

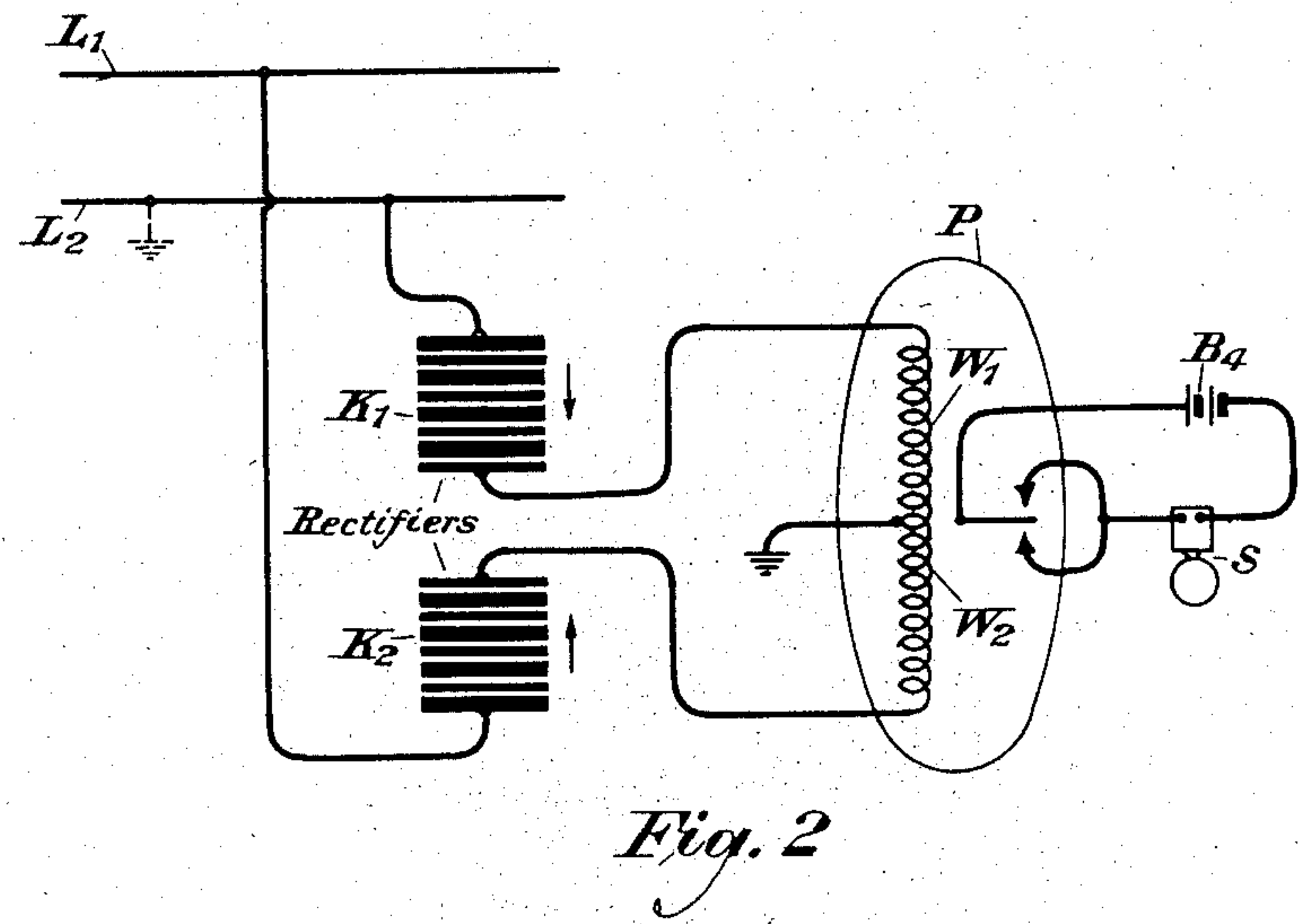
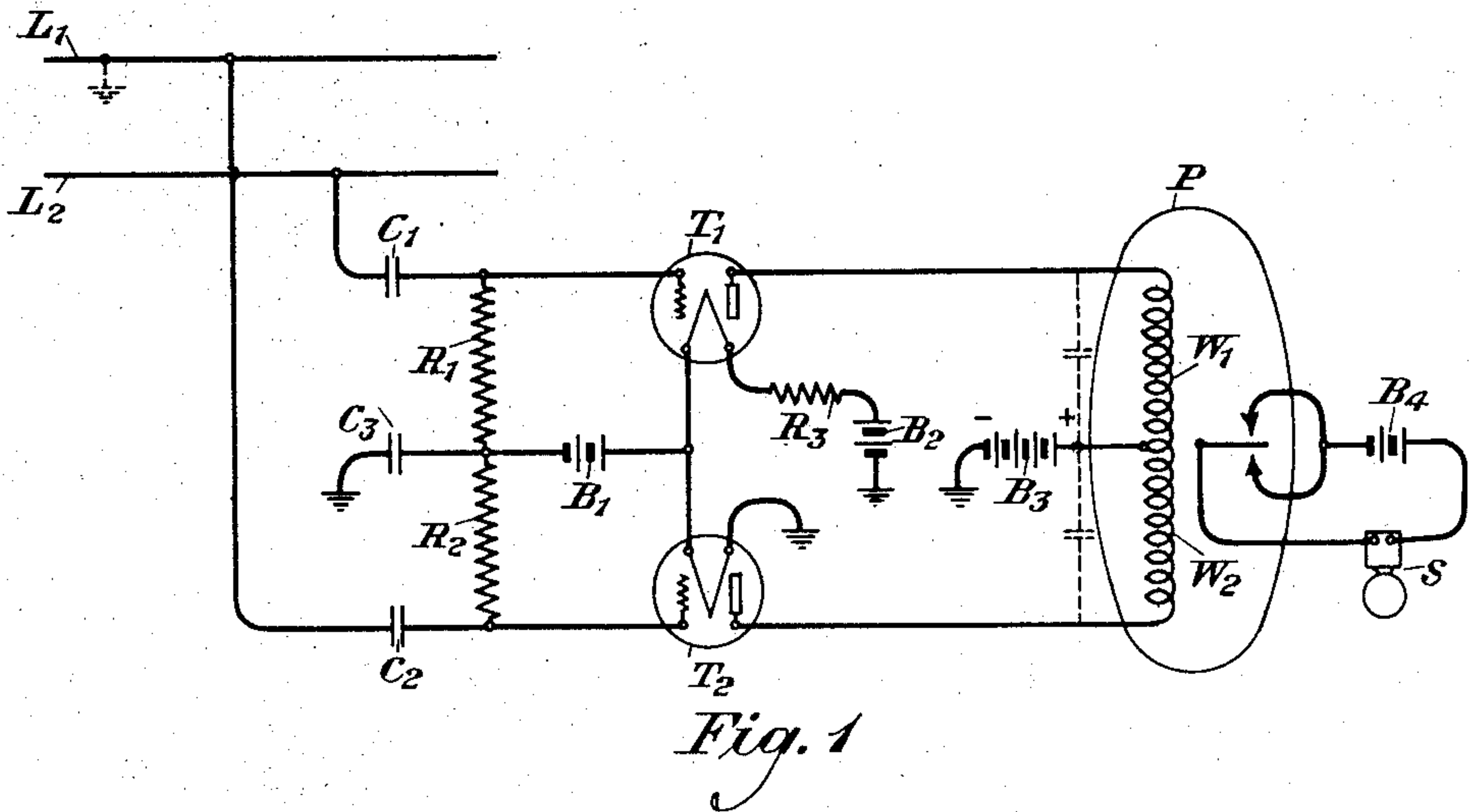
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GROUND DETECTING ARRANGEMENT

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GROUND DETECTING ARRANGEMENT

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This invention relates to rectifying and detecting systems as well as to testing systems. More particularly this invention relates to arrangements for determining and indicating the presence of a grounded condition on one of the conductors of an electric circuit.

One of the difficulties encountered in circuits transmitting alternating or other current is caused by the accidental grounding of one of the circuit conductors. Such a condition frequently reduces the quality of transmission and this is especially true of circuits employed in telephony for the transmission of speech or ringing currents.

One of the objects of this invention is to provide arrangements for quickly determining and indicating whether one of the conductors of a line has become partially or completely grounded or whether the line has become otherwise unbalanced.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing of which Figures 1 and 2 represent two embodiments of the invention.

Referring to Fig. 1 of the drawing, reference characters L_1 and L_2 represent the conductors of a line suitable to transmit alternating current of any frequency as, for example, 135 cycles. The line may be one used in telephony and may also, if desired, transmit speech currents or carrier currents or currents employed for ringing purposes. The line formed by conductors L_1 and L_2 is normally ungrounded and the apparatus connected thereto will be used to determine the presence of a ground on either of its conductors, as will be apparent from the detailed description hereinafter following.

The conductors L_1 and L_2 are bridged by a balanced network which includes two equal condensers C_1 and C_2 and two equal impedances R_1 and R_2 which may preferably be resistances, as shown, all of which are connected in series relationship. The terminal common to resistances R_1 and R_2 is connected to ground through a condenser C_3 .

The reference character T_1 and T_2 represent two three-element vacuum tubes which may be used in this invention as detectors or rectifiers. The resistance R_1 is connected between the grid and filament electrodes of tube T_1 through a battery B_1 and the resistance R_2 is connected between the filament and grid electrodes of the tube T_2 through the same battery B_1 . The battery B_1 is common to the grid electrodes of tubes T_1 and T_2 and its potential and polarity are such as

to insure the proper functioning of these tubes as detectors or rectifiers.

The filaments of the tubes T_1 and T_2 are connected in series with each other as well as in series with the resistance R_3 and a battery B_2 . The battery B_2 supplies the current required to properly heat these filaments to suitable electron emitting temperatures, and the resistance R_3 may be employed as a rheostat to control the flow of current through these filaments.

The plate electrodes of tubes T_1 and T_2 are connected to each other through the windings W_1 and W_2 of the relay P . The device P may be a polar relay or, if desired, any form of neutral relay well known in the art. The positive terminal of a battery B_3 is connected to the junction of windings W_1 and W_2 of relay P and the negative terminal of battery B_3 is grounded. Battery B_3 supplies equal positive potentials to the plate electrodes of tubes T_1 and T_2 and substantially equal currents normally flow through the circuits formed by the plate and filament electrodes of tubes T_1 and T_2 .

Under normal conditions, the armature of relay P is in its mid position and it is free from its associated contacts. Both of these contacts are tied together and they are connected in series with an alarm circuit which may include a battery B_4 and a bell or sounder S . Obviously, any other well known form of alarm circuit may be used in the practice of this invention and it may include other forms of audible devices or visual devices, or both.

The grid electrodes of tubes T_1 and T_2 are equally biased by the battery B_1 to such an extent that no currents, or negligibly small equal currents, flow through the windings W_1 and W_2 of the relay P . When the conductors L_1 and L_2 are ungrounded, a small alternating current flows through the series circuit formed by the condenser C_1 resistances R_1 and R_2 and the condenser C_2 thereby impressing equal alternating voltages on the grids of the vacuum tubes T_1 and T_2 . The average plate currents are thereby increased, but remain equal to each other so that the armature of the relay P will stay in its neutral position and no current will flow through the bell or sounder S . To avoid vibrations due to the pulsations of the plate current, the armature of the relay P may be made relatively heavy or, if desired equal condensers may be bridged across the windings W_1 and W_2 , as shown in dotted lines.

When one of the conductors L_1 or L_2 becomes partially or completely grounded, a very differ-

ent condition will arise. Let it be assumed that the conductor L_1 is so grounded, as shown in dotted lines. Then the condenser C_2 , resistances R_2 and condenser C_3 will form a local circuit which is grounded at both ends and practically no voltage will be impressed across the terminals of the resistance R_1 . At the same time, an increased current will flow over the circuit including the conductor L_2 , the condenser C_1 , resistance R_1 , condenser C_3 and ground. This current will provide an increased potential across the terminals of the resistance R_1 which will substantially increase the current which flows from battery B_3 through the winding W_1 of the relay P . The armature of relay P , being controlled by the greater of the currents flowing through the windings W_1 and W_2 , will close one of its contacts and current will promptly flow from battery B_4 through bell or sounder S .

Any midpoint ground on an element connected to conductors L_1 and L_2 will not unbalance the circuit formed by condenser C_1 , resistances R_1 and R_2 and condenser C_2 which bridges these conductors and will therefore, not operate the alarm circuit.

Fig. 2 shows the circuit formed by conductors L_1 and L_2 bridged by two oppositely poled rectifiers K_1 and K_2 which are connected in series with each other and with the windings W_1 and W_2 of the polar or neutral relay P , the junction common to these windings being grounded. Each of these rectifiers may consist of a plurality of units, each including two electrodes, one formed by a metallic element, such as copper, in physical contact with another element, such as the oxide of copper. Each rectifying unit will present good conductivity when poled in one direction and poor conductivity when poled in the opposite direction. Such a unit is sold commercially under the name of "Rectox". The group of units forming each of the rectifiers K_1 or K_2 will freely transmit current in the direction indicated by the adjacent arrows, the respective currents neutralizing each other when the rectifiers are poled in opposite directions, as is the case in this invention.

Inasmuch as the rectifiers K_1 and K_2 are oppositely poled, practically no current or very small currents will flow through these rectifiers and through the windings W_1 and W_2 of relay P , if neither of the conductors L_1 or L_2 is grounded. The normal current circulating through these rectifiers may be reduced to any desired extent merely by increasing the number of component units. However, upon the grounding of one of the conductors such as L_2 , as shown in dotted lines, practically no current will flow through the rectifier K_1 and through the winding W_1 and, moreover, a large current will flow through the rectifier K_2 and the winding W_2 to ground. Since the armature of the polar or neutral relay P is controlled by the greater of the currents flowing through the winding W_1 and W_2 , it will be moved to close one of its associated contacts and this will cause the battery B_4

to send current through the ringer or sounder S . It will be apparent, of course, that any unbalanced grounded element connected to the line formed by conductors L_1 and L_2 will similarly operate the relay P and render the sounder S audible.

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. The combination of a two-wire telephone circuit, two equal resistances capacitively connected in series relationship with each other across said circuit so that no direct current normally flows therethrough, two rectifiers, each of said rectifiers being connected to one of said resistances, a normally unoperated polar relay having two windings and an armature which is normally unbiased from its contacts, each of the windings of said relay being connected respectively to said rectifiers, and an alarm circuit controlled by the armature of said relay and operated when said armature becomes biased to one of its contacts.

2. Apparatus for determining that one of the wires of a two-wire telephone circuit has become grounded, comprising a normally unoperated polar relay having two windings and an armature which is normally unbiased from its contacts, two rectifiers coupled respectively to said windings, and a pair of impedances capacitively connected in series with each other and across said telephone circuit so that no direct current normally flows therethrough, said impedances being coupled respectively to said rectifiers, the terminal common to said impedances being grounded.

3. The combination of a two-wire telephone line, two equal resistances, two condensers connected in series with said resistances across said line so that no current normally flows through said resistances, a third condenser connected between the terminal common to said resistances and ground, two vacuum tube rectifiers each having grid, filament and plate electrodes, each resistance being connected respectively to the grid and filament electrodes of said vacuum tube rectifiers, a normally unoperated polar relay having two windings and an armature which is unbiased from its contact, a source of direct current potential, each winding of the polar relay being connected respectively to the plate and filament electrodes of said vacuum tube rectifiers through the source of direct current potential, and an alarm circuit controlled by the armature of the polar relay and operated when said armature becomes biased to one of its contacts.

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