H. P. CLAUSEN.

ELECTRICAL TESTING SYSTEM.

APPLICATION FILED JULY 26, 1917.

1,340,933.

Patented May 25, 1920.

2 SHEETS—SHEET 1.

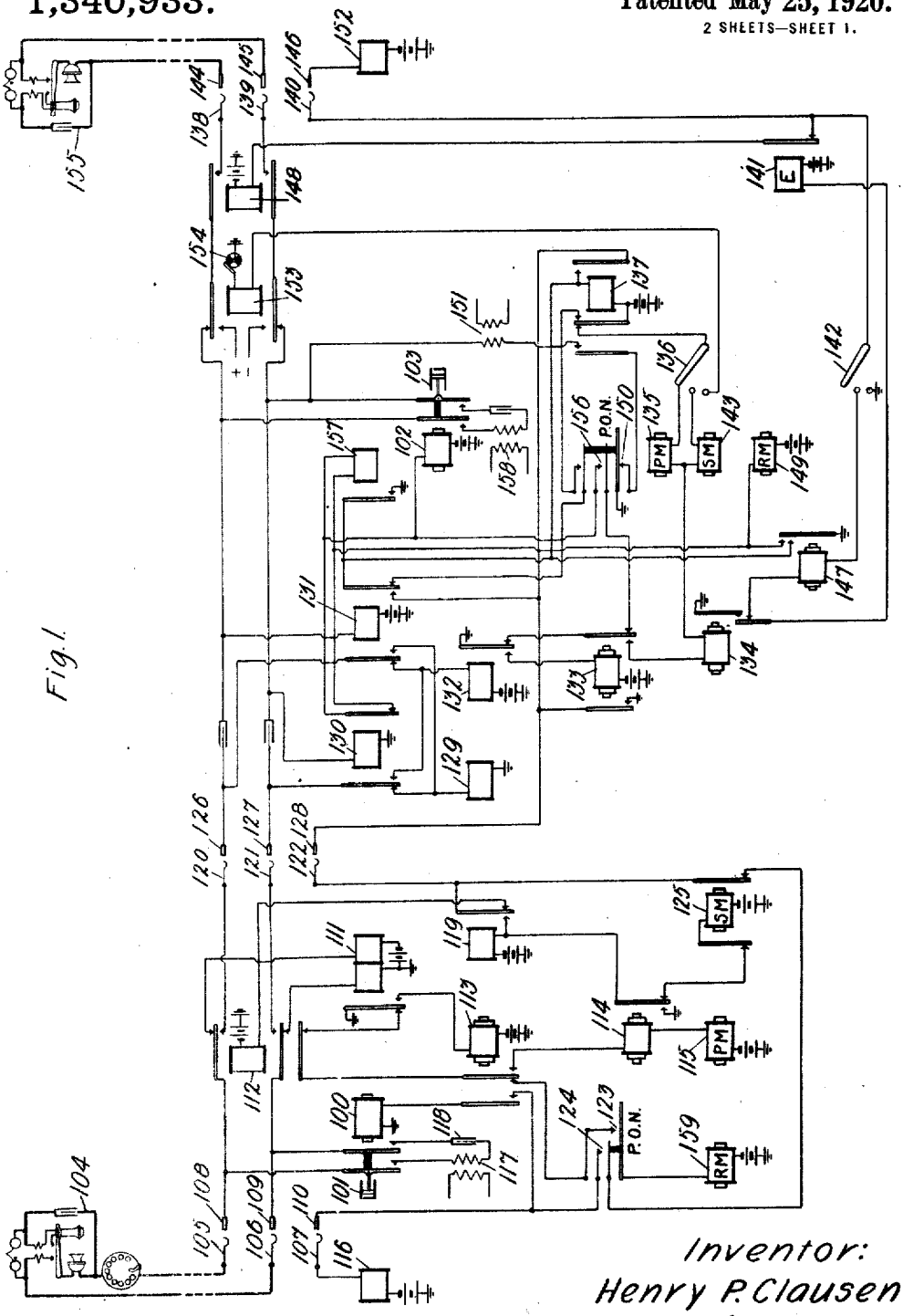

Fig. 1.

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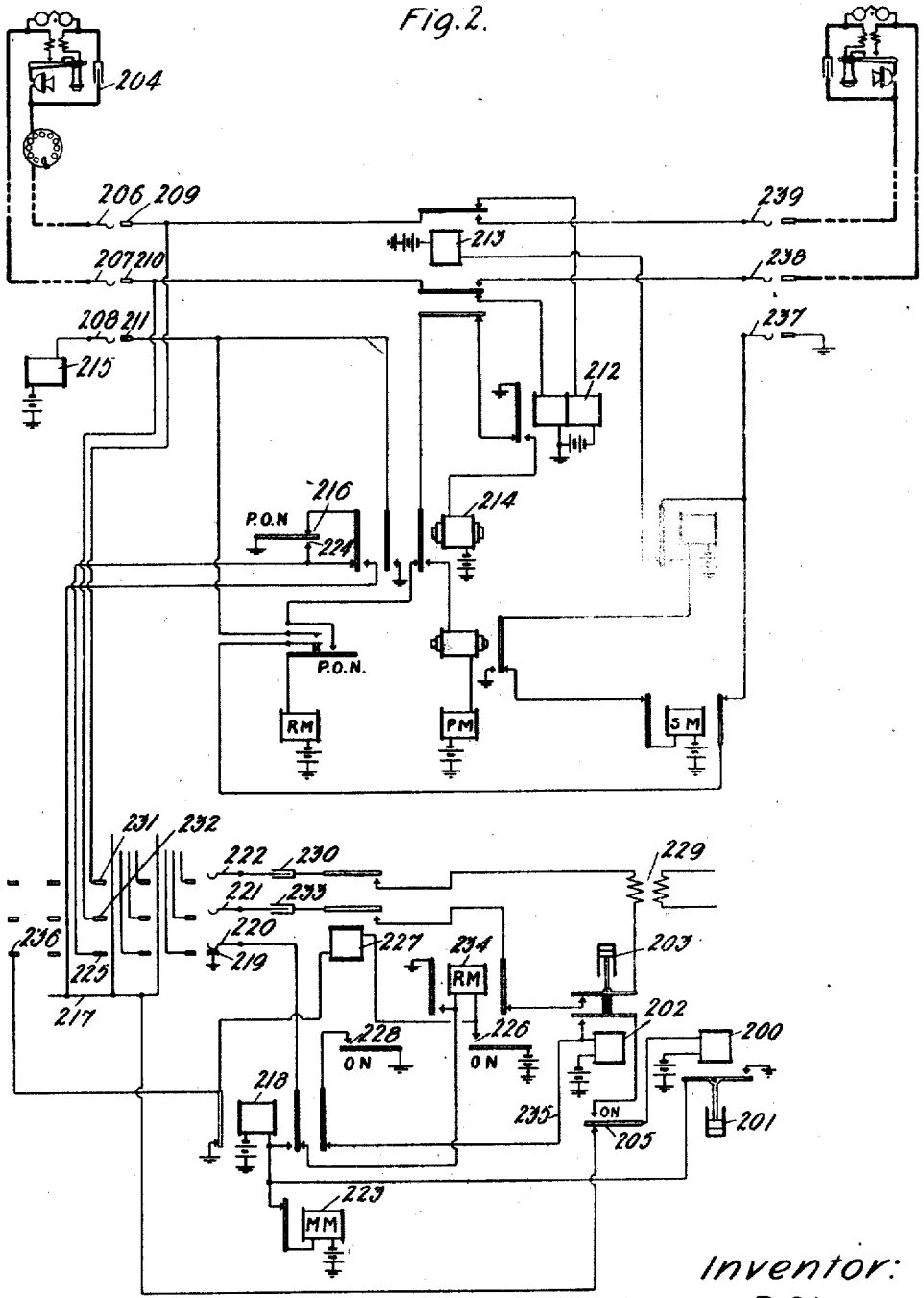
Fig. 2.



Inventor:
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UNITED STATES PATENT OFFICE.

HENRY P. CLAUSEN, OF MOUNT VERNON, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRICAL TESTING SYSTEM.

1,340,933. Specification of Letters Patent. Patented May 25, 1920.

Application filed July 26, 1917. Serial No. 182,946.

To all whom it may concern:

Be it known that I, HENRY P. CLAUSEN, a citizen of the United States, residing at Mount Vernon, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Electrical Testing Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to electrical testing systems, and is of particular value in connection with telephone systems where machine switching of connections is employed.

The object of the invention is to provide means for automatically detecting unstandard conditions arising from receivers inadvertently left off the hook and for applying signaling current to lines on which this has occurred for the purpose of attracting the attention of the delinquent subscriber.

Heretofore, this class of unstandard condition has been remedied only after a considerable period of time has elapsed, due to the fact that it could only be detected through the manipulation of certain testing apparatus at the will of an attendant, or an alarm has been sounded to summon the attendant, who thereupon, if not busy with more important duties, made a search for the unstandard condition. In any case, it often happened that before such unstandard condition could be detected, the delinquent party had left the vicinity of the substation and could not be summoned by the ordinary means, with the result that an inspector had to be sent to the residence or business office in which the particular substation was located, merely for the purpose of replacing a receiver inadvertently left off the hook.

According to the present invention, means are provided for automatically detecting a case of such unstandard condition and for immediately employing the usual means for notifying the delinquent subscriber, that is, for placing the "howler" on the line. The result obtained is that the subscriber is notified before he could have left the vicinity of his substation, and the unstandard condition is immediately remedied; the services of an attendant are not required; a smaller number of busy lines are encountered by calling subscribers; and the service is materially bettered.

A feature of the invention is a slow acting relay, which may be adjusted to act after a definite reasonable length of time. Such a relay may be associated with a first selector switch and be made responsive to a condition arising from the seizure of such switch and the failure on the part of the subscriber to send impulses, which indicates that the receiver had been inadvertently removed from the hook. Such a relay may also be associated with a connector switch and may be made responsive to the condition arising in such a switch when the calling subscriber hangs up his receiver but the called subscriber fails to hang up his.

According to another feature of this invention, such slow acting relay may be associated with a number of selector switches and be connected directly with the held switch when its service is required, thus reducing the equipment necessary for detecting such unstandard conditions.

Other new and valuable features will appear from the following detailed description and the appended claims.

In the drawings, Figure 1 represents two substations connected through a first selector and connector switch, each of which has associated therewith a slow acting relay for detecting receivers off the hook and for placing howler current on the line; and Fig. 2 represents a modification of the scheme and shows means whereby the slow acting relay may be associated with a plurality of switches.

Referring now especially to Fig. 1, attention is directed to slow acting relay 100, which is shown with a dash-pot 101 mechanically connected to the armature so as to cause the movement of the relay to be slow. It is well known to those skilled in the art that any reasonable time interval in the operation of such a relay, may be obtained. Attention is also directed to a slow acting relay 102, provided with a dash-pot 103 similar in construction to the relay 100.

Should a subscriber at station 104 remove his receiver for its hook, any well known type of line switch or line finder switch may be employed to set the brushes 105, 106 and 107 on the terminals 108, 109 and 110. A circuit is thereupon established from ground, battery, right-hand winding of relay 111, the normal contact and upper armature of relay 112, terminal 108, brush 105 to

and through an apparatus of the substation 104, brush 106, terminal 109, innermost lower armature and contact of relay 112, left-hand winding of relay 111 to ground. Relay 111 thereupon attracts its armature and establishes a circuit for the energization of first slow relay 113, from ground, armature and alternate contact of relay 111, winding of relay 113 to battery and ground. Relay 113 attracts its armatures and through its innermost left-hand armature prepares a circuit to be hereinafter described for the energization of the second slow relay 114 and the primary magnet 115. At the same time, the first slow relay 113 establishes a circuit from ground, the winding of relay 100, the outermost left-hand armature and alternate contact of relay 113, a release wire connected to the terminal 110, brush 107, relay 116, battery and ground. Through this circuit, relay 100 is energized, but due to the action of the dash-pot 101, it does not close its contacts until a definite period of time has elapsed.

If now the subscriber at station 104 has inadvertently removed the receiver from its hook, thereby energizing relay 100, and does not transmit a series of impulses, the circuits, as just described, will remain in the present condition until after the definite period of time which it takes relay 100 to attract its armatures has elapsed, when a circuit will be established from one terminal of the secondary winding of induction coil 117, the condenser 118, the contact and innermost armature of relay 100, the lower limb of the telephone line, terminal 109, brush 106, to and through the apparatus of the substation 104 including the receiver, the brush 105, the terminal 108, the outermost armature and contact of relay 100 to the other terminal of the secondary winding of induction coil 117. The primary winding of this coil is connected to a source of rather high frequency alternating current, which being transformed in the secondary winding and projected over the line, so actuates the receiver at substation 104 that a distinct "howl" is heard thereat, which notifies the subscriber who has inadvertently removed his receiver that he has established an unstandard condition. If in response to this "howl" the subscriber replaces the receiver on its hook, the relay 111 will become deenergized and the selector switch will be released in a manner to be hereinafter noted.

If, on the other hand, the subscriber at sub-station 104 wishes to initiate a call, he will manipulate his dial switch shortly after removing the receiver from its hook. Upon the first opening of the line circuit by this dial switch, a circuit will be established from ground, armature and normal contact of relay 111, contact and outermost armature of relay 112, innermost left-hand armature and alternate contact of relay 113, the winding of relay 114, the winding of relay 115 to battery and ground. Relay 114 attracts its armature and establishes a circuit from ground, the alternate contact and armature of relay 114, the winding of relay 119 to battery and ground. The energization of primary magnet 115 causes the brushes 120, 121 and 122 to be advanced in the primary direction one step, whereupon the primary off-normal contacts 123 and 124 will be closed. The closure of contact 124 establishes a circuit from ground, alternate contact and armature of relay 114, the alternate contact and armature of relay 119, the right-hand armature and normal contact of secondary magnet 125, and primary off-normal contact 124 and thereafter through the circuit previously described to relay 116. The ground thus placed on the release trunk short-circuits the winding of relay 100 and causes it to become deënergized, whereby it is prevented from placing howler current on the line of the calling substation.

During the sending of the remaining impulses from the substation 104, the previously described circuit through the windings of relays 114 and 115 is intermittently established, whereby the primary magnet 115 is intermittently energized and drives the brushes 120 to 122 inclusive, step by step in the primary direction. The relay 114 however, being slow to release, responds to the series of energizations as a whole, and keeps its armature in connection with its alternate contact.

At the end of this series of impulses, the armature of relay 111, by remaining in its attracted position for a considerable period of time, opens the circuit through relays 114 and 115 and allows both to become deënergized. Immediately thereafter, a circuit is established from ground on the terminal 128, if this terminal is connected to a busy connector switch, to the armature and alternate contact of relay 119, winding of relay 119, battery and ground and in parallel with the winding of relay 119 through the armature and normal contact of relay 114, the contact and left-hand armature of magnet 125, the winding of secondary magnet 125 to battery and ground. The secondary magnet 125 attracts its armatures and in so doing advances the brushes 120 to 122 inclusive in their secondary direction over the terminals 126 to 128 inclusive until an idle trunk is encountered. Such idle trunk is denoted by the absence of ground potential of terminal 128, whereby the relay 119 and magnet 125 are deënergized.

A circuit is now established from ground, the winding of relay 100, the outermost armature and contact of relay 113, the primary off-normal contact 124, the contact and right-hand armature of magnet 125, the

armature and normal contact of relay 119, the winding of relay 112 to battery and ground. Through this circuit relay 112 is energized, and by attracting its armatures, establishes a circuit from ground, coil 129, left-hand armature and normal contact of relay 130, terminal 127, brush 121, alternate contact and innermost armature of relay 112, terminal 109, brush 106, to and through the apparatus of the subscriber's substation 104, brush 105, terminal 108, the upper armature and alternate contact of relay 112, brush 120, terminal 126, left-hand armature and normal contact of relay 131, winding of relay 132 to battery and ground. Through this circuit relay 132 is energized. Relay 132 thereupon establishes a circuit from ground, its armature and alternate contact, the winding of first slow relay 133 to battery and ground. Relay 133 attracts its armatures and places ground, through its left-hand armature, on the terminal 128 which thereupon shunts the winding of relay 100 and insures the continued energization of relay 112 through the circuit previously described.

The energization of relay 112 disconnects the relay 111 from the line of the calling subscriber, whereupon the first slow relay 113 is deënergized and the circuit of the relay 100 is opened.

If now the subscriber sends in another series of impulses, the armature of relay 132 will be caused to vibrate and the following circuit will be thereby intermittently closed; ground, armature and normal contact of relay 132 and right-hand armature and alternate contact of relay 133, winding of second slow relay 134, winding of primary magnet 135, first position contact and side-switch wiper 136, normal contact and innermost left-hand armature of relay 137 to battery and ground. The primary magnet 135 responds to each separate energization and drives the brushes 138 to 140 inclusive, in their primary direction. Slow relay 134, however, responds to the series of energizations as a whole and maintains a circuit from ground, armature and alternate contact of relay 134, winding of escape relay 141 to battery and ground.

At the end of this series of impulses, the armature of relay 132 remains in its attracted position for a considerable period of time, whereby the relay 134 becomes deenergized and in so doing causes the deenergization of escape relay 141 which drives the side-switch wipers 136 and 142 into their second positions.

The sending of the last series of impulses results in a similar action to that just described, with the exception that this time the secondary magnet 143 is energized in place of the primary magnet 135 and the brushes 138 to 140 inclusive are driven the prescribed number of steps in their secondary direction.

At the end of this series of impulses, if the line called be a busy line, a circuit will be established from ground on the terminal 146, the side-switch wiper 142 in its second position, the winding of relay 147, the normal contact of relay 134, the winding of relay 141 to battery and ground. Relay 141 therefore does not deënergize as before but holds its armature in the attracted position to prevent the energization of relay 148.

Relay 147 becomes energized in this circuit and in turn establishes a circuit from ground, armature and lower contact of relay 147, winding of relay 137 to battery and ground. Relay 137 establishes a holding circuit for itself from ground, the contact and left-hand armature of relay 133, the right-hand armature and alternate contact and winding of relay 137 to battery and ground.

The relay 147 also establishes a circuit from ground, the armature and upper contact of relay 147, the winding of release magnet 149, to battery and ground, whereby the brushes 138 to 140 are returned to their normal position. When they thus reach their normal position, the primary off normal contact 150 will be closed, whereupon a circuit will be established from ground, primary off-normal contact 150, the outermost left-hand armature and contact of relay 137, the secondary winding of induction coil 151 to the lower limb of the telephone line. The primary winding of induction coil 151 is supplied from a source of current, which being connected with a line notifies the calling subscriber by a characteristic sound which it causes in his receiver, that the called line is busy.

If, on the other hand, the called line proves to be idle, then upon the deënergization of relay 134 and the consequent deenergization of relay 141, the side-switch wipers 136 and 142 will be moved into their third positions. A circuit will now be established from ground, third position contact and side-switch wiper 142, the brush 140, the terminal 146, the winding of relay 152 to battery and ground and in parallel therewith through the contact and armature of relay 141, the winding of relay 148, to battery and ground. Relay 148 is energized in this circuit and closes the talking conductors of the connector switch through to the brushes 138 and 139. The movement of the side-switch wiper 136 into its third position establishes a circuit from ground, battery, innermost left-hand armature and normal contact of relay 137, side-switch wiper 136, its third position contact, the winding of relay 153, the interrupter 154 to ground. Through the connection of interrupter 154 the relay 153 is intermittently energized in this circuit and intermittently applies ring-

ing current through its alternate contacts and armatures to the line of the called substation 155.

When the subscriber at substation 155, in answer to the summons of his bell, removes the receiver from its hook, circuit will be established during an interval in which the brush of the interrupter 154 is on an insulating segment, from ground, winding of relay 130, normal contact and lower armature of relay 153, lower armature and contact of relay 148, brush 139, terminal 145, to and through the apparatus of the subscriber's substation 155, terminal 144, brush 138, contact and upper armature of relay 148, upper armature and normal contact of relay 153, winding of relay 131 to battery and ground. The action of relays 130 and 131 in the well known manner reverses the direction of the current flowing through the calling subscriber's line and maintains the relay 132 energized over the circuit heretofore described.

Relay 131 by the attraction of its armatures also establishes a circuit from ground, the left-hand armature and contact of relay 133, the alternate contact and right-hand armature of relay 131, the winding of relay 137 to battery and ground. Relay 137 becomes locked up over the circuit heretofore described and opens the circuit through which relay 153 is energized by the attraction of its innermost left-hand armature.

Conversation between the subscriber at the calling substation 104 and the called substation 155 may now proceed.

We will assume that the subscriber at the calling substation 104 replaces his receiver upon the hook, but the subscriber at called substation 155 inadvertently fails to replace his receiver. Through this action, relay 132 becomes deënergized, whereby a circuit is established from ground, the armature and normal contact of relay 132, the primary off-normal contact 156, the winding of relay 157, the winding of release magnet 149 to battery and ground. The resistance of relay 157 is such that although it becomes energized in this circuit, sufficient current does not flow to cause the energization of release magnet 149.

Since the armature of relay 132 becomes retracted, the slow release relay 133 becomes deënergized and retracts its armatures. Ground is now placed on the release trunk of the connector at the contact and armature of relay 157 through the right-hand armature and alternate contact of relay 131 to replace the ground removed at the left-hand armature and contact of relay 133. A circuit is also established from ground, the armature and normal contact of relay 132, the right-hand armature and normal contact of relay 133, the primary off-normal contact 156, the winding of slow acting relay 102, to battery and ground. In time, the relay 102 will attract its armatures and through the agency of an induction coil 158, will place the howler on the called subscriber's line. In answer to the summons of this howl, the subscriber at substation 155 will replace his receiver on its hook, whereupon the relays 130 and 131 will become deënergized. Relay 130 through the closure of its right-hand armature and contact short-circuits relay 157, whereby sufficient current is caused to flow through relay 149 to cause its energization. This in turn causes the release of the connector switch. The retraction of its right-hand armature by the relay 131, removes ground from the release trunk of the connector switch whereby relays 137 and 112 are deënergized. The retraction of its armatures by the relay 112 establishes a circuit from ground, armature and normal contact of relay 111, the normal contact and lowermost armature of relay 112, the innermost left-hand armature and contact of relay 113, primary off-normal contact 123, the winding of release magnet 159 to battery and ground, whereupon the selector switch is released.

If now, the called subscriber had properly replaced his receiver on its hook at the termination of the conversation, a circuit would have been established from ground, armature and normal contact of relay 132, right-hand armature and normal contact of relay 133, primary off-normal contact 156, right-hand armature and contact of relay 130, winding of release magnet 149 to battery and ground, whereby the release magnet 149 would have become energized to release the connector switch and return the apparatus concerned in this connection to its normal condition before the energization of relay 102 could have become effective.

Referring now especially to Fig. 2, attention is directed to the slow acting relays 200 and 202 provided with the dash-pots 201 and 203 respectively. These relays are similar in construction and operation to the slow-acting relays 100 and 102. The relay 200 is associated with a plurality of selective switches, such as that shown in the upper part of the figure, and is responsive to an unstandard condition caused by the removal of the receiver from its hook at a calling substation. The relay 202 is also responsive to the same unstandard condition but is not directly associated with the selective switches.

When a calling subscriber at a substation, such as 204, removes his receiver from its hook, any well known type of line switch or line finder switch may place the brushes 206 to 208 inclusive on the terminals 209 to 211 inclusive, thereby establishing a circuit from ground, battery, the right-hand winding of relay 212, the normal contact and upper armature of relay 213, terminal

209, brush 206, to and through the apparatus at the subscriber's substation 204, brush 207, terminal 210, innermost lower armature and normal contact of relay 213, left-hand winding of relay 212 to ground.

Relay 212 is energized in this circuit and attracts its armature, thereby establishing a circuit for the energization of relay 214, extending from ground, the armature and alternate contact of relay 212, the winding of relay 214, to battery and ground. Relay 214 attracts its armatures and establishes a circuit from ground, alternate contact and middle left-hand armature of relay 214, the release trunk of the selector switch, the terminal 211, brush 208, relay 215, battery and ground.

At the same time a circuit is established from ground, primary off-normal contact 216, outermost left-hand armature and alternate contact of relay 214, the common conductor 217, the off-normal contact 205, winding of relay 200, to battery and ground. Relay 200 is energized in this circuit but, due to the connection of its armature with the dash-pot 201, does not actuate its contact for a definite period of time.

If, as before, the receiver at the substation 204 has been inadvertently removed from its hook and no impulses transmitted then the circuit for the energization of relay 200 will be established for a period of time long enough to cause its actuation. Thereupon, a circuit will be established from ground, the contact and armature of relay 200, the winding of relay 218, battery and ground. Relay 218 attracts its armature and establishes a holding circuit for itself from ground, normal position terminal 219, brush 220, innermost right-hand armature and contact of relay 218, the winding of relay 218 to battery and ground. A circuit is thereupon established for the energization of the motor magnet 223 from ground, terminal 219, brush 220, innermost right-hand armature and alternate contact of relay 218, contact and armature of motor magnet 223, to battery and ground. The motor magnet 223, through the actuation of its armature, breaks its own circuit and in the well known manner drives the brushes 220 to 222 step by step over their associated terminals.

At the first such step, the off-normal contact 205 is opened, thus causing the de-energization of relay 200 and the removal of the ground connection with the winding of relay 218.

It will be noted that terminals associated with brush 220 lead to the normal contact and outermost left-hand armature of relays 214 and thence to ground through the primary off-normal contacts 216, in case the selector switches to which they are connected are idle, or to ground through the primary off-normal contacts 224 in case the selector switches to which they are connected are busy.

Therefore, the holding circuit of relay 218 will be maintained until the brush 220 encounters the terminal 225, leading to the selector switch in which the unstandard condition exists. In this case, no ground will be connected to the terminal 225, whereupon the relay 218 will become deënergized; the motor magnet 223 will become deënergized, and the brushes 220 to 222 inclusive will be left in association with the terminals leading to the selector switch in which the unstandard condition exists.

Thereupon a circuit will be established from ground, battery, off-normal contact 226, the winding of relay 227, the left-hand armature and normal contact of relay 218, to ground. Through this circuit relay 227 is energized and attracts its armatures. At the same time a circuit is established from ground, off-normal contact 228, outermost right-hand armature and normal contact of relay 218, winding of relay 202, to battery and ground. Relay 202 becomes energized in this circuit and after a definite period of time has elapsed it attracts its armatures, whereby a circuit is established from one terminal of the secondary winding of the induction coil 229, the contact and uppermost armature of relay 227, condenser 230, the brush 222, the terminal 231, the upper limb of the talking circuit of the selector switch, terminal 209, brush 206 to and through the apparatus of the subscriber's substation 204 including its receiver, the brush 207, the terminal 210, the terminal 232, the brush 221, condenser 233, the innermost armature and contact of relay 227, the right-hand armature and contact of release magnet 234, the contact and uppermost armature of relay 202, to the other terminal of the secondary winding of induction coil 229. The primary winding of the induction coil 229, as before, is connected to a source of "howler" current, whereby a howler tone is placed on the delinquent subscriber's line.

The attraction of its armatures by the relay 202, establishes a circuit from ground, the off-normal contact 228, the outermost right-hand armature and contact of relay 218, the contact and innermost armature of relay 202, the off-normal contact 205, the winding of relay 200, to battery and ground.

The relay 200 attracts its armature and after a definite period of time has elapsed closes its contact, whereby the beforementioned circuit for the energization of relay 218 is closed. The motor magnet 223 is energized and the brushes 220 to 222 inclusive are stepped forward. The attraction of its armature by the relay 218 again opens the energizing circuit of relays 200 and 202, whereby they retract their armatures. The

attraction of its left-hand armature by the relay 218 also opens the energizing circuit of the relay 227, whereby the source of howler current is disconnected from the brushes 221 and 222 so as to prevent the transmission of this current to the lines encountered by these brushes.

If no unstandard condition of a similar nature exists in the bank of the selective switches served by the testing switch, then the brush 220 will finally be driven into association with terminal 236, which, due to the energization of relay 218, is found in open circuit. The relay 218 thereby becomes deënergized and a circuit is established from ground, the contact and left-hand armature of relay 218, the terminal 236, the brush 220, the innermost right-hand armature and normal contact of relay 218, the winding of release magnet 234, the off-normal contact 226, to battery and ground. The release magnet 234 attracts its armatures and establishes a holding circuit for itself from ground, left-hand armature and contact of release magnet 234, off-normal contact 226, to battery and ground. In the well known manner the brushes 220 to 222 are returned to normal under the influence of release magnet 234.

If, in answer to the summons of the howler current, the subscriber at station 204 has in the meantime replaced his receiver on its hook and thereby deënergized relays 212 and 214, the common conductor 217 will be free from ground when the normal position of brushes 220 to 222 inclusive is reached. If, on the other hand, the subscriber at station 204 has not replaced his receiver on its hook the operation just described will be repeated, and thereafter repeated again and again until the subscriber does replace his receiver.

Assume that the subscriber at substation 204 has not inadvertently removed his receiver from its hook, but has initiated a call. Then shortly after the energization of relays 212 to 214 he will manipulate his dial switch, in which case an operation very similar to that described in connection with the selector switch of Fig. 1 will take place. Upon the first step of the brushes 237 to 239 inclusive the primary off-normal contact 216 will be broken and the contact 224 will be established. This will set up a standard condition and the energization of relay 200 being of only a short duration, its contact will not be closed and the operation of the testing switch, as described, will not take place.

The further operation of the selector switch shown in the upper part of the figure, being well known to those skilled in the art, will not be further described.

What is claimed is:

1. In an electrical testing system, telephone lines, a telephone station including a receiver and a switchhook on each of said lines, selective switches for interconnecting said lines, a source of current for causing a distinctive tone in said receivers, and means common to said switches responsive to an unstandard condition in said switches arising from a receiver being left off its hook for automatically connecting said source of current to said lines.

2. In an electrical testing system, telephone lines, a telephone station including a receiver and a switchhook on each of said lines, selective switches for interconnecting said lines, a source of signaling current, and means common to said switches responsive to an unstandard condition caused by the removal of a receiver from its hook for connecting said source of current to said lines.

3. In an electrical testing system, telephone lines, a telephone station including a receiver and a switchhook on each of said lines, selective switches for interconnecting said lines, a source of signaling current for actuating said receivers, and means including a slow acting relay common to said switches responsive to an unstandard condition caused by the removal of a receiver from its hook for connecting said source of current to said lines.

4. In an electrical testing system, normally open circuits, a station on each of said circuits arranged upon actuation to close said circuit, selective switches for interconnecting said circuits, a source of signaling current, and means common to said switches responsive to a prolonged closure of said circuit before said interconnection has been established for connecting said source of current thereto.

5. In an electrical testing system, normally open circuits, a station on each of said circuits, said station being arranged upon use to close said circuits, selective switches for interconnecting said circuits, a source of signaling current, and means associated with said switches responsive to a prolonged closure of either of two connected circuits for automatically connecting said source of current thereto, said signaling current being connected before disconnection of said circuits.

6. In an electrical testing system, normally open circuits, means for interconnecting said circuits, a source of signaling current, and means including a slow acting relay common to said switches responsive to a prolonged closure of said circuits for automatically and periodically connecting said source of current thereto.

In witness whereof I hereunto subscribe my name this 24th day of July, A. D., 1917.

HENRY P. CLAUSEN.