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TEST CIRCUIT

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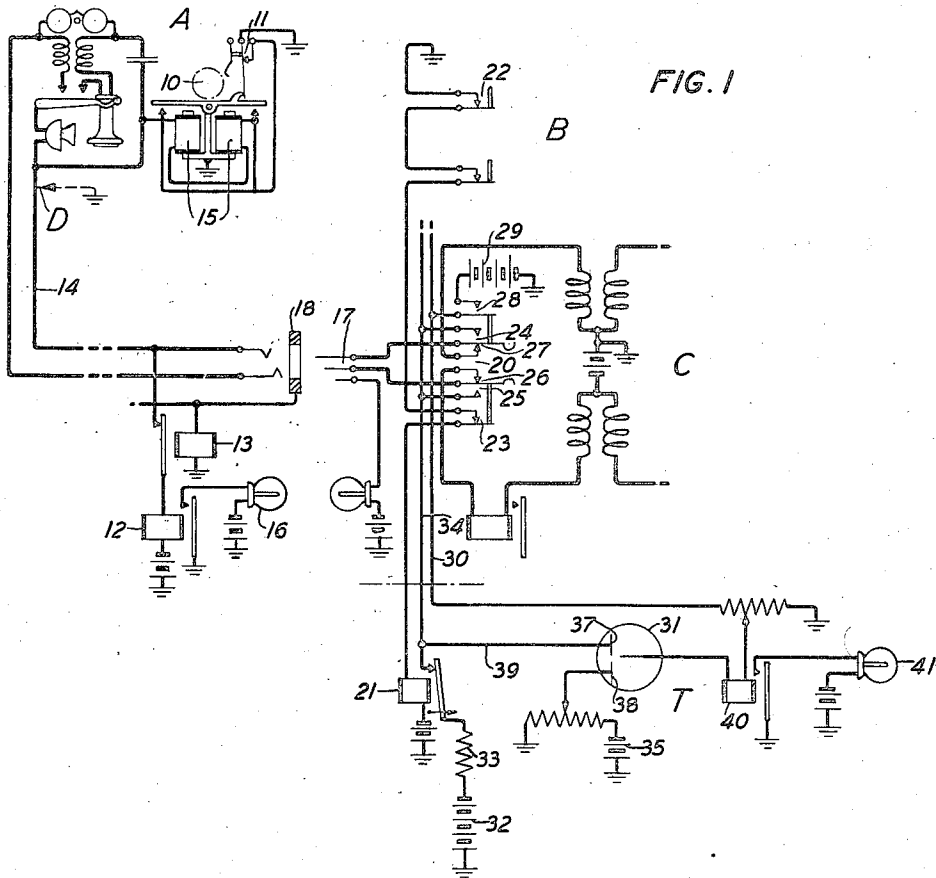


FIG. 3

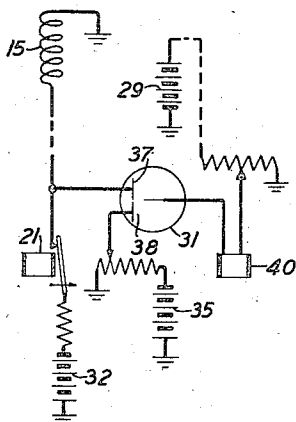
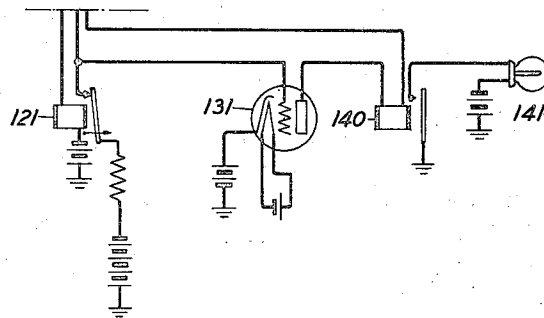


FIG. 2



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TEST CIRCUIT

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This invention relates to test circuits and particularly to the utilization in such circuits of gaseous conductor or discharge tubes for distinguishing between inductive and non-inductive circuit conditions.

The gaseous tube employed in the circuits of this invention is a tube filled with a low pressure gaseous content, such as neon, argon, helium, mercury vapor or combinations of gases of this group. Such a tube is characterized by the fact that the contained gas ionizes and becomes conducting at a predetermined specified potential and once rendered conducting, maintains this condition of conductivity at a lower potential and until such time when some other condition is imposed on the tube, such as opening the output circuit, to stop the ionization phenomenon.

The present invention has for its object the utilization of such a tube in a test circuit for distinguishing between inductive and non-inductive circuits.

In its general aspect, this invention utilizes the energy stored in an inductive circuit as the means for imposing on the tube a potential of such a nature as to cause the gas in the tube to become ionized and therefore conductive and including in the circuit completed by the ionization of the gaseous content a signal control device such as a relay.

The present invention finds particular application in telephone systems of the prepayment type wherein a subscriber is required to deposit a coin or token in the telephone coin box before a desired connection can be completed. In such systems, the deposit of a coin at a pay station effects the completion of a circuit to the central office which includes the inductive windings of the coin control magnet which constitutes an essential element in the equipment located at the subscriber's station. This circuit is completed by the application of ground potential to the telephone line.

Unscrupulous persons, in an endeavor to defraud the operating companies and obtain free calls, have resorted to the practice of simulating the deposit of a coin by artificially grounding the telephone line. The circuit to the central office completed in this manner, however, does not include the inductive windings of the coin control magnet and is therefore a non-inductive circuit. The present invention utilizes this fact by providing a test circuit which includes means which is rendered responsive when associated with an inductive circuit and unresponsive when associated with a non-inductive circuit.

In order to disclose its practicability and to more clearly describe its functioning, the present invention is shown in the drawing as applied to a telephone system of the prepayment type, but it is to be understood that it is equally applicable to any type of electric circuit, the inductive or non-inductive characteristic of which is to be determined.

In the drawing

Fig. 1 shows a subscriber's telephone line of the prepayment type terminating in the usual manner at a central office at which there is located an operator's cord circuit with which may be associated the test circuit of this invention. The test circuit of Fig. 1 utilizes a gaseous tube of the cold cathode type;

Fig. 2 shows the test circuit in which a hot cathode type tube is substituted for the tube in Fig. 1; and

Fig. 3 is a simplified schematic showing the circuit conditions which prevail during the test and just prior to the opening of the circuit on test.

It is believed that the invention will be readily understood from the following detailed description made with reference to the accompanying drawing, the figures of which have been generally described above.

Initiating call by coin deposit

A subscriber at station A desiring to obtain a telephone connection removes the receiver and deposits a coin in the coin box located at the station A. The deposit of the coin closes the coin contacts 11 to ground in the well known manner. A circuit is thereby established extending from grounded battery, winding of line relay 12, armature and back contact of cut-off relay 13, tip conductor 14 of the subscriber's line circuit, windings of coin control magnet 15 to ground at the contacts 11.

Relay 12 operates in this circuit and causes line lamp 16 to be lighted in an obvious circuit. Upon noting the lighted line lamp 16, an operator at central office B inserts the answering plug 17 of a cord circuit C into the jack 18 associated with the lighted line lamp 16. Cut-off relay 13 now operates in an obvious sleeve circuit and opens the circuit to line relay 12, which relay releases its armature causing line lamp 16 to be extinguished.

The operator may now test the line for coin ground by actuating key 20. It will be noted that the test circuit generally indicated at T is common to a plurality of cord circuits such as C and that slow-to-release relay 21 is normally

energized, the circuit for this relay extending to ground on the back contact 22 associated with a key, such as key 20, individual to the last cord circuit located at the operator's position.

Actuation of key 20 associated with cord circuit C opens the energizing circuit for relay 21 at the contact 23 and at contacts 24 and 25 connects the tip of plug 17 to conductor 34. At contacts 26 and 27, key 20 disconnects the conductors of cord circuit C from the plug 17. At contact 28, key 20 connects the positive terminal of battery 29 to conductor 30 thereby completing a circuit to the anode of tube 31.

Relay 21 being slow to release maintains, for a short period of time, a circuit extending from grounded battery 32, resistance 33, armature and front contact of relay 21, conductor 34, contacts 24 of key 20, tip springs of plug 17 and jack 18, conductor 14, windings of coin control magnet 15 to ground at coin contacts 11. This circuit is maintained for a period of time sufficiently long to fully build up the current through the inductance of the coin control magnet coils.

It will be understood that the potentials of batteries 32, 35, and 29 are fixed so as to be just below the minimum critical operating point of the tube so that the tube does not flash under normal conditions of no test.

When relay 21 releases, the inductive circuit previously traced through the coin control magnet 15 is opened whereupon the energy stored in the magnet coils is released causing a potential reversal and rise on cathode 37, this cathode being connected to the inductive circuit by way of conductor 39. This rise in potential on cathode 37, due to the potential rise generated by the breaking of the circuit including the inductance of the coin control magnet, raises the potentials on the tube above the critical breakdown point, causing the gas in the tube to ionize and become conductive so that relay 40 operates in a circuit extending from the battery 29, contacts 28 of key 20, conductor 30, winding of relay 40, anode of tube 31 to the tube cathode 38. Relay 40 operates in this circuit completing an obvious circuit for signal lamp 41.

The lighting of lamp 41 indicates to the operator that the test circuit has been associated with an inductive circuit, and in the case illustrated, that a coin has been deposited in the coin box. The key 20 may then be restored and the call extended in accordance with usual practice. Restoration of key 20 opens contact 28 thereby interrupting the anode circuit of the tube, ionization stops and the tube is rendered inert.

Line fraudulently grounded

Should the subscriber at station A attempt to obtain service without depositing a coin in the coin box by simulating this act by grounding the line, the test is made in the same manner as hereinbefore described.

It will be noted that fraudulently grounding the line at D, for example, causes the line relay 12 to operate in an obvious circuit which in turn causes line lamp 16 to be lighted. The operator proceeds to answer the call in the usual manner and tests the calling line by the actuation of a key 20 associated with the cord she uses in answering the call.

Key 20 performs the same functions as hereinbefore described in connection with a call initiated in accordance with prescribed practice. It will be noted, however, that the inductive windings of the coin control magnet 15 are not in-

cluded in the tip circuit being open to ground due to the absence of a coin in the coin box; consequently, the circuit extending from battery 32, resistance 33, armature and front contact of relay 21, conductor 34, contacts 24 of key 20, tip springs of plug 17 and jack 18, conductor 14 to ground at D is a non-inductive circuit, so that when relay 21 releases to open this circuit, there is no change of potential on the control cathode 37 and consequently there is no ionization of gas in the tube 31, which accordingly remains inert. The circuit to relay 40 is not completed and lamp 41 remains unlighted.

Upon making the test and noting the failure of lamp signal 41 to light, the operator immediately recognizes that an unstandard condition exists on the line, that is, that the line has been fraudulently or accidentally grounded. When such a condition exists, the operator does not complete the connection.

With reference to Fig. 2 of the drawing, tube 131 corresponds to tube 31 of Fig. 1, relay 121 to relay 21, relay 140 to relay 40 and lamp signal 141 to 41. It is believed unnecessary to repeat the description made with reference to Fig. 1 in describing the operation of the test circuit shown in Fig. 2. The operation of the systems is identical. The test circuit of Fig. 2 distinguishes from that of Fig. 1 in utilizing a hot cathode type of tube in place of the cold cathode tube of Fig. 1.

The cathode of tube 121 is continuously heated and the grid serves as the control element. When this test circuit is associated with an inductive circuit and the test is made, the breaking of the inductive circuit causes a reversal and rise of potential on the grid element of the tube 131, causing the tube to flash and become conductive. Relay 140 thereupon operates in the plate or anode circuit of the tube, causing the signal lamp 141 to be lighted. When the circuit tested is non-inductive, there is no reversal of potential on the grid, the tube remains inert and no signal indication is evidenced.

From the foregoing it is apparent that the present invention provides a simple, practical and accurate arrangement for discriminating between an inductive and a non-inductive circuit to ground which utilizes either hot or cold cathode gas-filled tubes, the tubes being arranged to function on the potential rise created when an inductive circuit is broken.

What is claimed is:

1. In combination, an electric circuit capable of having either an inductive or a non-inductive characteristic, a test circuit including means for discriminating between inductive and non-inductive circuits, said means comprising a gas-filled tube, and means for associating said electric circuit with said test circuit to be tested thereby.

2. In combination, an electric circuit capable of having either an inductive or a non-inductive characteristic, a test circuit including means for discriminating between inductive and non-inductive circuits, said means comprising a gas-filled tube having a control electrode normally maintained at a certain predetermined potential, and means for connecting the control electrode of said tube with said electric circuit in such a manner that the potential of said electrode is altered and said tube flashes when said electric circuit has an inductive characteristic.

3. In combination, an electric circuit including an energy storing device, a test circuit including a gas-filled tube having a control electrode normally maintained at a certain predetermined po-

tential, a source of energy, means for connecting said energy storing device with said source of energy and with said control electrode, means for subsequently disconnecting said energy storing device from said source of energy whereupon the energy stored in said storing device due to its connection with said source of energy is released to alter the potential of said electrode and cause said tube to flash.

4. In combination, an electric circuit including an inductive winding, a test circuit including a gas-filled tube having a control electrode normally maintained at a certain predetermined potential, a source of energy, means for connecting said inductive winding with said source of energy to permit a build-up of current in said winding, said means also connecting said winding with said control electrode, and means for subsequently breaking the connection between said source of energy and said winding whereupon the decay of current in said winding causes a reversal of potential on said control electrode and the tube flashes.

5. In combination, an electric circuit including a coil, a test circuit including a gas-filled tube having a control electrode normally maintained at a certain predetermined potential and an anode, a signal control device connected to said anode, a source of energy, means for connecting said coil with said source of energy to permit a build-up of current in said coil, said means also connecting said coil with said control electrode and means for subsequently breaking the connection between said source of energy and said coil whereupon the decay of current in said coil causes a reversal of potential on said electrode and said tube flashes causing said signal control device to operate in the anode circuit of said tube.

6. In combination, a circuit having an inductive characteristic, a circuit having a non-inductive characteristic, a test circuit including means for distinguishing between the characteristics of said circuits, said means comprising a gas-filled tube which functions to actuate a signal when said first circuit is tested and which remains inert when said second circuit is tested, and means for associating said test circuit with said other circuits.

7. In combination, a line circuit including an inductive winding, a source of energy, a test circuit including a gas-filled tube having a control electrode and having a critical operating point, the potentials on said tube being adjusted to a value below the critical operating point, means for associating the control electrode of said tube with said line circuit and connecting said energy source to said inductive winding, a signal control relay, and means for subsequently breaking the circuit from said energy source to said inductive winding whereupon the energy stored in said inductive winding releases and raises the potential of said control electrode beyond the critical operating point of said tube, whereupon said tube

flashes and completes a circuit to said signal control relay.

8. In combination, a gas-filled tube having two cathodes and an anode, all of said electrodes being electrically biased in such a manner as to render said tube normally inert, an energy storage device connected in parallel with one of said cathodes to the biasing source for said cathode, means for disconnecting the biasing source from said last mentioned cathode and said energy storing device for causing the energy stored in said device to be released and to effect a reversal of potential on said last mentioned cathode whereupon said tube is rendered conductive, and a signal control relay in the anode circuit of said tube.

9. In combination, a telephone line of the prepayment type having a coin receptacle associated therewith, said line being capable of being grounded through the coin control magnet by the deposit of a coin, or directly by fraud or accident, a test circuit including means for discriminating between the coin ground and the direct ground, said means comprising a gas-filled tube which functions when the line tested is coin grounded and which remains inert when the line test is direct grounded, and a signal control device controlled by said tube.

10. In combination, a telephone line having associated therewith a coin receptacle including a coin control magnet, a test circuit including a gas-filled tube having a control electrode normally maintained at a predetermined potential, said test circuit being located at a central office, a source of energy, means at the central office for connecting the control electrode of said tube with the coin control magnet of said telephone line after said line has been seized by the deposit of a coin in the coin receptacle and for connecting said magnet with said source of energy, and means for subsequently breaking the connection between said magnet and said source of energy whereupon and as a consequence thereof, the potential on said control electrode is altered and said tube flashes.

11. In combination, a telephone line terminating at a central office, means for grounding said line through an inductive winding, means at said central office for completing a connection to said line, a test circuit at said central office, said test circuit including a gas-filled tube having a control electrode, a source of energy normally associated with said control electrode to maintain said electrode at a certain predetermined potential, means for connecting the inductive winding of said line with said source of energy and with said control electrode, and means automatically operating a predetermined period of time after the connection of said inductive winding with said source of energy and said control electrode for breaking the connection between said source of energy and said inductive winding, whereupon the potential on said control electrode is altered and said tube is rendered conductive.

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