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LINE INSULATION TESTING CIRCUIT

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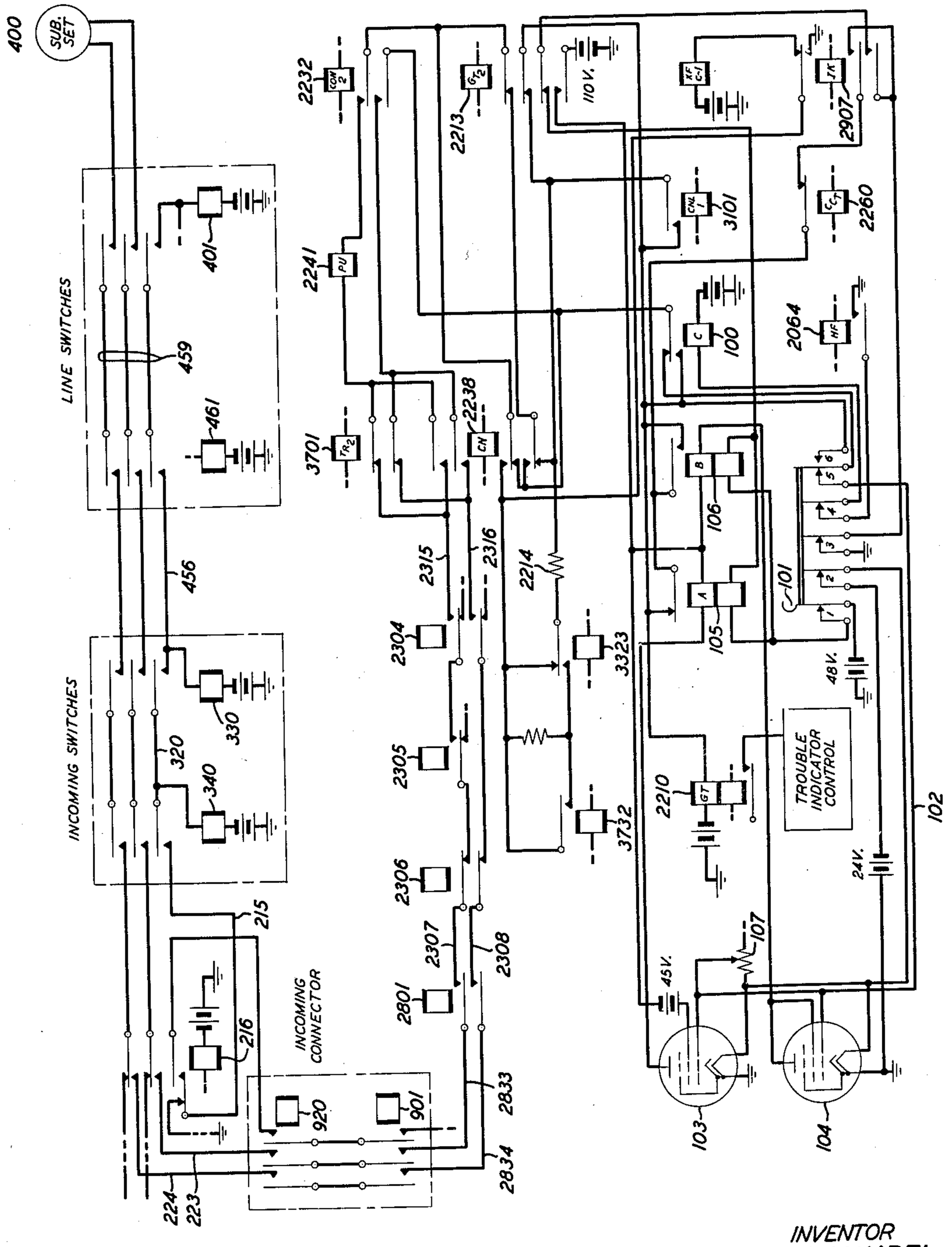

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LINE INSULATION TESTING CIRCUIT

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This invention relates to telephone systems and has for its object to facilitate the maintenance of subscribers' lines. A more specific object of the invention is to test the insulation resistance of a line each time that the line is called.

The routine testing of subscribers' lines for low insulation resistance is a well-known procedure. Further, an additional test for the presence of a false battery is often made as a separate step in such routine testing.

In accordance with the present invention, means is provided to simultaneously test a line for low insulation resistance and for connection to a false battery potential.

A feature of the invention lies in the use of a pair of vacuum tubes and associated circuits so arranged that one tube is responsive to leakage to ground and the other tube is responsive to false battery potential. The response of either tube is effective to indicate a trouble condition on the tested line.

As a further feature of the invention this testing means is included in the common control circuit or marker of a cross bar system which is so arranged that each time it connects with a line, as a called line, the testing means is connected with the line. If either trouble condition exists, the marker is prevented from completing a connection with the called line.

These features of the invention will be more clearly understood from a consideration of the following description read in connection with the drawing which shows in schematic form a called subscriber's line and the terminating end of a connection therewith, together with a skeletonized showing of the marker circuits concerned with the present invention.

This drawing is based on the disclosure of Patent 2,232,371, granted to Dehn and Myers February 18, 1941, and reference is made to that patent for a complete disclosure of a marker in which the present invention may be employed. For convenience in referring to the Dehn et al. patent, the same reference numerals have been applied to the elements of the drawing as are used for the corresponding elements in the Dehn et al. drawing. The elements added in accordance with the present invention have been given designations between 100 and 199.

As set forth in the Dehn et al. patent, when a call has been extended to an incoming junctor, the incoming junctor is connected with an incoming sender in which the wanted line designation is registered. When the designation has been registered, the incoming sender is connected with a terminating marker through a marker connector and the designation is transmitted to the marker. As soon as the marker is connected with the sender, relay **2801** is operated.

Having received the wanted line designation, the marker connects with a number group circuit to obtain the location of the called line and then operates an incoming

connector including relays **901** and **920** to obtain control of the incoming switches and the incoming junctor. As a result of the operation of the incoming link connector, check relay **2907** is operated. With relay **2907** operated, a circuit is closed from ground over the front contact of relay **2907**, back contact of relay **3223**, resistance **2214**, middle lower contact of relay **2213** to battery through the upper winding of relay **2210**. With relay **2210** operated, relay **216** in the incoming junctor is also operated. Relay **2907** also closes a circuit from battery over contact **1** of key **101** through the lower windings of relays **105** and **106**, outer lower back contact of relay **2213**, outer front contact of relay **2907** to ground over contact **3** of key **101**. This circuit serves to thoroughly magnetize the cores of relays **105** and **106** preparatory to their use in the line test.

When the marker has received the location of the called line from the number group circuit it operates a line choice connector to obtain control of the line swtiches. The marker then selects and tests the wanted line and, if it is idle, tests for and selects an idle channel, after which it operates hold magnet **461** of the secondary line switch and hold magnet **330** of the secondary incoming switch followed by hold magnet **340** of the primary incoming switch. With relay **216** operated, the marker is connected with the talking conductors of the partially set-up connection over contacts **2** and **4** of relay **216** and contacts of relays **920** and **901** in the incoming connector circuit. The marker then tests this connection for freedom from ground and if the talking conductors through the switches are in the proper condition, relay **2305** operates in turn operating hold magnet **401** of the primary line switch completing the connection between the marker and the called line. With relay **2305** operated, relay **2304** is also operated. A continuity test is made as described in the Dehn et al. patent and, if the result of this test is satisfactory, relay **2232** is operated. Following the continuity test the marker sets the ringing control relays of the incoming junctor and checks the accuracy of such setting. If the check is satisfactory relay **2213** is operated.

The called line is now connected over contacts of the primary line switch, secondary line switch, secondary incoming switch, primary incoming switch, contacts of relay **216**, contacts of relays **920** and **901** of the incoming connector circuit to conductors **2833** and **2834**. With relays **2304**, **2305** and **2232** operated, the tip conductor **2834** is extended over front contact of relay **2801**, conductor **2308**, back contact of relay **2306**, front contact of relay **2304**, conductor **2316**, back contact of second trial relay **3701**, front contact of relay **2232**, back contact of relay **100**, contact **5** of key **101** to conductor **102**. The ring conductor **2833** is also connected over front contact of relay **2801**, conductor **2307**, back contact of relay **2306**, front contact of relay **2305**, front contact of relay **2304**, conductor **2315**, back contact of relay **3701**, through the winding of relay **2241**, front contact of relay **2232**, back contact of relay **2238**, back contact of relay **100** and contact **5** of key **101** to conductor **102**. When relay **2213** operates, the energizing circuits through the lower windings of relays **105** and **106** are opened and plus 110-volt battery is connected to the upper windings of relays **105** and **106**. Plus 110-volt battery is also connected in series with minus 45-volt battery to the screen grid of tube **103**. The upper winding of relay **105** is connected to the plate of tube **103**, while the upper winding of relay **106** is connected to the plate of

tube **104**. Relay **2213** also opens the energizing circuit for relay **2210**.

The means for making the insulation resistance and false battery tests includes two vacuum tubes **103** and **104** and the two relays **105** and **106**. Both tubes are shown as pentodes but a triode might be substituted for tube **104**. In each tube the cathode and suppressor grid are connected together and to ground, while the control grid is connected to conductor **102** which is connected to the two conductors of the subscriber's line as previously described. In tube **104** the plate or anode and the screen grid are connected together and through the upper winding of relay **106** to plus 110-volt battery over a contact of relay **2213**. The plate or anode of tube **103** is connected through the upper winding of relay **105** to the plus 110-volt source. The screen grid is also connected to the plus 110-volt source through a minus 45-volt source so that the plate has a potential of 45 volts above that of the screen grid. The heater elements are energized from a minus 24-volt source over contact **2** of key **110**. This same source is connected through resistance **107** to the control grids of the two tubes to supply a normal bias. Resistance **107** is adjustable to determine the range of leakage resistance to be indicated, but for average conditions is 75,000 ohms.

When relay **2213** operates, the circuits through the upper windings of relays **105** and **106** are closed and the circuits through the lower windings are opened as well as the operating circuit for relay **2210**. The normal plate current in tube **103** operates relay **105** but the normal plate current through tube **104** does not operate relay **106**.

A high resistance ground will normally appear on the line conductors having a tendency to cause the control grids of the tubes to become positive, increasing the current flow through the tubes, this increase in current flow through relay **105** holding that relay operated. If the insulation resistance is sufficiently high, the increase will be insufficient to operate relay **106**, but if the insulation resistance is in the range to be detected, the increase in current flow will also cause the operation of relay **106**. With relay **106** operated, a circuit is closed from battery through the upper winding of relay **2210**, contact of relay **106**, contact of relay **2260**, contact of relay **2907**, contact **3** of key **101** to ground, holding relay **2210** operated. As described in detail in the above-mentioned Dehn et al. patent, the failure of relay **2210** to release blocks the completion of the call and causes a trouble indication to be set up.

On the other hand, if a false battery potential is present on the line, the control grids become negative, reducing the current flow through the tubes. Therefore relay **106** cannot operate and relay **105** releases. With relay **105** released, a circuit is closed from battery through the upper winding of relay **2210**, back contact of relay **105**, contact of relay **2260**, contact of relay **2907**, contact **3** of key **101** to ground, preventing the release of relay **2210** to block the completion of the call.

Lines leading to a P. B. X present a different condition from individual lines and are ordinarily given a loop test by the marker. When such a line is identified by the number group circuit, it causes the operation of relays **2064** and **2238** as described in the Dehn et al. patent. With relay **2064** operated, a circuit is closed from ground over a contact of relay **2064**, contact **4** of key **101** to battery through the winding of relay **100**, operating relay **100**. With relay **2238** operated, when relay **2213** operates, the tip and ring conductors are disconnected from one another, the ring conductor being extended to ground at the front contact of relay **2907** while the tip conductor is connected to the ground test lead. With relay **100** operated, this lead is disconnected from the tube circuit and is extended to the upper winding of relay **2210** so that the ground test is made in the usual manner.

If for any reason it is not desired to use the insulation testing equipment, key **101** will be opened. At its contact **1** the operating circuit for relays **105** and **106** is opened; at its contact **2** the heater circuit for tubes **103** and **104** is opened; at its contact **3** ground is disconnected from the armatures of relays **105** and **106**; at its contact **4** the circuit of relay **100** is opened; at its contact **5** the line test circuit is disconnected from the control grids of tubes **103** and **104**; and at its contact **6** the line test circuit is extended to the upper winding of relay **2210** so that the marker makes the ground test in the usual manner.

Relay **2260** is operated when it is desired to cancel the continuity test and, when so operated, disconnects ground from the armatures of relays **105** and **106** to render them ineffective. Relay **3101** is used when it is necessary to set the incoming junctor to give an overflow signal and holds relay **2210** operated.

What is claimed is:

1. In a telephone system, subscribers' lines subject to leakage to ground and connection with false battery potential, means for testing said lines comprising a pair of vacuum tubes, each tube having an input electrode and an output circuit, means to connect one of said lines with said testing means, a relay in the output circuit of each of said tubes, control circuits for one of said tubes to render said one tube responsive to leakage to ground on said connected line to operate one of said relays and control circuits for the other of said tubes to normally operate the other one of said relays and to render said other tube responsive to false battery potential on said connected line to release said other relay, and means responsive to the operation of said one relay or to the release of said other relay to indicate a trouble condition on said connected line.

2. In a telephone system, subscribers' lines subject to leakage to ground and connection with false battery potential, means for testing said lines comprising a pair of vacuum tubes, each tube having a cathode, an anode and a control grid, one of said tubes having an auxiliary grid, a bias voltage connected to the control grids of both tubes, an auxiliary voltage connected to said auxiliary grid, a first relay connected to the anode of said one tube and normally operated by the current flow through said first tube, a second relay connected to the anode of said other tube and normally non-operated, said tubes responsive to a predetermined leakage to ground on said connected line to hold said one relay operated and operate said second relay, said tubes responsive to a false battery potential on said connected line to release said first relay and prevent the operation of said second relay, and means responsive to the operation of said second relay or to the release of said first relay to indicate a trouble condition on said connected line.

3. In a telephone system, called lines, a control circuit for controlling the establishment of connections with said called lines, means for connecting said control circuit with one of said called lines, means in said control circuit for testing the talking conductors of said one line for ground, electronic means in said control circuit for simultaneously testing the talking conductors of said lines for low leakage resistance and false battery potential, and means for alternatively connecting said one line with said ground test means or said electronic test means.

4. In a telephone system, called lines, a control circuit for controlling the establishment of connections with said called lines, means for connecting said control circuit with one of said called lines, means in said control circuit for testing the talking conductors of said one line for ground, electronic means in said control circuit for simultaneously testing the talking conductors of said lines for low leakage resistance and false battery potential, said ground test means being normally effective, and manually controlled means for disabling said ground test means and rendering said electronic test means effective.

5. In a telephone system, called lines of a plurality of classes, a control circuit for controlling the establishment

of connections with said called lines, class indicating means in said control circuit, means for connecting said control circuit with one of said called lines, means in said control circuit for testing the talking conductors of said one line for ground, electronic means in said control circuit for simultaneously testing the talking conductors of said lines for low leakage resistance and false battery potential, said ground test means being normally effective, manually controlled means for disabling said ground test means and rendering said electronic test means effective, and means under the control of said class indicating means to disable said electronic test means and render said ground test means effective.

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