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INSULATION TEST SET

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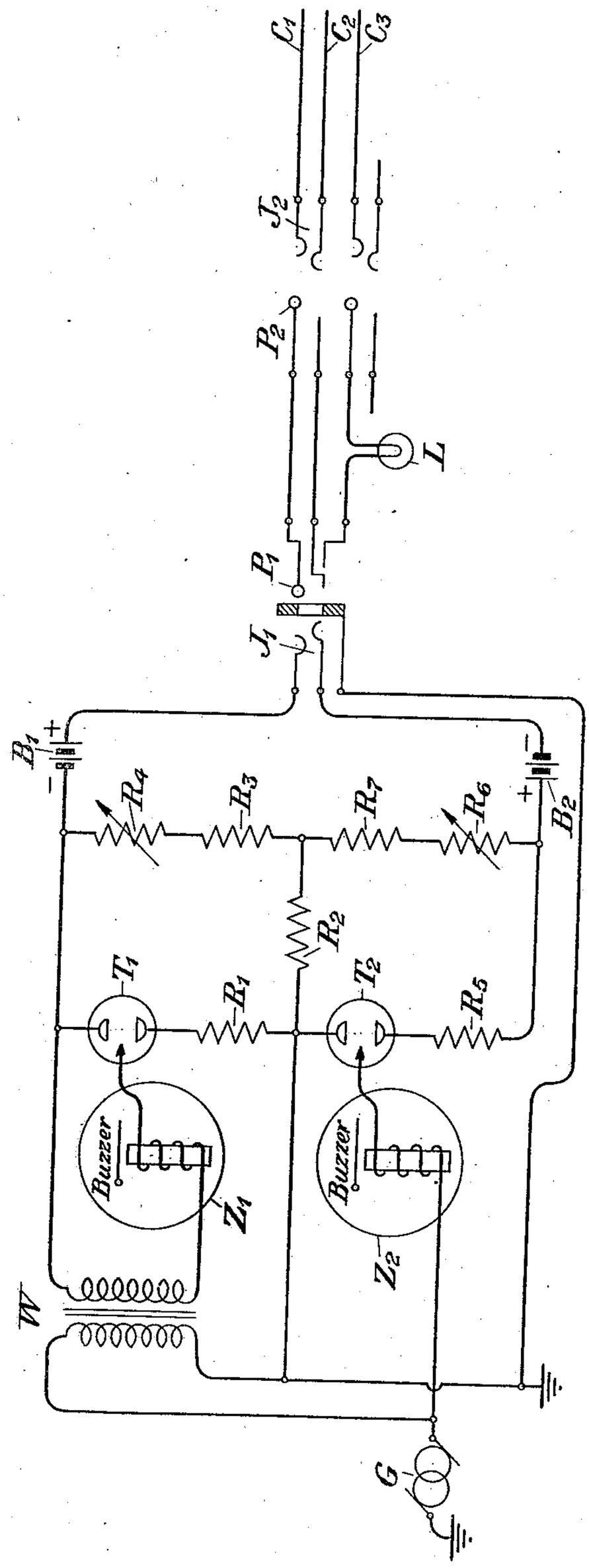

INVENTOR
R. M. Edmonds
BY Jefferson Ehrlich
ATTORNEY

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INSULATION TEST SET

Robert Mason Edmonds, Elmira, N. Y., assignor to American Telephone and Telegraph Company, a corporation of New York

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This invention relates to testing apparatus and systems, and more particularly to apparatus and systems for determining whether the conductors of a telephone line are grounded or are short-circuited to each other.

In connection with systems for testing the conductors of telephone lines to determine whether or not they are grounded or are short circuited to other lines, it has heretofore been proposed to isolate each of the various conductors from the system and connect each isolated conductor to a loop of well-known type, such as a Varley loop, arranged in the form of a Wheatstone bridge circuit, to determine whether or not the resistance to ground of the isolated conductor is greater than a predetermined value. This prior arrangement of separately studying each telephone conductor is a slow and costly process and is of little value where insulation tests must be made rapidly over hundreds of conductors during periods when wet weather conditions prevail.

Accordingly it is an object of the present invention to provide a testing arrangement for rapidly determining which of the two conductors of a telephone or other line is grounded, and at the same time determine whether the two conductors of the line are short-circuited to each other.

Another object of this invention is to provide a testing arrangement involving two detecting devices so set up that one of the detecting devices will be operated only when the resistance to ground of one of the conductors of a line is less than a predetermined value and the other detecting device operated only when the resistance to ground of the other conductor of the line is less than the same predetermined value.

It is a further object of this invention to have both detecting devices operated when the two conductors of the line are short-circuited to each other.

And it is a still further object of this invention to so arrange the testing apparatus that in connecting the testing apparatus to a telephone line the presence of a "busy" condition on the line will be rapidly determined.

In accordance with one embodiment of this invention two three-electrode gas tubes are connected in parallel branches, each branch including an individual battery. The gas tube and battery of each branch are then connected to one of the conductors of the line to be tested. When the insulation to ground of either of the conductors of the line is below a predetermined value, the voltage supplied to the battery in the same branch will be sufficient to fire the associated gas tube. Each gas tube circuit also includes an indicating device to indicate that the corresponding gas tube has been fired. Thus each branch of the testing system separately detects the presence of low insulation resistance to ground of but one of the line conductors. An additional circuit is superimposed on the testing arrangement, this circuit including another indicating device, such as a lamp, which will become operated only when the two conductors of the telephone line are "busy."

This invention will be better understood from the more detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, the reference characters T_1 and T_2 designate two three-electrode gas tubes of the cold cathode type which are connected in the two branches of the testing system to be described. The input electrodes of the tube T_1 are connected in a circuit including resistors R_1, R_2, R_3 and R_4, the resistor R_4 being adjustable for calibrating purposes. Likewise the input electrodes of the tube T_2 are connected to a similar circuit including resistors R_5, R_6, R_7 and R_2, the resistor R_6 being likewise adjustable for calibrating purposes. The resistor R_2 is, of course, common to the two circuits or branches just referred to. The upper terminal of resistor R_4 is connected to the tip terminal of a jack J_1 by means of a battery B_1, and a similar battery B_2 which is of opposite polarity but of like potential is connected between the lower terminal of resistor R_6 and the ring terminal of jack J_1.

The primary winding of transformer W is connected between an alternating current generator G and ground. This primary winding is also connected in circuit with the anode of tube T_2 and its upper input electrode through the winding of a buzzer designated Z_2 which is of well known type. The secondary winding of transformer W—which may have the same number of turns as the primary winding—is connected in circuit with the anode of tube T_1 and its upper input electrode through the winding of a buzzer designated Z_1. It will be apparent that the buzzer Z_1 will be operated only when the gas tube T_1 is fired, and that the buzzer Z_2 will be operated only when the gas tube T_2 is fired.

The drawing also shows a special patch cord including two plugs P_1 and P_2 of well known types. The tip and ring contacts of plug P_1 may, of course, engage the tip and ring terminals of the jack J_1 in the usual manner, the sleeve terminals of the two plugs P_1 and P_2 being connected in a circuit which includes a lamp L for determining the busy condition of each line to be tested as will be explained hereinafter. The plug P_2 may engage the line C_1—C_2 to be tested, the connection being established for example, through a jack J_2 which may be part of the test connector of a step-by-step central office sys-

tem, the test connector being employed for the routine testing measurements to be performed by the apparatus of this invention. Only one of the jacks of the test connector has been shown for illustrative purposes. The two upper terminals of the jack J_2 are, of course, wired to the two conductors C_1 and C_2 of the telephone or other line to be tested by the apparatus, while the next lower terminal of jack J_2 extends to the sleeve conductor C_3 of the central office equipment which includes a cut-off relay (not shown) of well known type.

Assume that the plug P_1 has engaged jack J_1, and that plug P_2 has engaged the test connector jack J_2 of the central office system, and that a routine test is to be made to determine the insulation conditions of the conductors C_1 and C_2 of one of the telephone lines of the system. If the insulation resistance to ground of the conductor C_1 is less than a predetermined value, current will flow from battery B_1 over conductor C_1 through its "insulation" resistance, the interconnected circuit including ground, resistors R_2, R_3 and R_4, battery B_1, the tip terminals of jack J_1 and plug P_1, the tip terminals of plug P_2 and jack J_2 and the conductor C_1 (including the path through the insulation of the latter conductor having a low resistance to ground). This current will establish a potential across resistors R_2, R_3 and R_4, which is sufficient to ionize the gas between the input electrodes of tube T_1, the voltage being applied to input electrodes of tube T_1 through resistor R_1. As the gas within the tube T_1 becomes ionized, the buzzer Z_1 will be operated to indicate instantly to the operator that the insulation resistance of the conductor C_1 is below the value for satisfactory operation. The voltage to operate the circuit of buzzer Z_1 is obtained from the secondary winding of transformer W.

On the other hand, if the insulation resistance of the conductor C_2 of the telephone line being tested is below the predetermined value previously established, current will then flow from battery B_2 over a circuit which includes ground, resistors R_2, R_7 and R_6, battery B_2, the ring terminals of jack J_1 and plug P_1, the ring terminals of plug P_2 and jack J_2 and conductor C_2 (including the leakage path to ground from conductor C_2). The current flow through resistors R_2, R_7 and R_6 is such as to apply a voltage through resistor R_5 to the input electrodes of tube T_2 to ionize the gas therein. Upon ionization of the gas of tube T_2, the buzzer Z_2 will be operated, the operated circuit including generator G, the winding of buzzer Z_2, the anode and upper cathode of tube T_2 and ground. Thus the operator will be instantly informed that the conductor C_2 of the line being tested has an insulation which does not meet the standard of good service.

Thus it will be observed that one of the two gas tubes will be fired and its connected buzzer will be operated when one of the two conductors of a telephone line has an insulation resistance to ground below a predetermined value. The gas tube ionized and the associated buzzer operated will indicate which of the two conductors is faulty.

Suppose now that the conductors C_1 and C_2 are short-circuited to each other, or that the resistance or impedance therebetween is below some predetermined value. In that event the two batteries B_1 and B_2 will be connected in series with each other to the conductors C_1 and C_2, the interconnected circuit including battery B_1, the tip terminals of jack J_1 and plug P_1, the tip terminals of plug P_2 and jack J_2, conductors C_1 and C_2, the ring terminals of jack J_2 and plug P_2, the ring terminals of plug P_1 and jack J_1, battery B_2, resistors R_6 and R_7 and resistors R_3 and R_4. The flow of current through resistors R_3 and R_4 will be sufficient to apply a voltage through resistors R_1 and R_2 to the input electrodes of tube T_1 to ionize the gas therein and thereby operate the buzzer Z_1. Likewise the flow of current through resistors R_6 and R_7 will be sufficient to apply a voltage through resistors R_2 and R_5 to the input electrodes of tube T_2 to ionize the gas therein and thereby operate the buzzer Z_2. Thus it will be observed that the presence of a short-circuit across the telephone conductors C_1 and C_2 will result in both tubes T_1 and T_2 being fired and both buzzers Z_1 and Z_2 being operated. This condition will, therefore, be readily distinguished from the previous conditions in which but one of the conductors had an insulation resistance to ground below some predetermined value in which case but one gas tube was fired and its corresponding buzzer operated.

It will be observed that the lamp L is in the sleeve circuit of the testing system and that it is connected to the sleeve conductor C_3 at the central office. This lamp will be lighted when the conductors C_1 and C_2 of the telephone line are not busy because in that case the conductor C_3 will have a voltage applied thereto sufficient to operate the busy lamp L. The circuit for lamp L will include the conductor C_3 and the battery (not shown) connected thereto, the sleeve terminals of jack J_2 and plug P_2, the lamp L, the sleeve terminals of plug P_1 and jack J_1 and ground. In the event, however, that the telephone line which includes conductors C_1 and C_2 is busy, the battery voltage just considered will be removed from the conductor C_3 due to the operation of the cut-off relay (not shown) at the central office, and then no current will flow through the lamp L. Thus the lamp L will be lighted only when the telephone line is not busy. The test operator will, therefore, be able to determine instantly whether or not the line being tested is busy. Indications obtained by the test apparatus from a busy line will, of course, be ignored because the impedance properties of the conductors of the line are at that time considerably changed from their normal values.

In one installation in which the circuit of this invention was used the batteries B_1 and B_2 were of the 90-volt type and the tubes T_1 and T_2 were of the 333-A type. Such voltages will not be suitable for use on lines connected to four-party gas tube sets. To satisfactorily test the lines of such sets batteries of lower voltages may be employed. If 45-volt batteries are used, then the tubes T_1 and T_2 may be, for example, of the thyratron type.

In making tests with the apparatus of this invention it may happen that either or both of the gas tubes will be fired and the corresponding buzzers operated only momentarily. This transient condition is usually brought about by the capacity between the conductors of the line, by the capacity of the condensers in the subset, etc. This capacity may be sufficient to allow a transient current to flow over the line conductors and through the testing circuit. Such a transient reaction is not an indication of low insulating resistance in either or both of the line conductors unless the indication fails to stop. The apparatus of this invention is intended to indicate a

faulty condition in the line conductors by operating the indicating devices Z_1 and Z_2 for a sufficient interval of time which lasts longer than the momentary clicks that may be obtained from natural line capacities.

It has been shown hereinabove that the two tubes T_1 and T_2 of the two branches of the testing system control the operation of audible indicating devices such as buzzers Z_1 and Z_2 respectively. It will be understood that the buzzers Z_1 and Z_2 may be omitted if desired and that tubes T_1 and T_2 may be employed to act as visual indicators. In the latter situation one of the tubes may be painted red, for example, and the other green.

It will be understood that the testing circuit of this invention may be used with any form of signaling or other circuit. It will also be understood that any one or all of the plug and jack arrangements shown herein may be omitted if so desired and other means may be provided for establishing connections to the circuit or circuits to be tested.

While this invention has been shown and described in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. Apparatus for determining which of the two conductors of a telephone line has an insulation resistance to ground below a predetermined value, comprising two batteries, two circuits, each of which is conductively connected to one of the conductors of the line and one of the batteries, two gas tubes which are normally inert, each of which is associated with one of the batteries and one of said conductors, means responsive to the grounding of one of said conductors to initiate the flow of current from the corresponding battery to ionize the associated gas tube, and two indicating devices controlled respectively by said gas tubes.

2. Testing apparatus for a two-wire line to determine which of the two conductors of the two-wire line has an insulation resistance to ground below a predetermined value, comprising two equal sources of voltage each of which may be connected conductively to one of the wires of the line, two gas tubes which are normally inert, two networks respectively interconnecting the two gas tubes to the two sources of voltage respectively, means responsive to the grounding of one of said wires to initiate the flow of a substantial current from the corresponding source of voltage to ionize the respective gas tube connected thereto, and means to indicate which of the gas tubes has become ionized.

3. Testing apparatus for a two-wire line to determine which of the two conductors of the two-wire line has an insulation resistance to ground below a predetermined value, comprising two equal sources of voltage each of which may be connected conductively to one of the wires of the line, two gas tubes which are normally inert, two networks respectively interconnecting the two gas tubes to the two sources of voltage respectively, means responsive to the drop in the insulation resistance to ground of one of the wires of said line to initiate flow of a substantial current from the corresponding source of voltage to ionize the respective gas tube connected thereto.

4. Testing apparatus for a two-wire line to determine which of the two conductors of the two-wire line has an insulation resistance to ground below a predetermined value, comprising two gas tubes each of which is normally inert and is conductively connected to one of the wires of said line, means for firing either of said tubes when the wire connected thereto becomes grounded, and means for firing both tubes when the two wires are short-circuited to each other.

5. Testing apparatus for a two-wire line to determine which of the two conductors of the two-wire line has an insulation resistance to ground below a predetermined value, comprising two gas tubes which are normally inert, two networks each including a separate source of potential, said networks respectively conductively interconnecting said two tubes with the two wires of said line, means responsive to a grounded condition on either of said wires to fire the respective gas tube, connected to the grounded wire, and means responsive to a short-circuit between said wires to simultaneously fire both gas tubes.

6. Testing apparatus for a two-wire telephone line comprising two gas tubes which are normally inert, means responsive to a short-circuit between the wires of said line to ionize the gas within both tubes simultaneously, and further means for indicating whether the telephone line is busy during the time when the gas within the two tubes is ionized.

7. Testing apparatus for telephone lines comprising two sources of potential, two resistors connected in series with each other and with said sources, said series circuit including the near-end terminals of a telephone line to be tested, two gas tubes which are normally inert and are connected respectively across said resistors, and means for indicating whether either or both of said gas tubes have been fired.

8. Testing apparatus for a two-wire line to determine which of the two conductors of the two-wire line has an insulation resistance to ground below a predetermined value, comprising two equal sources of potential, two resistors having a common grounded terminal, each resistor being conductively connected to one of the wires of said line through one of said sources of potential, and two gas tubes each of which is normally inert and is bridged across one of said resistors, said gas tubes being fired when the voltage across the respective resistors exceeds a predetermined potential.

9. Testing apparatus for a two-wire line to determine which of the two conductors of the two-wire line has an insulation resistance to ground below a predetermined value, comprising two equal sources of potential, two resistors having a common grounded terminal, each resistor being conductively connected to one of the wires of said line through one of said sources of potential, and two gas tubes each of which is normally inert and is bridged across one of said resistors, said gas tubes being fired when the voltage across the respective resistors exceeds a predetermined value, two indicating devices controlled respectively by said gas tubes, and a source of alternating potential for operating both of said indicating devices.

ROBERT MASON EDMONDS.