Jan. 23, 1940. R. E. HERSEY 2,187,784

TELEPHONE SYSTEM

Filed June 17, 1938 4 Sheets-Sheet 1

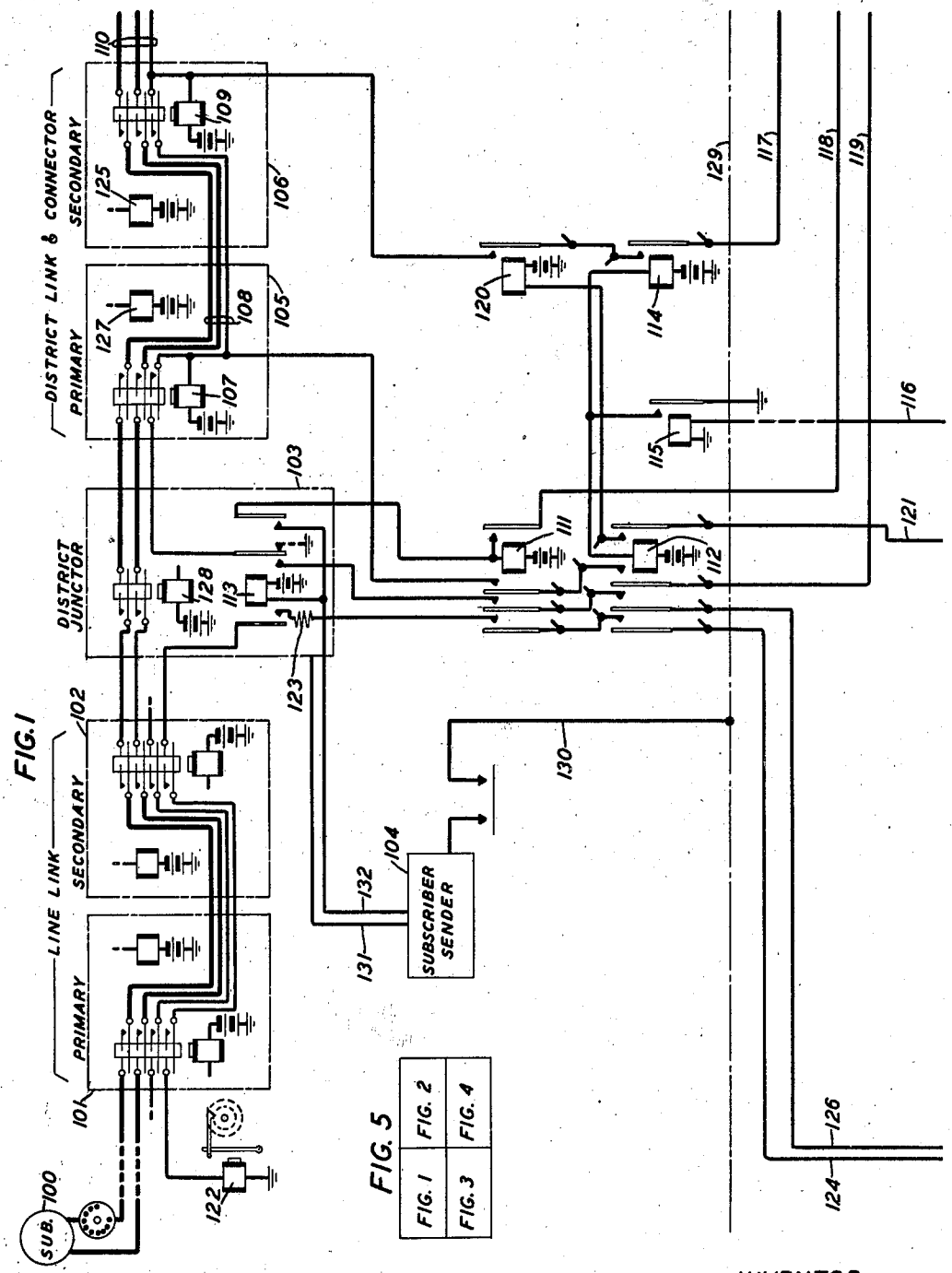

FIG. 1

FIG. 5

FIG. 1	FIG. 2
FIG. 3	FIG. 4

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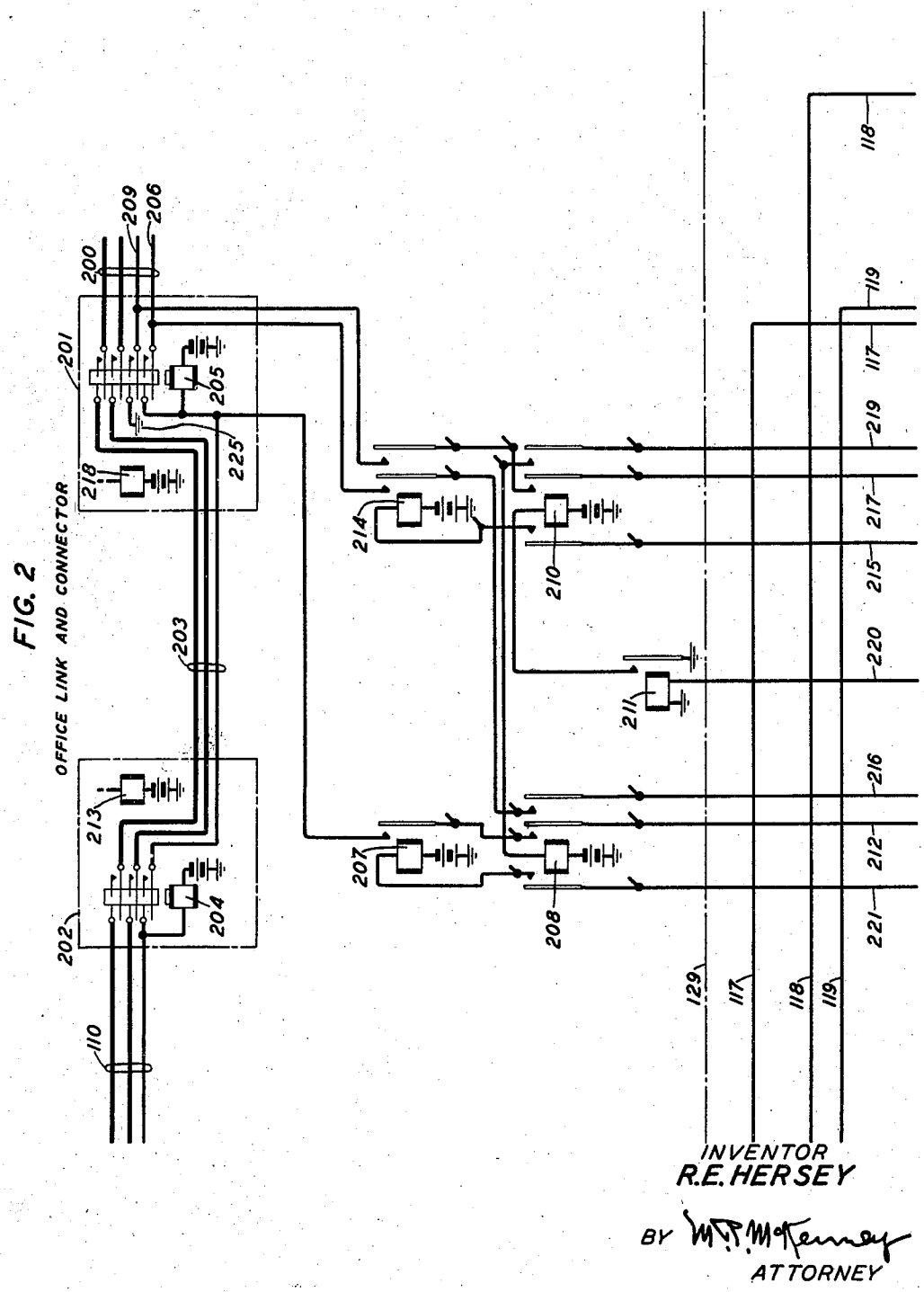
TELEPHONE SYSTEM

Filed June 17, 1938 4 Sheets-Sheet 2



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TELEPHONE SYSTEM

Filed June 17, 1938 4 Sheets-Sheet 3

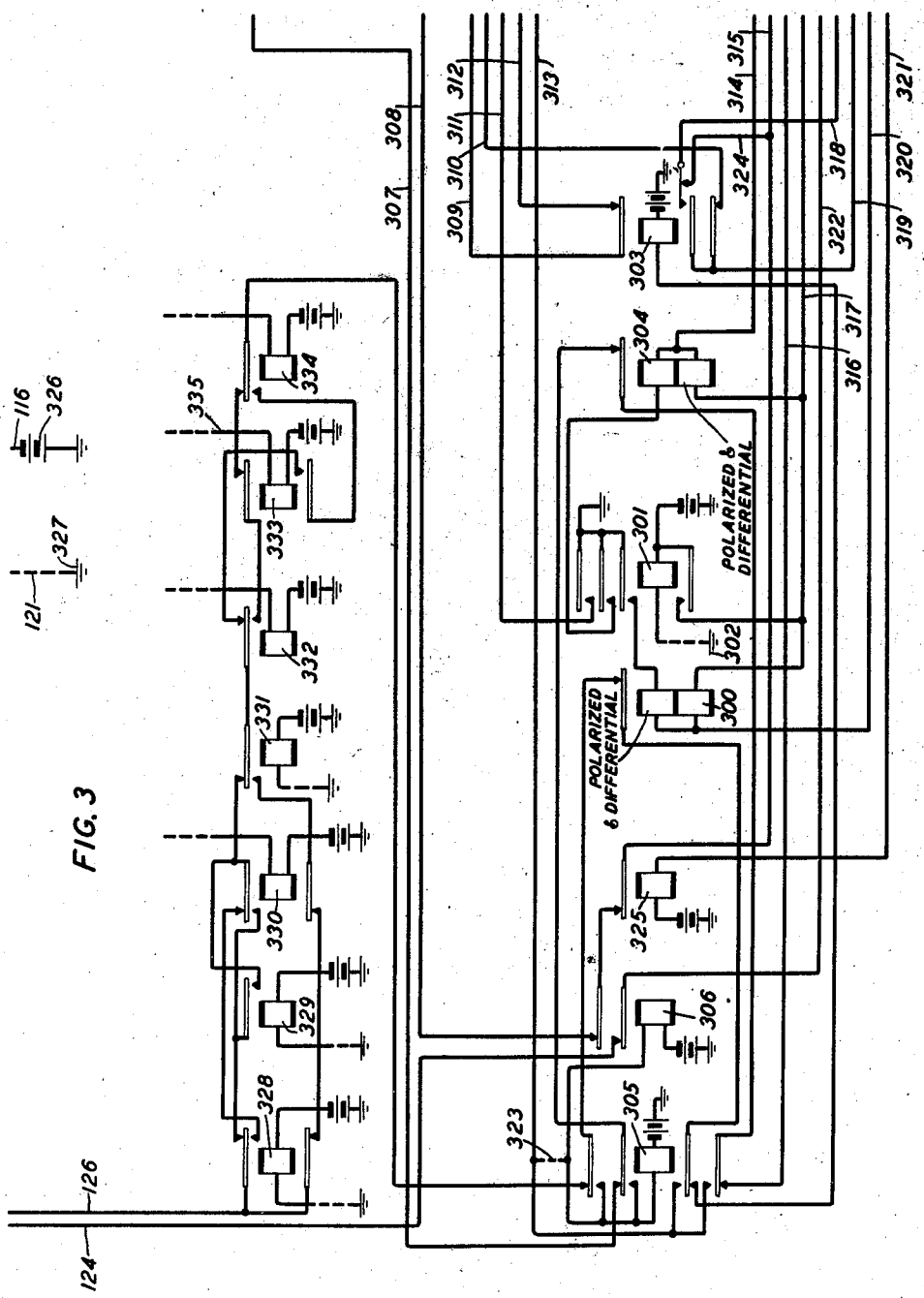

FIG. 3

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Jan. 23, 1940. R. E. HERSEY 2,187,784

TELEPHONE SYSTEM

Filed June 17, 1938 4 Sheets-Sheet 4

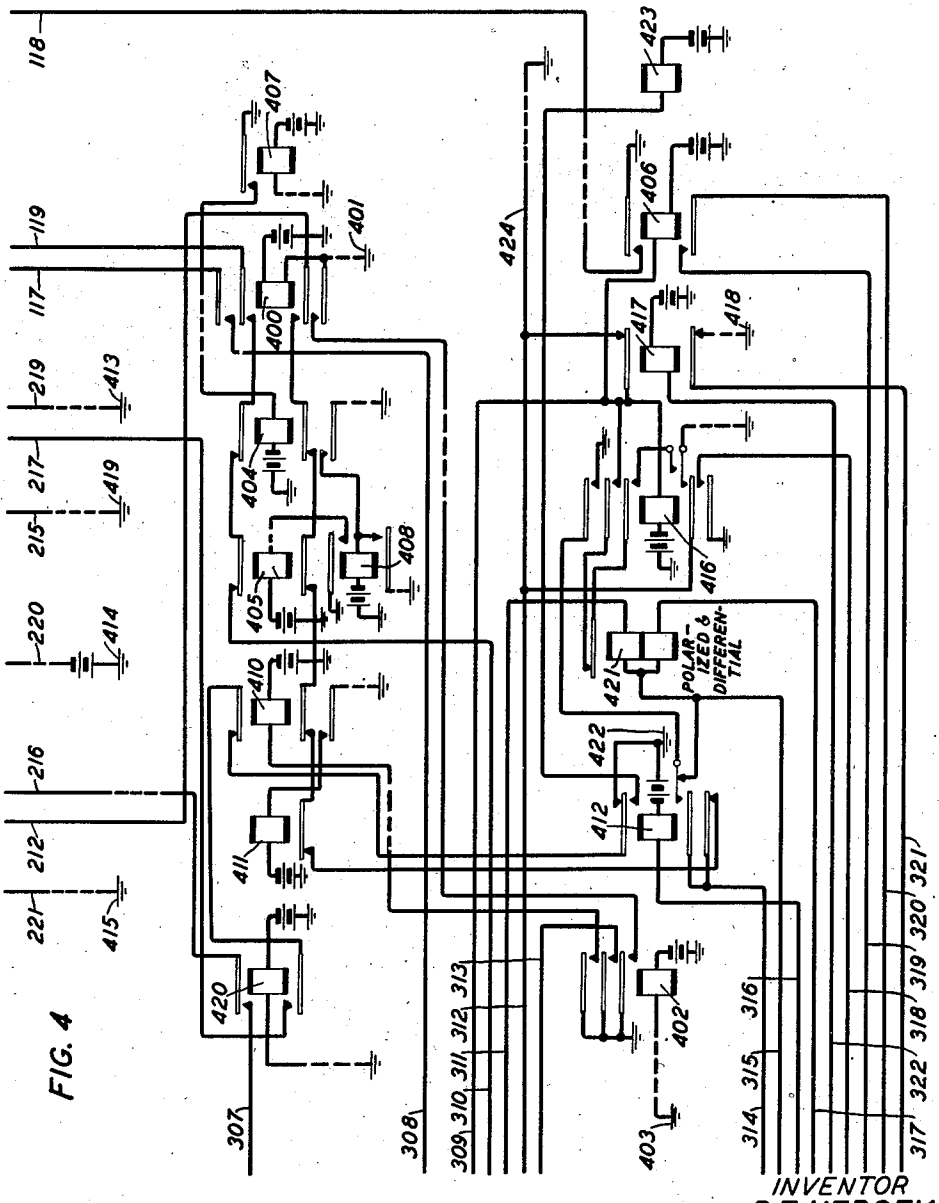

FIG. 4

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Patented Jan. 23, 1940 2,187,784

UNITED STATES PATENT OFFICE

2,187,784

TELEPHONE SYSTEM

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Application June 17, 1938, Serial No. 214,353

5 Claims. (Cl. 179—175.2)

This invention relates to telephone systems and particularly to systems in which automatic switches are used for establishing conversational connections.

The objects of the invention are to obtain a more positive and complete test of the operative condition of the switches and connecting circuits used in establishing a talking connection; to test the condition of the connecting circuits both before and after the switches are operated to close the desired connection; to combine in the same control mechanism the function of performing the verifying tests and the function of operating the selective switches; and otherwise to secure improvements in systems of this kind.

The present invention is applicable to systems of the character in which the selective switches are operated under the control of register senders or markers located at the central office, and which receive the called designations either from a subscriber's dial or from an operator's position. Where cross-bar switches are used in these systems and common markers are associated temporarily with the switch frames for the purpose of testing trunks and links interconnecting the different switches and for the purpose of operating the switch magnets to close the contact sets and establish the connection over the links and trunks, it is particularly desirable to test the several circuits involved for unstandard conditions and to test the connection after its establishment for continuity through the closed contacts of the switches and also for the presence of any unstandard conditions. Since the common marker that controls the establishment of these connections causes the selective operation of the switch magnets, and since the success of the finally established connection depends upon the component connecting circuits being free from any unstandard conditions and upon the proper closure of all of the switch contacts involved, the several verification tests can best be made by mechanism located in the marker and which cooperates with the mechanism that causes the operation of the switch magnets. If the various tests are all successful, the marker proceeds in its regular manner with the establishment of the connection and with its release from the switch frames after the connection has been completed. On the other hand, if trouble is encountered at any stage, the marker is in a position to prevent any further progress with the connection and to bring into operation trouble indicating devices for making a record giving the details of the trouble condition.

A feature of the invention is a system of the general character above mentioned in which a common marker serves to operate a plurality of successive switches to establish a connection by joining in tandem a plurality of serially related link circuits; in which the links are tested to determine if their conductors are continuous and are in proper condition for operating the switches; in which the switches are operated to establish the connection, and the operated contacts of all switches are then tested to determine if they have closed properly; in which all links are again tested to determine if they are free from unstandard conditions; and in which the marker refuses to proceed with the normal establishment of the connection in case any of these tests proves unsatisfactory.

Another feature is a combined verifying and switch operating mechanism in which relays are connected respectively to the successive links involved in a connection to test the conductors of said links, to control the operation of the successive switches, to control the test of the closure of the successive contacts in the established connection and to test the connection after its establishment for the presence of any unstandard conditions.

The foregoing and other features of the invention will be described more in detail in the folowing specification.

The specification is accompanied by drawings in which:

Fig. 1 shows in abbreviated schematic form a subscriber line connected through a line link and control circuit and district junctor to a district link and connector circuit;

Fig. 2 shows similarly an office link and connector circuit which serves to further extend the connection from a calling line;

Figs. 3 and 4 disclose part of a common switch controlling marker; and

Fig. 5 is a block diagram showing the manner in which the several figures of the drawings should be arranged.

General description

The invention is illustrated in an automatic telephone system in which automatic switches of the cross-bar type are used as the medium for extending connections from subscribers' lines over trunks to other subscribers' lines. These cross-bar switching mechanisms are controlled by register senders at the central office, which receive the designations from the calling subscribers' dials, and by decoder markers, which are

connectable to the senders for receiving information from the senders, and which are connectable to the proper switch frames for the purpose of testing the outgoing trunks and for testing the connecting links and for operating the magnets of the cross-bar switches to establish the connections.

While the system disclosed is not limited to the use of cross-bar switches of any particular type, reference may be had to the patent to Reynolds 2,021,329 of November 19, 1935, for an understanding of the construction and operation of a switch suitable for use in such systems. Because of the complicated nature of these systems, and since it is not necessary to an understanding of the invention that the system in all of its details be disclosed, much of the circuits and equipment has been eliminated in the present disclosure for the sake of simplicity. And in the following descriptions reference will be made to numerous operations which are not fully disclosed in all of their details. Wherever such references occur it will be understood that the circuits and equipment so referred to are already old in the prior art, and in particular reference is here made to the following for a detailed disclosure of all operations and equipment referred to herein but not specifically disclosed: Carpenter Patent 2,093,117 of September 14, 1937; and Carpenter application Serial No. 214,356, filed June 17, 1938.

When the subscriber at station **100** initiates a call, a connection is established through the cross-bar switches **101** and **102** to the district junctor circuit **103**, and to a subscriber sender **104**, represented schematically by a box. Sender **104** is connected by a plurality of conductors, represented conventionally by conductor **131**, to district junctor **103** and to junctor relay **113** by conductor **132**. It is also connected by a plurality of conductors to the marker circuit shown in part by Figs. 3 and 4. This connection is indicated conventionally by the connection of conductor **130** to the marker boundary line **129**. When the subscriber dials the office code, this is recorded in the sender, and then the marker in cooperation with the sender determines the pair of office frames upon which is located the group of trunks leading to the called destination. An idle trunk **200** of the district group, located on the secondary office switch **201**, is then selected and the marker proceeds to select an idle connecting channel extending from junctor **103** to the trunk **200**. This channel consists of a link **108**, connecting primary and secondary district switches **105** and **106**, junctor **110** connecting secondary district switch **106** and office primary switch **202**, and link **203** connecting primary and secondary office switches **202** and **201**.

Detailed description

The aforementioned idle channel having been selected, this system will now be described in detail. After an available channel consisting of the link **108**, junctor **110** and link **203** has been selected, relay **400** which is identified with the selected channel, operates through a circuit from ground **401**. Relay **400** operated, locks through its lowermost contacts to ground on the innermost contacts of relay **402**, which operates from ground **403**, when a circuit is closed indicating that the register relays of the marker have operated and registered the office code, the district frame with which the calling district junctor **103** is associated and that certain other functions have been performed. Relay **400** operated now closes three circuits through its two upper, and its lower inner contacts, which closure initiates the performance of the following functions:

(1) The operative condition of the links **108** and **203** of the district link and connector circuit and of the office link and connector circuit respectively, which are identified with the selected channel, is checked.

(2) If the aforesaid links **108** and **203** are found to be in operative condition, then hold magnets **107**, **109**, **204** and **205** are operated.

(3) With the hold magnets all operated, a test is made to determine the continuity of the established connection through the operated contacts of the switches **105**, **106**, **202** and **201**.

(4) With the connection established from the calling district junctor **103** to the outgoing trunk **200**, the marker before releasing makes certain tests to determine if any unstandard conditions exist. If any of these tests indicates an unstandard condition then the call is blocked, and the marker releases after a predetermined interval. The aforementioned tests are as follows:

(*a*) Checking the operation of a relay in the district junctor, which relay is operated when the tip party of a two-party line is calling.

(*b*) Checking the condition set up in the district junctor, when the call is other than a tip party call.

(*c*) Checking the condition of the district junctor for calls to an operator.

(*d*) Checking the district junctor circuit for the operation of a relay that establishes a talking charge condition.

(*e*) Checking a no-charge condition in the district junctor.

(*f*) Checking the registration of a zone-charge condition in the multiple registration circuit.

(*g*) Checking for the condition existing on a zone-charge call when all multiple registration circuits are busy in the case of district junctors arranged for message rate or time charging of local calls, or for no-message rate or time charging of local calls.

(*h*) Checking the continuity of the circuit through which the message register of the calling line operates.

(*i*) Checking for the presence of ground on the sleeve conductor of the outgoing trunk to make sure that the trunk will be held busy after the call is established.

The various features before outlined will now be discussed in order.

Checking the operative condition of the links of the selected channel

Relay **400** operated closes two circuits for checking the operative condition of links **108** and **203** identified with the selected channel. If there is no ground on the winding terminals of associated hold magnets **107** and **205**, and a battery potential is found thereon, it is an indication that these magnets are in an operative condition. If a trouble ground is connected or a cross ground from another operated hold magnet, which might for instance be connected through contacts of relay **111**, which are multipled to contacts of a similar relay not shown, it would be an indication that the link associated with this magnet is unavailable. If no battery should be connected to the winding, due perhaps to a blown fuse, or should the operating circuit be open for any reason, this also is a condition which the test about to be described would detect. Assuming that the magnet **107** is in operative condition, a circuit is

accordingly closed for polarized relay 300. The upper and lower windings of this relay are connected differentially in series, by the connection of ground on the upper innermost contacts and battery on the lower contacts of relay 301, which operates from ground 302, to register an off-normal condition of the marker in a manner similar to relay 402, before discussed. The lower winding of relay 300 predominates magnetically and causes its contacts to remain closed. The operating circuit for relay 300 may be traced from battery through the winding of magnet 107, left inner contacts of relays 111 and 112 over conductor 119 through upper inner operated contacts of relay 400, upper outer break contacts of relays 404 and 405 over conductor 310 through lower outer break contacts of relay 303, over conductor 319, through lower make contacts of relay 406, over conductor 320, and through the upper winding of relay 300 to ground on the upper innermost contacts of relay 301. This circuit connection causes the current in the lower winding of relay 300 to be reduced due to the shunting effect of the winding of magnet 107 and the current in the upper winding of relay 300 to be increased due to the reduction of circuit resistance from the multipled connection of the lower winding of relay 300 and the winding of magnet 107. The current in the upper winding of relay 300 now predominates and relay 300 operates, opening its break contacts. If, however, there is a ground on the winding of hold magnet 107 then the current in the lower winding of relay 300 is increased while the upper winding is short-circuited by the direct ground connection. Relay 300 under this condition accordingly does not operate.

The functions of the several relays having contacts in the test circuit above discussed will now be mentioned in detail, these relays and their functions being the same as those disclosed in greater detail in the above-mentioned application of W. W. Carpenter Serial No. 214,356, filed June 17, 1938. Relay 111 is identified with the group of district junctors in which junctor 103 is located and is operated from ground in sender 104, through the outer operated contacts of relay 113. Relays 112 and 114, connected in multiple, are marker connecting relays and are furnished one per marker for each district link and connector frame. These relays operate when ground is connected by the operation of relay 15, which in turn is operated when start battery 326 is connected over conductor 116 by the marker which may be selected to handle the call initiated by the subscriber of station 100. Relay 404 is a relay that is held operated from ground on the contacts of relay 407, which latter relay operates when the channel test paths are closed. In order to insure that all hold magnets have ample time to release fully, after the channel test is made, and before their operation is started, the opening of the circuit of relay 404 is delayed for an interval. During this delay relay 408 is connected to make a final test for ground on sleeve conductor 206 of the selected trunk to make sure that this trunk is then actually available. If the test then discloses the presence of ground on this sleeve conductor, then relay 408 operates and locks and operates relay 405. If relay 405 should thus be operated the circuit before traced for relay 300 is not closed and relay 300 is not operated. In other words, the link associated with district primary hold magnet 107 is reported unavailable if ground should thus be found on the sleeve conductor 206 of the selected trunk 200, with which is associated link 108 of the channel selected to reach said trunk 200. The operation of relay 300 is also blocked if relay 406 also fails to operate and thereby close its lower contacts. Relay 406 and relay 416 in multiple therewith, operate through upper break contacts of relay 417 and over conductor 424, which is extended through a circuit and contacts not shown, of relays 112, 111 and 113, to check the operation of these relays.

When relay 400 operates a second circuit is also closed for operating relay 304 to test the availability of link 203 between office primary switch 202 and office secondary switch 201. Relay 304 is a polarized relay similar to relay 300 before described. Its windings are connected differentially in series, the upper winding being connected to ground on the upper middle contacts and its lower winding to battery on the lower contacts of relay 301. The operating circuit for relay 304 may be traced from battery through the winding of secondary office hold magnet 205, contacts of relay 207, right inner contacts of relay 208, over conductor 212 through lower inner contacts of relay 400, lower inner break contacts of relay 404, lower contacts of relay 405, lower inner contacts of relay 410, lower contacts of relay 411, lower outer break contacts of relay 412, over conductor 314 to the center point of the connection between the upper and lower windings of relay 304. As in the case of relay 300, if there is no ground on the winding of magnet 205, the shunting effect of this winding on the lower winding of relay 304 reduces the current in this winding, while at the same time the current in the upper winding is increased so that relay 304 operates. If, however, there is a trouble ground on the winding of magnet 205, the current in the lower winding of relay 304 is increased by the direct ground connection, while the upper winding is short-circuited. The effect of this is to cause relay 304 to maintain its contacts closed. If no battery should be connected to the winding of magnet 205, then, of course, relay 304 fails also to operate for this type of trouble condition. Relays 410 and 411, through the lower break contacts of which the operating circuit for relay 304 was traced, are relays that are operated and held when two markers select the same trunk and then test the same sleeve conductor 209. In other words, if the condition of a single trunk being selected simultaneously by each of two markers occurs, then the operation of the test relay 304 is prevented by the operation of relays 410 and 411. The operating circuit for relay 304 was traced through contacts of relays 207 and 208. Relay 208 is operated from marker ground 413 through right outer contacts of associated relay 210, and over conductor 219 when relay 210 operates due to the selective operation of relay 211 by marker battery 414 over conductor 220. Relays 208, 210 and 211 are operated, since these relays are associated with the office frame on which is located the selected trunk 200. Relay 207 is selectively operated from marker ground 415, over conductor 221 and through left contacts of relay 208 and is identified with the particular switch of the selected office frame upon which the selected link 203 terminates.

The operation of relays 300 and 304 to check the availability of the links between the primary and secondary district switches 105 and 106, respectively, and between the primary and secondary office switches 202 and 201, respectively, has been just discussed. If as before described, one

of these links has been found unavailable due to the improper grounding of the associated hold magnet 107 or 205, or due to the absence of battery potential and relay 300 or 304 did not operate, then the call is blocked as to be hereinafter described. The call is also blocked if the operation of relay 300 or 304 is prevented by non-continuous circuits through the contacts of the several relays, as hereinbefore described. When for any reason relay 300 or 304 fails to operate, resulting in the blocking of the call, a trouble release signal is given to the subscriber sender, as described in the aforesaid Carpenter application Serial No. 214,356, filed June 17, 1938, the marker releases and the subscriber sender selects another marker for a second trial. If, however, the links 108 and 203 associated with relays 300 and 304 respectively, are satisfactory for use as indicated by the operation of these relays, they and associated apparatus function as now to be described.

Operation of hold magnets

Magnets 107 and 205 start their operation in series with the windings of relays 300 and 304, respectively. Relay 300 in operating opens with its break contacts a locking circuit for relays 305 and 306, which circuit is traced from battery through the windings of relays 305 and 306 in multiple, upper outermost make contacts of relay 305, contacts of relay 300, lower innermost make contacts of relay 305 to ground on the upper middle contacts of relay 402 over conductor 313 which ground operated relays 305 and 306 over conductor 313 through a circuit, not shown but indicated by the broken lines 323. Relay 304 in operating also opens a second locking circuit for relays 305 and 306. This circuit is traced from the windings of relays 305 and 306 through upper, innermost make contacts of relay 305, break contacts of relay 304, and lower outermost make contacts of relay 305 to the operating ground on conductor 313. Relays 305 and 306 accordingly release. It should be observed here that to effect the release of relays 305 and 306, both relays 300 and 304 must operate; if only one relay operates, indicating that only one of the tested links is available, then relays 305 and 306 do not release and the circuit for the subsequent operation of relays 303 and 412, is kept open at the lower inner and outer break contacts of relay 305, respectively, and the operating circuit for magnets 109 and 204 is open at the outer break contacts of relay 306. Relay 306 released closes a circuit from ground on the upper outermost make contacts of relay 416, operated as hereinbefore described, through lower inner normally closed contacts of relay 412, over conductor 315 to junction point 324 and in multiple with this circuit path another circuit path from ground on the lower outermost contacts of relay 416 over conductor 313 through lower inner normally closed contacts of relay 303 to said junction point 324, thence through break contacts of relay 325, upper outer break contacts of relay 306, over conductor 308, through upper outermost contacts of operated relay 400, over conductor 117, through contacts of relays 114 and 120 to the multipled windings of hold magnets 109 and 204 of the district secondary and office primary switches which magnets are now operated. The purpose of relay 114 has already been described. Relay 120 is operated through the right contacts of relay 112, over conductor 121 from ground 327 in the marker circuit and is one of a number of similar relays in the district link and connector circuit, each one of which is connected through individual contacts on the marker connecting relay 112. The proper relay 120 is selectively operated by the marker route relays and its selective operation gives access to the junctors, for example, junctor 110, which connect the calling district frame with the office frame upon which is located the group of trunks extending to the called location. Relay 325 is controlled over conductor 321, through a circuit connecting with the lower break contacts of relay 417.

Relay 417 is arranged to check the continuity of the path for the subsequent operation of line message register 122. The operating circuit for relay 417 is traced from ground through winding of message register 122, lowermost switch contacts of line link switches 101 and 102, left operated contacts of relay 113, resistance 123, left outermost contacts of relays 111 and 112, over conductor 124, through inner contacts of relay 306 over conductor 322 and through winding of relay 417 to battery. If the circuit path just traced is closed, indicating that register 122 can be subsequently operated, relay 417 operates, but not register 122. If for any reason relay 417 should fail to operate, indicating that the circuit for the register 122 is open, then relay 325 operates subsequently from ground 418 and opens with its break contacts the operating circuit for magnets 109 and 204.

Assuming now that the circuit path for operating magnets 109 and 204 is closed, these magnets operate and close the associated cross-points of switches 106 and 202, it being understood that the select magnets 125 and 213 were previously operated, through circuits not shown here in detail. If magnets 107 and 205 are now not yet completely operated through the circuits just traced through the windings of relays 300 and 304 respectively, their operation is now insured and completed by the direct ground connection extended to the left through operated innermost switch contacts of magnet 109 towards magnet 107 and to the right towards magnet 205 through operated innermost switch contacts of magnet 204, provided, however, that magnets 109 and 204 have actually operated and closed properly their associated contacts.

Checking the continuity of the circuit through operated switch contacts

With all hold magnets 107, 109, 204 and 205 energized and presumably operated the means for checking their actual operation as evidenced by a continuous circuit through their respective associated innermost operated switch contacts, will now be discussed. With relay 300 operated as before described, when magnet 109 operated its operating ground was extended through its associated innermost operated switch contacts to the winding of magnet 107. This operating ground now acts, over the operating circuit for relay 300 before traced, as a shunt on the upper winding of relay 300, which accordingly releases, responding only to the effect of its lower winding. Similarly, the same operating ground is extended through associated innermost switch contacts of magnet 204 to the winding of magnet 205, causing the release of relay 304 by reason of the shunting of its upper winding. The release of relays 300 and 304 is evidence of the satisfactory closure of the switch contacts associated with magnets 109 and 204, respectively, and said release closes circuits for testing the

satisfactory closure of the switch contacts associated with magnets 107 and 205 (it being understood that select magnets 127 and 218 have been previously operated through circuits not shown) and at the same time determines whether certain standard circuit conditions necessary for the successful functioning of the established connection exist. The functioning of the circuits for testing the closure of the switch contacts associated with magnets 107 and 205 will be described first. Ground connected through the innermost operated switch contacts of magnet 107 is extended through right operated innermost contacts of relay 113, left middle operated contacts of relays 111 and 112, over conductor 126, contacts of relays 328, 329, 330, 331, 332, 333 and 334, operated or not operated in various combinations as to be hereinafter discussed when the testing for standard conditions is described. When all conditions are standard a continuous circuit through the contacts of the aforementioned relays is closed. From the armature of relay 334 the circuit being traced continues through upper outer break contacts of relay 305, break contacts of relay 300 released as described, lower inner break contacts of relay 305 and to battery through the winding of relay 303, which operates, indicating that the circuit through the switch contacts associated with magnet 107 has been satisfactorily closed. Another circuit, to test the contacts of magnet 205, is traced through the winding of relay 412 from the operating ground of magnet 205 through its inner associated switch contacts and through inner contacts of relay 214 which is one of a number of similar relays of the office link and connector circuit which is selectively operated through left contacts of relay 210, over conductor 215, from ground 419 in the marker. The particular relay 214 which is operated depends upon the level of the switch horizontal upon which the selected trunk is found. From the inner contacts of relay 214 the circuit being traced continues through right outer contacts of relay 208, over conductor 216, upper operated contacts of relay 420, over conductor 307, through upper inner break contacts of relay 305, break contacts of relay 304, released as described, lower outer break contacts of relay 305, over conductor 316 and to battery through winding of relay 412, which operates if the circuit is complete. Relay 420 through the upper contacts of which the circuit for relay 412 was traced, is operated in response to the selection of the idle trunk 200. Relay 303 in operating opens with its upper contacts one of three holding circuits for the multiplied relays 406 and 416 by disconnecting conductor 309 from conductor 312. The other circuits are opened by relays 417 and 421. Relay 417 in operating as before described disconnects with its upper break contacts conductor 312 from the windings of relays 416 and 406. The operation of polarized relay 421 will now be discussed. Normally the upper winding of relay 421 is connected over conductor 311 to ground on the upper outermost contacts of relay 301 and the lower winding over conductor 317 to battery on the lower contacts of relay 301. Ground is also connected to the center point of the upper and lower windings of relay 421 through lower inner normally closed contacts of relay 412 to ground on the upper outermost contacts of relay 416, and also over conductor 315 through lower inner normally closed contacts of relay 303, over conductor 318 to ground on the lower outer contacts of relay 416. When relays 303 and 412 operate through the circuits before traced, the ground shunt is removed from the common winding terminal of relay 421 which then operates from ground on the upper outermost contacts of relay 301, over conductor 311, through upper winding of relay 421, over conductor 315, thence through the circuit path hereinbefore traced for the operation of hold magnets 109 and 204. The upper winding of relay 421 is also energized (*a*) through its lower winding to battery, (*b*) through the windings of magnets 107 and 205 and switch contacts of magnets 109 and 204, (*c*) through windings of relays 303 and 412, connected by way of switch contacts associated with magnets 107 and 205. Relay 421 does not operate, however, if after the grounds on the upper and lowermost contacts of relay 416 have been removed by the operation of relays 303 and 412, there still remains a trouble ground, connected to the winding terminals of hold magnets 109 and 204, which would continue to shunt the upper winding of relay 421, thereby preventing its operation. If, however, relay 421 operates, then all holding circuits for relays 406 and 416 are opened and these relays release.

Relay 303 in operating connects ground on the lower outer make contacts of relay 416, over conductor 318, through lower inner make contacts of relay 303, over conductor 319, through lower make contacts of relay 406, over conductor 320 to the center winding terminal of relay 300, thereby maintaining this relay non-operated. A similar connection is made for relay 304 when relay 412 operates and connects ground on the upper outermost make contacts of relay 416, through its lower make-before-break contacts to conductor 314, thereby holding relay 304 non-operated. This arrangement of grounding the center winding terminals of relays 300 and 304 when relays 303 and 412 operate insures that the operating circuits of relays 303 and 412 are satisfactorily maintained through the contacts of relays 300 and 304. Relays 303 and 412 in operating disconnect with their lower outer break contacts the operating circuits before traced for relays 300 and 304, respectively. Relay 412 in operating also functions with its upper transfer contacts to hold trunk 200 busy and to effect the normal release of the marker as to be hereinafter described.

When the connection between the district junctor 103 and the selected trunk 200 has been established, the marker circuit then tests for certain standard conditions before releasing. These will now be discussed as before outlined.

Checking the tip party relay in the district junctor

In order to insure that a calling tip party on a two-party selective subscriber line is properly charged and not the ring party the operation of relay 333 is effected by applying ground in the sender 104 to the conductor 335 and in operating causes a relay, not shown, in the district junctor 103, to operate. This latter relay when operated, causes a ground indication to be returned to the marker effecting the operation of the tip party check relay 334. With relays 333 and 334 thus operated, relay 332, which is operated as hereinafter described for calls other than tip party calls, must not be operated. With relays 333 and 334 operated the operating circuit for relay 303, hereinbefore traced, passes through make contacts of relays 334 and 333 and break contacts

of relay 332. Should an unstandard condition exist as would be indicated by relays 332, 333, 334 all not operated or relays 332 and 333 both operated, or relays 332 and 334 both operated, or only relay 333 or relay 334 either alone operated, then relay 303 would not operate, the holding circuit for relays 416 and 406 would not be opened and the marker circuit would be released only after a time interval, the sender selecting another marker to complete the call. In the case of an operator class call from a tip party line, the ground indication is not returned to the marker from the district junctor. In this class of call, accordingly, the marker must cancel the test for the tip party line and cause the operation of relays 333 and 334 so as to close partially the circuit for the operation of relay 303.

Checking for a call other than a tip party call

For a call other than a tip party call a circuit is closed for operating relay 332, but neither relay 333 nor 334 is operated under this condition. The circuit for relay 303 is accordingly taken through break contacts of relays 334 and 333 and make contacts of relay 332. If relay 332 should fail to operate under this condition the call would be blocked.

Checking for an operator class call

For an operator class call a relay in the district junctor circuit, not shown, is operated and locked and the locking ground is returned to the marker operating relay 330. Under this condition the operating circuit for relay 303 passes through make contacts of relay 330. If relay 330 should fail to operate under this condition the call would be blocked.

Checking the district junctor for a talking charge condition

The district junctor 103 is arranged so that a talking charge relay, not shown, is operated, whenever the message register 122 is to be operated once for each call, or once for each predetermined timed interval, when the call over the selected trunk 200 is completed. The operation of the aforesaid relay causes a ground to be returned to the marker which operates relay 330. The circuit for relay 303 accordingly passes through make contacts of relay 330 and upper break contacts of relay 328. Relay 328, which is operated for a zone charge condition as hereinafter described, must not be operated when relay 330 is operated. Accordingly should relay 330 not be operated with relay 328 not operated, or should relays 330 and 328 both be operated then relay 303 cannot operate and the call would be blocked.

Checking a no-charge condition in the district junctor

In the case of calls for which the message register 122 should not be operated, the talking charge relay of district junctor 103 is not operated and the no-charge relay 331 is operated in response to the operation of a certain route relay, not shown, which is operated when the call is directed to a destination for which there is to be no charge. Under this condition the circuit for relay 303 is completed through make contacts of relay 331 and lower break contacts of relay 330, which under this condition should not be operated. Should relay 331 fail to operate, or should relay 330 simultaneously operate for this condition, then relay 303 would not operate and the call would be blocked.

Checking the registration of a zone charge condition

Whenever the calling subscriber initiates a call to a zone beyond the local area for which one or more operations of register 122 is required, district junctor 103 calls into service a multiple registration common control circuit, not shown. When the zone charge condition has been properly registered in the common control circuit, relay 328 is operated and the circuit for relay 303 is then completed through make contacts of relay 328. For this condition relay 330 should not be simultaneously operated. If relay 328 should fail to operate, or should both relays 330 and 328 be simultaneously operated, then the circuit for relay 303 would be open and the call would be blocked.

Checking for a zone charge call when all multiple registration circuits are busy

When all multiple registration circuits are busy, relay 329 is operated which causes the operation through a circuit, not shown, of the talking charge relay of district junctor 103, of which relay the operation was hereinbefore discussed. With this arrangement the calling party may be undercharged, but suffers no delay because of the all-busy condition of the zone registration circuits. Relay 330 is accordingly operated, and the operating circuit for relay 303 is completed through make contacts of relay 330 as described under "Checking the district junctor for a talking charge condition". There is also another circuit path through contacts of relay 329 which is not necessary when a talking charge relay is furnished in the district junctor, but which is required when no talking charge relay is furnished as described in the following paragraph.

For district junctors that are arranged so that the message register 122 is operated only when a multiple registration circuit is called into service, a talking charge relay is not furnished. Consequently when relay 329 is operated due to all multiple registration circuits being busy as before described, no ground is returned to operate relay 330 and it is accordingly necessary that the check for the operation of the district talking charge relay be canceled. This is accomplished when relay 329 operates and short-circuits the make contacts of relay 330, thereby preparing the operating circuit for relay 303. If relay 329 should fail to operate under this condition, the call would be blocked.

Checking for the continuity of the message register circuit

When relays 111, 112 and 113 have operated and when an idle channel between the district junctor 103 and the selected trunk 200, has been selected and relay 306 has released, a circuit is closed for operating relay 417 which was described in connection with "Operation of hold magnets". Should relay 417 fail to operate indicating that the message register circuit is open, then relays 416 and 406 are not released. Relay 406 in not releasing prevents the release of relay 111 locked through its right contacts over conductor 118. District junctor relay 113 is also held to the same ground through its right outer contacts. The marker would accordingly not release until timed out. If relay 417 should operate, however, relays 406 and 416, would then release, assuming that relays 303 and 421 operated.

Relay 406 in releasing, releases relays 111 and 113. Relay 113 in releasing connects ground through its break contacts to the winding of magnet 107 through the lower switch contacts associated with magnet 107. This ground is extended to hold also magnets 109, 204 and 205 after the holding ground furnished by the marker is removed when the marker subsequently releases.

Checking for ground on sleeve conductor of outgoing trunk

When trunk 200 was selected and relay 420 operated as before discussed, a circuit was closed for immediately grounding sleeve conductor 209 so as to make the trunk test busy to panel selectors, which may also have access to this trunk, prior to the final connection of ground 225. This circuit is traceable from conductor 209, through outer contacts of relay 214, right inner contacts of relay 210, over conductor 217, through lower operated contacts of relay 420, upper break contacts of relay 410, to ground 422 through the upper break contacts of relay 412. When relay 412 operates, it transfers with its upper contacts the circuit for sleeve conductor 209 before traced from ground 422 to the winding of relay 423, the contacts of which are not shown here. Relay 423 operates, if ground 225 has been properly connected by the operation of its associated switch contacts, and then the normal release of the marker circuit is effected, assuming that all other tests hereinbefore described have indicated the existence of standard conditions.

After the marker releases and the sender has completed its functions, the sender effects the operation through a circuit, not shown, of relay 128 which completes the transmission circuit between the subscriber station 100 and the selected trunk 200.

What is claimed is:

1. In a telephone system, a plurality of serially related switches, link circuits interconnecting said switches, means for testing said link circuits for an unstandard condition thereon, means for operating said switches to establish a connection over all of said links in series, means for testing the continuity of the established connection through said links, and means for testing the established connection for the presence of an unstandard condition thereon.

2. In a telephone system, a plurality of serially related switches, link circuits interconnecting said switches, means including test relays and circuits therefor for testing said links for unstandard conditions thereon, switch magnets operated over said test circuits for establishing a connection through said switches and including said links in series, means controlled by said test relays for verifying the operation of said switch magnets, and means for testing the connection thus established for unstandard conditions.

3. In a telephone system, a plurality of serially related switches, link circuits interconnecting said switches, a common controlling and testing mechanism having means therein including test relays and test circuits for testing the condition of said links preparatory to the establishment of a connection, switch magnets operable over said test circuits to close contacts of said switches and establish a connection over said links in series, means including said test relays for verifying the operation of said magnets and the closed condition of the switch contacts, means in said common mechanism for testing the established connection for the presence of an unstandard condition thereon, and means for releasing said common mechanism for use in establishing other connections.

4. In a telephone system, three serially related links, switches for connecting said links to each other, two relays and circuits therefor for testing respectively two of said links, means dependent upon said test for causing the operation of all of said switches to establish a connection over said links in series, means including said relays for testing the continuity of the established connection through said switches, and a third relay for testing all of the links in the established connection to determine if an unstandard condition is present.

5. In a telephone system, first, second and third link circuits arranged in series, means for testing said first and third link circuits to determine whether an unstandard condition exists thereon, automatic switches for establishing a connection over said links in series, operating magnets for said switches and means dependent upon said test for closing operating circuits for said magnets, means for verifying the operated condition of said magnets and the continuity of the connection extending over said link circuits, and means connected to the second one of said link circuits for testing the established connection including all three of said link circuits to determine whether an unstandard condition exists thereon.

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