March 24, 1925. 1,531,046

D. L. TEMPLE

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 23, 1922 2 Sheets-Sheet 1

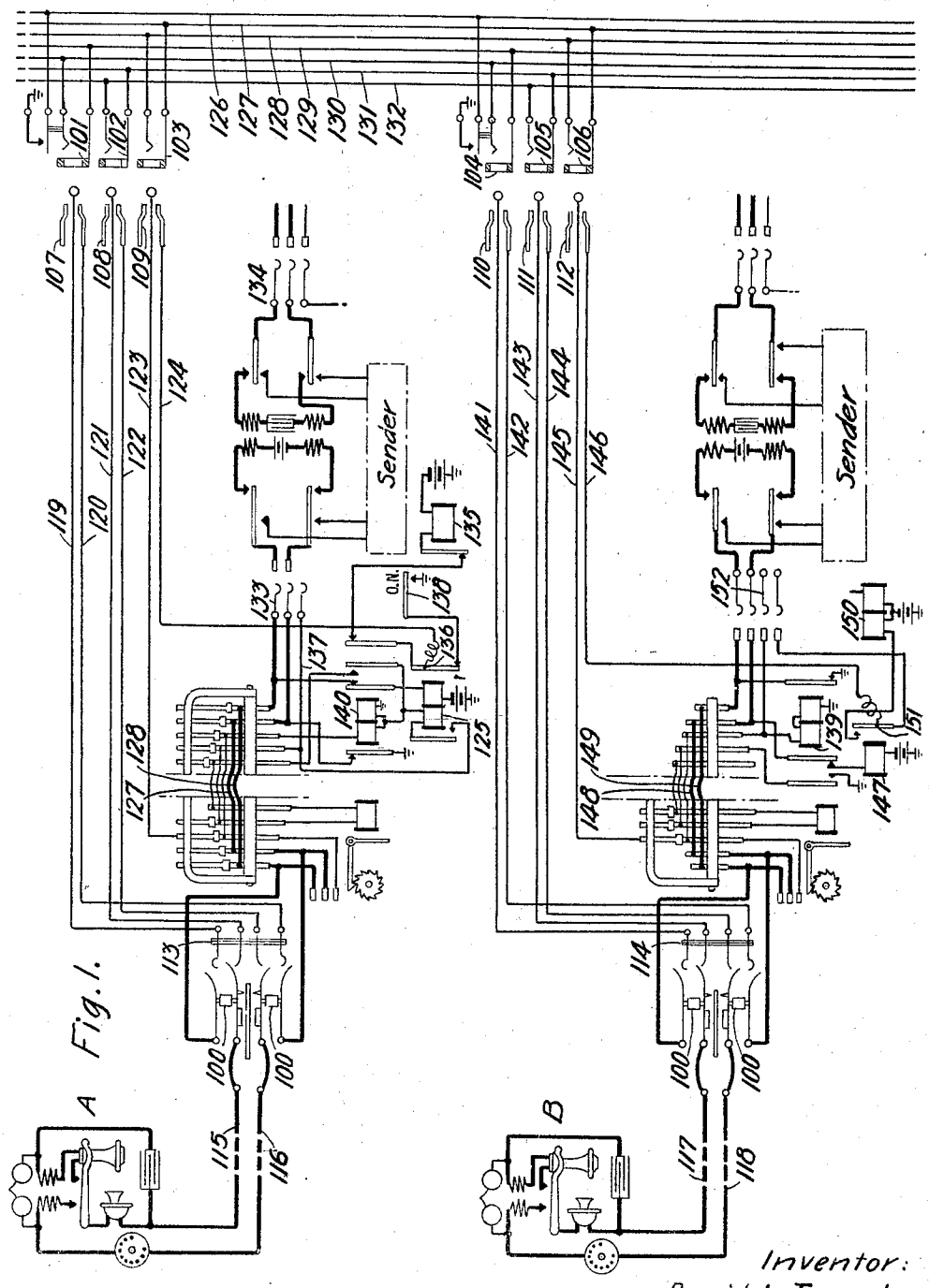


Fig. 1.

Inventor:
David L. Temple.
by W. L. Beatty, Att'y.

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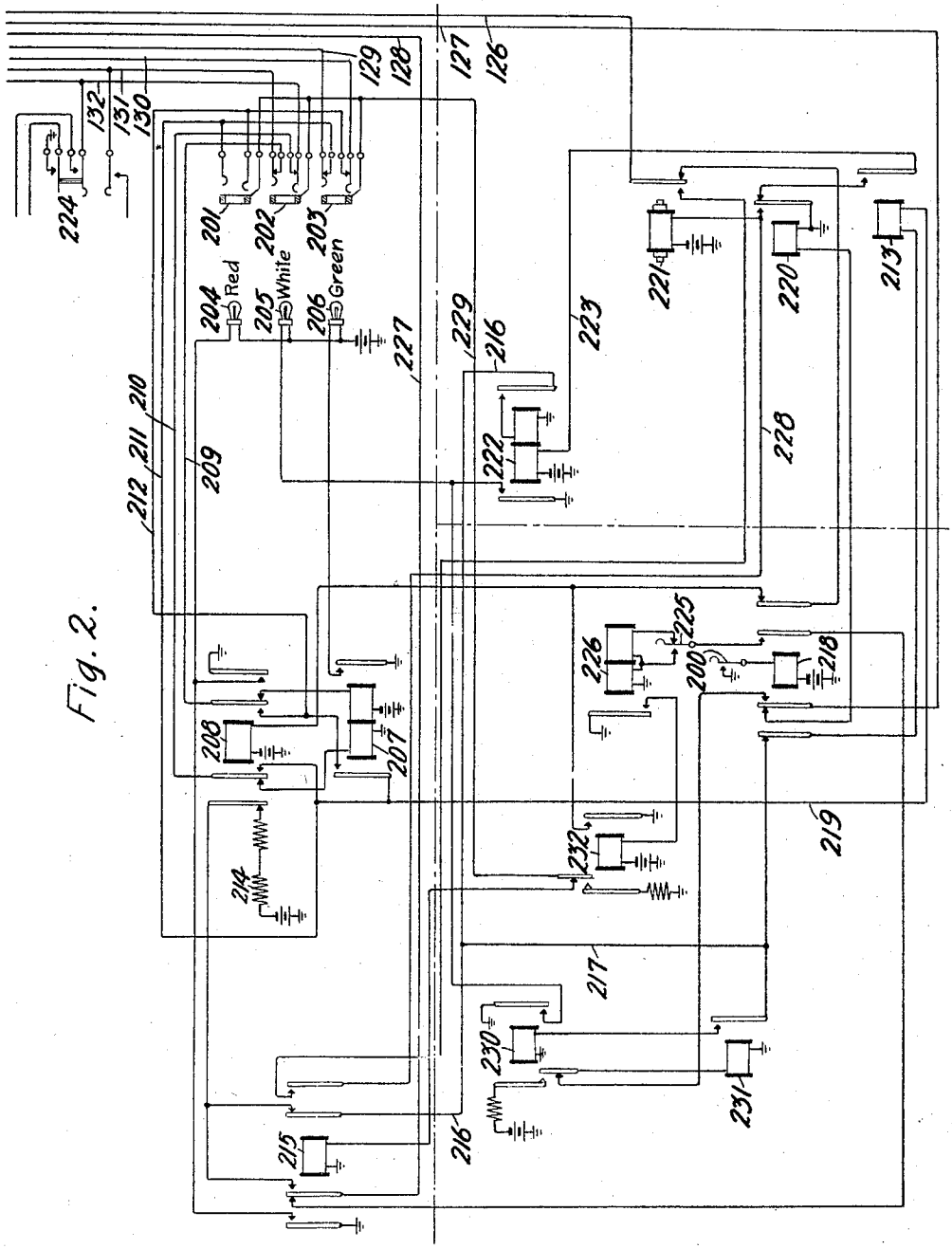


Fig. 2.

Inventor:
David L. Temple.
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Patented Mar. 24, 1925. 1,531,046

UNITED STATES PATENT OFFICE.

DAVID L. TEMPLE, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed October 23, 1922. Serial No. 596,204.

To all whom it may concern:

Be it known that I, DAVID L. TEMPLE, a citizen of the United States, residing at New York, in the county of New York, State of New York, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone exchange systems, and particularly to an arrangement for observing and testing for temporary unstandard conditions on subscribers' lines or central office equipment in exchanges provided with automatic switches.

Grounds or crossed lines of very brief duration may occur on a subscriber's line or on central office equipment due to a variety of causes. The touching of bare conductors in a wind storm, worn insulation permitting contact or grounding by trees, vibration and so on, may be mentioned as examples. When such grounds occur in an exchange in which connections are made by manual means, the occasional flashing of the line lamp will attract the operator's attention who can report and cause the trouble to be remedied. In exchanges in which connections are made by automatic switches there is no such means for indicating brief grounds, and the condition may result in more or less serious interference with service and consequent complaints, while the ordinary testing or indicating equipment, such as used for permanent grounds, would fail to reveal any trouble.

It is the object of the present invention to provide improved means by which such a condition when suspected may be indicated to an attendant and by which such attendant may determine the location of such temporary condition.

More specifically, it is the object of the invention to provide a visual signal to indicate temporary grounds or crossed lines, which signal is so operated as to enable an attendant to distinguish between a normal call, a temporary ground or cross on the subscriber's line, and a temporary ground or cross on the subscriber's central office equipment.

A feature of the invention is the provision of means to indicate such unstandard conditions for lines served either by line switches or by the line finders, or for either individual lines or the lines of a P. B. X. group when served by the line finders or line switches.

Another feature of the invention resides in the provision of means whereby an operator may variably adjust the testing apparatus so that it will function correctly, irrespective of the character of the switching device used in establishing connection between the line under consideration and an idle trunk.

Other and further features of the invention will become apparent from a consideration of the following description and the appended claims.

Referring to the drawing Figs. 1 and 2, when arranged with Fig. 2 below Fig. 1, illustrate a portion of an automatic telephone exchange to which the circuits and apparatus embodying the present invention are adapted. Fig. 1 shows in the upper portion, a subscriber's line incoming to the central office where it is extended through the distributing frames to an individual line switch. A first or district selector, register sender and trunk outgoing from the district selector, are also indicated diagrammatically. In the lower part of the figure a similar showing is made of another subscriber's line incoming to the central office, which line is extended to a district selector by means of a line finder. An arrangement by which the line and central office conductors may be extended through to jacks leading to the testing circuits is illustrated.

Fig. 2 shows the circuits and apparatus by which the visual signal is controlled and jacks by means of which tests may be made. The apparatus in the lower right hand dotted rectangle is used when the line under observation is connected to a line switch, the apparatus in the lower left hand rectangle is used when the line is served by a line finder, and the apparatus above the dotted line is used in connection with both types of connections.

Reference may be made to U. S. Patent No. 1,393,728 S. B. Williams Jr., granted October 11, 1921 for the disclosure of a complete telephone exchange system employing line finders, and to U. S. Patent No. 1,395,977, F. A. Stearn and F. J. Scudder, granted November 1, 1921, for the disclosure of a complete telephone exchange

system employing line switches, with which systems the circuits and apparatus of the present invention are adapted to be used.

When, from subscribers' complaints or for other reasons it is suspected that intermittent grounds or crosses are occurring on one or more lines, the heat coils of such lines are removed and spring plugs, such as 113 or 114, are inserted in their place. To these plugs are connected plugs, such as 107 and 108 or 110 and 111, for connecting the lines to the central office equipment through an indicating circuit, such as shown in Fig. 2 by means of jacks 101 and 102 or 104 and 105, which jacks may be located at any convenient point, preferably near the distributing frames. The indicating circuit of Fig. 2 is individually associated with a line during the time it is connected with it. The jacks, such as 103 or 106, are provided to receive plugs, such as 109 or 112, one wire of which is connected to the sleeve conductor of the line at the intermediate distributing frame, and the other to a clip connector which is fastened to the armature of the line relay. The jacks and lamps for several indicating circuits, such as shown in Fig. 2, appear at an attendant's desk where, as more fully described below, brief grounds or cross connections appear as momentary lighting of the various lamps, and from which tests may be made.

The operation of the circuits when connected to a subscriber's line served by a line switch will first be described. Spring plug 113 is inserted in place of the heat coils 100 at the distributing frame: conductor 123 is connected to the test conductor at the intermediate distributing frame, and conductor 124 clipped to the right hand armature of the line relay 125; plugs 107, 108 and 109 are inserted in jacks 101, 102 and 103 respectively, closing ground to conductor 126. Key 200 is open at this time.

If, now, the subscriber initiates a call by lifting his receiver from the hook, a circuit is closed from grounded battery, right hand winding of the relay 207, inner right hand armature and back contact of relay 208, conductor 209, upper closed contact of jack 202, conductor 131, sleeve of jack 102, sleeve of plug 108, conductor 122, conductor 116, through substation "A," conductor 115, conductor 121, tip of plug 108, tip contact of jack 102, conductor 132, lower closed contact of jack 202, conductor 210, inner left hand armature and back contact of relay 208, left hand winding of relay 207 to ground. Relay 207 is energized and at its right hand armature closes an obvious circuit for green lamp 206. At its left hand armature relay 207 closes a circuit for line relay 125 which may be traced from grounded battery, right hand winding of relay 125, inner right hand armature and back contact of relay 140, jumper wire 128, conductors 119, 130 and 212, left hand armature and front contact of relay 207, conductors 211, 129 and 120, jumper wire 127, left hand armature and back contact of relay 140 to ground.

The energization of relay 125 in the above traced circuit causes the operation of the line switch 133 to select an idle district selector 134 and the advance of the district selector sequence switch from position 1 into position 2, during which the selection of an idle sender takes place without further action on the part of the subscriber.

If, now, the subscriber fails to operate his dial, the district selector remains in position 2 and a time alarm circuit (not shown) functions to notify the attendant. This time alarm scheme forms no part of the present invention and therefore will not be described. Should a ground occur on the conductor 115, or a cross-connection between the conductors 115 and 116 of sufficient duration, the operation will proceed as above outlined.

At the time plug 107 was inserted in jack 101, a circuit was completed for high resistance relay 213, which may be traced from grounded battery, resistance 214, outer left hand armature and back contact of relay 208, inner right hand armature and back contact of relay 215, conductors 216 and 217, outer left hand armature and back contact of relay 218, winding of relay 213, conductors 219, 211, 129 and 120, jumper wire 127, left hand armature and back contact of relay 140 to ground. At the same time a circuit was completed for relay 220 which may be traced from grounded battery, winding and armature of line switch stepping magnet 135, outer right hand armature and back contact of relay 140, right hand armature of relay 125, clip connector 136, conductors 124 and 127, inner left hand armature and back contact of relay 218, winding of relay 220 to ground. Relay 220 became energized in this circuit but stepping magnet 135 did not. The energization of relay 220 caused the energization of slow-to-release relay 221 by means of a circuit extending from grounded battery, winding of relay 221, armature and front contact of relay 220 to ground.

When now the relay 125 operates it closes a direct ground from the first two contacts on a line switch arc (not shown) to its right hand armature, which ground starts the line switch and shunts the relay 220. Relay 220 deenergizes and completes a circuit from grounded battery, left hand winding of relay 222, conductor 223, armature and front contact of relay 213, armature and back contact of relay 220 to ground. Relay 222 energizes and locks up in a circuit extending from grounded battery, resistance

214, outer left hand armature and back contact of relay 208, inner right hand armature and back contact of relay 215, conductor 216, right hand armature and front contact of relay 222, right hand winding of relay 222 to ground. Relay 222 closes at its left hand armature an obvious circuit for lighting the white lamp 205.

As soon as the line switch advances two steps, the ground at the front contact of the right hand armature of relay 125 is broken and relay 220 again energizes, but relay 221 being slow to release, holds its armature attracted during this deenergization and also during the deenergization of 220 at each step of the line switch in seeking an idle district selector. When an idle district selector has been found, battery potential is connected to conductor 137, thus completing a circuit for the energization of relay 140 by way of the left hand armature and winding of relay 125 and right hand winding of relay 140 to ground. Relay 140 energizes, and at its left hand and inner right hand armatures, opens the circuit for relay 125; at its outer right hand armature opens the circuit for the stepping magnet 135, and at its intermediate right hand armature closes a locking circuit for itself. The deenergization of relay 125 completes a shunting circuit for relay 220 which extends by way of the right hand armature and back contact of relay 125 to off-normal contact 138, which shunt is maintained throughout the duration of the call. Therefore, relay 220 deenergizes for a sufficient length of time to permit relay 221 to deenergize. The deenergization of relay 221 closes a circuit from grounded conductor 126, armature and back contact of relay 221, outer right hand armature and back contact of relay 218, winding of relay 208 to grounded battery. Relay 208 energizes, and at its inner armatures opens the circuit for relay 207 and closes the line through to the central office equipment. The deenergization of relay 207 opens the circuit for lamp 206. At its outer left hand armature, relay 208 opens the circuits of relays 222 and 213, which relays deenergize and relay 222 opens the circuit of the lamp 205. At its outer right hand armature, relay 208 closes an obvious circuit for red lamp 204. therefore, the red lamp 204 is displayed alone during the conversation. At the completion of conversation, magnet 135 steps the line switch back to normal when the shunting circuit for relay 220 is opened, and that relay energizes, causing the energization of relay 221 and the opening of the circuit of relay 208, thus extinguishing lamp 204.

If a prolonged cross or a ground occurs while the line is connected to the indicating circuit, the lamps are lighted in the same manner as with a regular call, when the subscriber fails to dial; and other means, with which this application is not concerned, function to give warning.

Very brief grounds or cross connections, which this apparatus is particularly designed to detect, cause flashing of the lamps in a manner dependent upon the duration of the condition. Relay 207 is adjusted to operate at least as quickly as the line relay 125, so the briefest ground which would effect the apparatus at all would cause relay 207 to operate and light the green lamp momentarily. A slightly longer grounding of the line would also permit the operation of relay 125, the shunting of relay 220 and the operation of relay 222 to light the green and white lamps. Should the ground disappear before relay 222 becomes locked up, both white and green lamps would go out.

Should the ground on the line continue long enough to start the hunting movement of the line switch, but disappear before an idle district selector has been found, relay 207 deenergizes causing in turn the deenergization of relay 125 and the return of the line switch to normal. During the hunting operation of the line switch, the circuit of relay 220 has not been shunted or opened for a long enough period to permit the deenergization of relay 221. The circuit for energizing relay 208 will not be closed and relay 222 will remain locked up, and the lamp 205 lighted until the attendant releases it by the application of battery potential to the sleeve of one of the jacks 201, 202 or 203 and the operation of relay 215 opens the circuit of relay 222.

A somewhat longer grounding of the line might permit the selection of an idle district selector, resulting in the brief lighting of the three lamps but disappear before the district selector found an idle sender under which circumstances the district selector would restore to normal and the red lamp go out.

Should a ground or cross-connection occur within the central office, relay 125 would be operated, shunting relay 220 and causing the operation of relay 222 to light the lamp 205 momentarily. Should this ground exist long enough to permit the selection of an idle district selector, the operation of relay 140 will release relay 125, shunting relay 220 to permit the deenergization of relay 221 and the energization of relay 208. The white lamp is extinguished and the red lamp lighted as before.

If the substation "A" is selected as a called line, relay 140 is operated, opening the energizing circuit of relay 220, which is deenergized long enough to cause the deenergization of relay 221. Relay 221 closes at its armature and back contact a circuit for relay 208 from grounded battery, winding of relay 208, armature and back contact

of relay 218, armature and back contact of relay 221 to grounded conductor 126. Relay 208 energizes, lights lamp 204, and closes the line conductors through to the central office. The energization of relay 140 also opens at its left hand armature the circuit of relay 213 so that relay 213, releases its front contact before relay 220 has had time to close its back contact, and relay 222 is not operated to light lamp 205. Therefore, the red lamp 204 alone is displayed on calls terminating at the substation under observation.

When making tests on the line "A" the insertion of a plug in one of the jacks 201, 202, or 203 connects battery to the sleeve of the jack and thence by conductor 229, normally closed contact of relay 232, winding of relay 215 to ground. Relay 215 operates closing a circuit from grounded battery, resistance 214, outer left hand armature and back contact of relay 208, inner left hand armature and front contact of relay 215, conductors 227, 128, windings of relay 140 to ground operating relay 140 to make the line of substation "A" busy to incoming calls. Relay 215 at its outer left hand armature closes the circuit for lamp 204 to indicate that the line is busy.

If the line should be busy when a test is attempted, the insertion of the plugs and operation of relay 215 would be of no effect. As soon, however, as relay 140 releases, relays 220 and 221 operate again. Relay 208 releases and closes battery to its outer left hand armature, thus completing the circuit above traced, for the operation of relay 140 to make the line busy and to permit the making of the desired test. The operation of relay 140 again opens the circuit of relay 220. However, the operation of relay 215 has closed a locking circuit from grounded battery, winding of relay 221, conductor 228, outer right hand armature and front contact of relay 215, armature and front contact of relay 221 to grounded conductor 126, preventing the reoperation of relay 208 and the alternate energization and deenergization of this relay and relay 140.

If the line to be observed is one served by a line finder, key 200 is closed causing the energization of relay 218. If the line is an individual line or the last line of a P. B. X. group, key 225 is opened as shown; if any one but the last line of a P. B. X. group, key 225 is closed. Relay 226, it will be seen is connected in parallel with relay 139. In the case of individual lines and last lines of a P. B. X. group, both windings of relay 139 are used, whereas on all but the last lines of a P. B. X. group only one winding of relay 139 is used. Therefore, in order that relay 226 may operate in either case, the key 225 is provided to cut out the high resistance winding of relay 226, when only the low resistance winding of relays such as relay 139 is in use.

When a call is initiated by the subscriber of substation "B", a circuit is closed which may be traced from grounded battery, right hand winding of relay 207, inner right hand armature and back contact of relay 208, conductors 209, 131, 144, 118 through substation "B", conductors 117, 143, 132, 210, inner left hand armature and back contact or relay 208, left hand winding of relay 207 to ground. Relay 207 energizes, at its right hand armature closes an obvious circuit for lamp 206, and at its left hand armature closes a circuit which may be traced from grounded battery, winding of relay 147, inner left hand armature and back contact of relay 139, jumper wire 148, conductors 142, 129, 211, left hand armature and front contact of relay 207, conductors 212, 130, 141, jumper wire 149, right hand armature and back contact of relay 139 to ground. Relay 147 operates and starts the series of operations for causing an idle line finder to find the line, thus connecting it to an idle district selector, and causing the seizure of an idle sender, all of which takes place before the subscriber operates his dial. The operation of relay 147 also closes a circuit from grounded battery, winding of relay 150 in the line finder circuit, armature and front contact of relay 147, clip contact 151, conductors 146 and 127, inner left hand armature and front contact of relay 218, normally closed contact of relay 230, winding of relay 231 to ground. Relay 231 operates, and closes a circuit extending from ground, winding of relay 230, armature and front contact of relay 231, conductors 217 and 216, inner right hand armature and back contact of relay 215, outer left hand armature and back contact of relay 208, resistance 214 to grounded battery. Relay 230 operates, closing an obvious circuit for lamp 205 and a substitute circuit for relay 231.

When the line finder has found the line, battery from the district selector on brush 152 causes the operation of relay 139, opening the circuit of relay 147 and stopping the operation of the line finder. Battery on brush 152 by way of conductors 145, 128, and 227, inner left hand armature and back contact of relay 215, inner right hand armature and front contact of relay 218, winding of relay 226 to ground, causes the operation of this relay. The energization of relay 226 closes an obvious circuit for relay 232 which upon energization closes a circuit from grounded battery, winding of relay 208, right hand armature and front contact of relay 232 to ground, for energizing relay 208. At its left hand armature, relay 232 opens the circuit of relay 215 and places ground on the sleeves of test jacks 201, 202 and 203. The energization of relay

208 as above, lights the lamp 204, opens the circuit of relays 207 and 230. Lamps 205 and 206 are extinguished, and relay 230 released. At the time relay 139 is released on the completion of the call, relay 226 is also released, permitting the deenergization of relays 232 and 208, and the connection of relay 215 to the sleeves of jacks 201, 202 and 203.

As in the case of a line served by the line switch, a prolonged ground would cause the same sequence of operations as a regular call on which the subscriber fails to dial and the same lighting of the lamps.

In this case also the brief energization of relay 207 alone causes a flash of the green lamp. A somewhat longer existence of the trouble would cause the energization of relays 147, 231 and 230 and the brief lighting of the green and white lamps, while a somewhat longer persistence of the trouble might light all three lamps as above outlined but allow the red lamp to go out again. In the case of a line served by a line finder there is no stage at which the white lamp is permanently lighted.

If the ground or cross-connection occurred within the central office, relay 147 would energize, starting the line finder in operation, also connecting battery through relay 150 to relay 230, after which the operations are as above outlined. Lamp 205 is lighted momentarily or lamp 205 and 204 in succession depending on the duration of the trouble.

If the line is selected as a called line, relay 139 is operated and the battery which causes the operation of relay 139 also, by way of conductors 145, 128, 227, inner left hand armature and back contact of relay 215, inner right hand armature and front contact of relay 218 and windings of relay 226 to ground, causes the energization of relay 226, which causes the energization of relay 232 and in turn the energization of relay 208, lighting the red lamp to indicate to the attendant that the line is busy.

If a test is attempted while the line is busy, the energization of relay 232 holds open the circuit of relay 215, so that the insertion of a plug in one of the jacks 201, 202, 203 will have no effect, but when, on the release of the apparatus, relay 232 falls back, the circuit of relay 215 is completed and the line made busy for testing purposes.

From the foregoing it will be seen that when the indicating circuits are connected to a line, the condition of the line will be shown as follows:

In case the subscriber at substation "A" or "B" initiates a call, the circuits function to display green lamp 206 and white lamp 205 in succession momentarily, followed by red lamp 204. When the red lamp 204 lights, white lamp 205 and green lamp 206 are extinguished. When the call is completed, the red lamp 204 goes out. Should substation "A" or "B" be called, the red lamp 204 is displayed.

A ground on the ring conductor of the line or a cross-connection between the line conductors, if it exists for an appreciable time, will cause the same set of signals to be displayed as on the regular call, the red lamp remaining lighted until the central office apparatus is released by the attendant.

A temporary ground will, according to the time during which it exists, cause a flash of the green lamp, a flash of the green and white lamps, or a flash of the green, white and red lamps in succession.

Where the line undergoing observation is served by a line switch, a ground or cross connection continuing long enough to start the hunting movement of the switch, but not until an idle district selector has been found will cause the white light to remain lighted until released by the attendant.

Likewise a ground or cross-connection on the central office equipment will, according to its duration, cause a flash of the white lamp or a successive temporary lighting of the white and red lamps.

What is claimed is:

1. In an automatic telephone exchange system, subscribers' lines, each served by one of two kinds of trunking switches, means for indicating unstandard conditions on said lines, and a discriminating device operated in accordance with the kind of switch used to allow correct operation of said means.

2. In an automatic telephone exchange system, individual subscribers' lines, other subscribers' lines arranged in groups, said lines served by trunking switches, means for indicating unstandard conditions on said lines, and a discriminating device operated to allow correct operation of said indicating means whether said means is associated with an individual line or with one of a group of lines.

3. In an automatic telephone exchange system, subscribers' lines, each served by one of two kinds of trunking switches, central office equipment associated with said subscribers' lines, means for indicating unstandard conditions on said central office equipment, and a discriminating device operated in accordance with the kind of switch used to allow correct operation of said means.

4. In an automatic telephone exchange system, subscribers' lines adapted to be extended by automatic switches, central office equipment normally connected with said subscribers' lines, and means for indicating unstandard conditions on said lines and on said central office equipment, said means being operated in one manner to indicate an unstandard condition on said line and in a

different manner to indicate an unstandard condition on said central office equipment.

5. In an automatic telephone exchange system, subscribers' lines adapted to be extended by automatic switches, central office equipment normally connected with said subscribers' lines, and means for indicating unstandard conditions on said lines, said means being differently operated in accordance with the various durations of such unstandard conditions.

6. In an automatic telephone exchange system, subscribers' lines adapted to be extended by automatic switches, central office equipment normally connected with said subscribers' lines, and means for indicating unstandard conditions on said central office equipment, said means being differently operated in accordance with the various durations of such unstandard conditions.

7. In an automatic telephone exchange system, subscribers' lines, central office equipment normally connected to said subscribers' lines, and alternative means for connecting said subscribers' lines and said central office equipment, said connecting means including means differently operated to indicate unstandard conditions on said lines, on said central office equipment, and various durations thereof.

8. In an automatic telephone exchange system, subscribers' lines adapted to be extended by automatic switches, central office equipment associated with said lines, and means comprising a visual signal for indicating unstandard conditions on said lines and said central office equipment, said signal being operated in one manner to indicate an unstandard condition on said line and in a different manner to indicate an unstandard condition on said central office equipment.

9. In an automatic telephone exchange system, subscribers' lines adapted to be extended by automatic switches, central office equipment associated with said lines, and means comprising a visual signal for indicating unstandard conditions on said lines, said signal being differently operated in accordance with the various durations of said unstandard condition.

10. In an automatic telephone exchange system, subscribers' lines adapted to be extended by automatic switches, central office equipment associated with said lines, and means comprising a visual signal for indicating unstandard conditions on said central office equipment, said signal being differently operated in accordance with the various durations of said unstandard condition.

11. In an automatic telephone exchange system, subscribers' lines, central office equipment associated with said lines, and a visual signal differently operated to indicate unstandard conditions on said lines, on said central office equipment, and various durations thereof.

In witness whereof, I hereunto subscribe my name this 20th day of October A. D., 1922.

DAVID L. TEMPLE.