of said control circuits and to operate the associated automatic release relay in others of said control circuits in accordance with the order in which said timing means complete their operations, and means under the control of said auxiliary relay or said automatic release relay to operate said reorder signaling means in the associated trunk circuit, said operated automatic release relay being effective to release said link circuit and said operated auxiliary relay being effective to prevent the release of said link circuit.

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