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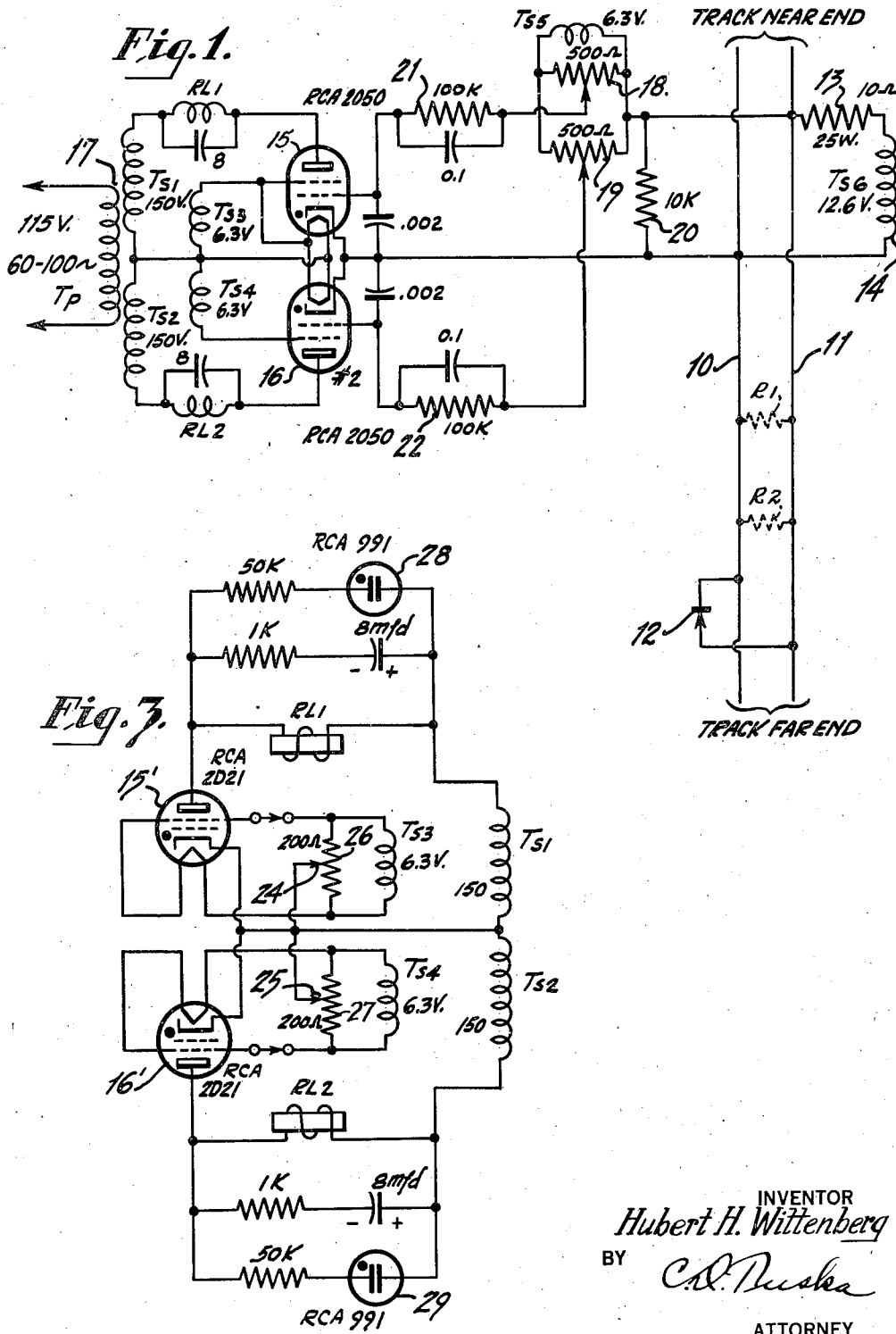
H. H. WITTENBERG

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HIGH-LOW IMPEDANCE ELECTRON TUBE DETECTOR

Filed Nov. 29, 1945

2 Sheets-Sheet 1



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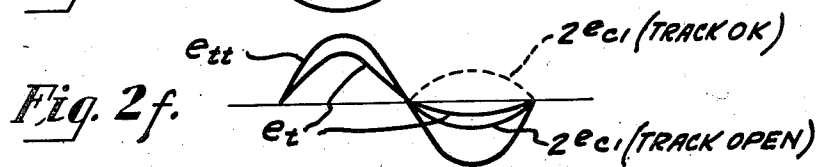
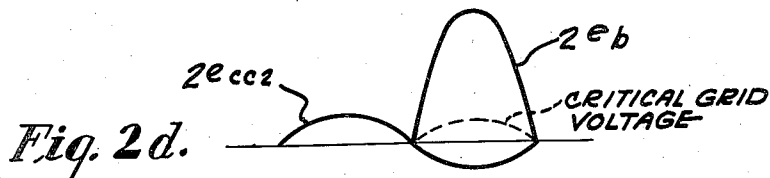
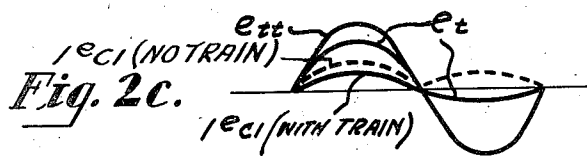
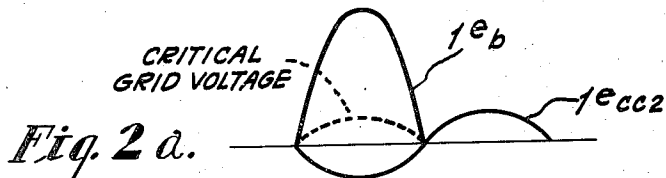
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HIGH-LOW IMPEDANCE ELECTRON TUBE DETECTOR

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2 Sheets-Sheet 2



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HIGH-LOW IMPEDANCE ELECTRON
TUBE DETECTORHubert H. Wittenberg, Lancaster, Pa., assignor to
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6 Claims. (Cl. 250-27)

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This invention relates to protective systems such as are useful in producing an effect in response either to a relatively low impedance or to a relatively high impedance between a pair of conductors which may be, for example, the two rails of a railway crossover or the like.

It is well known that there exists between the rails of any section of a railway an impedance which varies with the weather from a relatively low impedance in wet weather to a relatively high impedance in dry weather. Such variation in impedance is denoted herein as the "normal range of variation" in the impedance between the two rails or conductors. Any protective system associated with such conductors must of course be insensitive to this normal range of values of the impedance between the conductors.

The protective system, however, should be sensitive to impedances outside the normal range. Thus in the case of a short circuit between the two conductors when the impedance is below the normal range, the protective system should produce an effect such as lighting a red signal. Likewise in the case of an open circuit when the impedance is above the normal range, the system should produce the same effect.

In accordance with the present invention, this result is achieved by a protective system wherein (1) a unilateral impedance device such as a rectifier is connected between the conductors at one of their ends, (2) an alternating potential input means and a resistor are connected in series between the conductors at the other of their ends, (3) a pair of electron discharge devices connected in push-pull relationship each having applied to its anode and shield grid alternating potentials which are arranged to be of opposite polarity for ensuring its deenergization when the potential of its control grid decreases to a predetermined positive value, and (4) alternating potential bias means are connected between the conductors and the control grid circuits of the two electron discharge devices so that one of the devices is deenergized during the positive half cycle of its anode potential in response to an impedance lower than the normal range and the other of said devices is deenergized during the negative half cycle of its anode potential in response to an impedance higher than the normal range.

An important feature of one modification of the invention is the interconnection of the cathode heater and the shield grid of each device so that the device is deenergized in response to failure of the shield grid circuit.

Important objects of the invention are the pro-

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vision of an improved protective system which is insensitive to a predetermined or normal range of impedance values but is sensitive to impedance values above or below such range, the provision of a protective system which always "fails safe" so that any defect in the system instantly produces a danger signal, and the provision of an improved protective system and method of operation whereby failure of the system or dangerous conditions of the circuit protected are immediately indicated by a danger signal.

The invention will be better understood from the following description considered in connection with the accompanying drawings and its scope is indicated by the appended claims.

Referring to the drawings:

Figure 1 is a wiring diagram of one modification of the invention.

Figures 2A to 2F are explanatory curves relating to the operation of the system of Figure 1, and

Figure 3 is a wiring diagram of a modified form of the invention.

The system of Figure 1 includes a pair of conductors 10 and 11. Connected between these conductors at one of their ends is a unilateral impedance device 12 illustrated as a copper oxide rectifier. At the other of their ends the two conductors are interconnected through a resistor 13 and alternating potential input means 14 illustrated as the secondary winding of a transformer. Dotted line resistors R_1 and R_2 are intended to denote the normal range of variation in the impedance between the conductors.

A pair of electron discharge devices 15 and 16 connected in push-pull relationship have potential applied to their anodes and shield grids from the secondary windings Ts1 to Ts4 of a transformer 17. It should be observed that (1) current also is supplied from the secondary Ts3 to the cathode heaters of the devices 15 and 16, (2) a relay RL1 shunted by an 8 microfarad capacitor is connected in the anode circuit of the device 15, and (3) a relay RL2 shunted by an 8 microfarad capacitor is connected in the anode circuit of the device 16.

These relays RL1 and RL2 are series-connected in a control circuit in a well known manner so that deenergization of either of them actuates a controlled device such as a danger signal.

Bias potential for the control grids of the devices 15 and 16 is applied through a transformer winding Ts5 and a pair of 500 ohm resistors 18 and 19. Control potential is applied to the control grids from a 10 k. resistor 20 which is connected between the conductors 10 and 11 at the

"near end" of the conductors. The control grid circuit of the device 15 is from the cathode through the resistor 20, the resistor 18 and a 100 k. resistor 21 (shunted by 0.1 microfarad capacitor) to the control grid. The control grid circuit of the device 16 is from the cathode through resistors 20, 19 and 22 to the control grid. Each of these control grid circuits is shunted by a separate 0.002 microfarad capacitor.

Figures 2A to 2F show the relation between the various alternating potentials involved in the operation of the system.

In Figure 2A, the critical voltage below which the device 15 is deenergized is denoted by a dotted line curve and the anode and shield grid voltages of the device 15 are denoted respectively by the curves e_b and e_{c2} .

In Figure 2B, the bias voltage applied through the transformer secondary to the control grid of the device 15 is indicated by the curve e_{cc1} .

In Figure 2C, the curve e_{tt} denotes the potential applied by the secondary winding 14, the curve e_t denotes the potential actually applied between the conductors when current flows through the normal impedance between the conductors, the curve e_{c1} (no train) denotes the resultant potential applied to the control grid of the device 15 when the impedance between the conductors is within its normal range and the curve e_{c1} (with train) denotes the potential applied to the control grid of the device 15 when the impedance between the conductors is below its normal range.

It will be noted that, in passing from the potential e_{c1} (no train) to the potential e_{c1} (with train), the control grid of the device 15 assumes the "critical grid voltage" of this device. This results in deenergization of the device 15 and operation of the relay RL1 as previously explained.

In Figures 2D to 2F, the various potentials involved in the operation of the tube 16 are shown. In these figures, e_b denotes anode voltage, e_{c2} denotes shield grid voltage, e_{cc1} denotes control grid bias voltage, e_{c1} (track ok) denotes the resultant control grid voltage when the impedance between the conductors is within its normal range and e_{c1} (track open) denotes the resultant control grid voltage when the impedance between the conductors is above its normal range.

It will be noted that in passing between the potentials e_{c1} (track ok) and e_{c1} (track open) the control grid of the device 16 assumes the "critical grid voltage" of this device. This results in deenergization of the device 16 and operation of the relay RL2 as previously explained.

The electron discharge devices 15 and 16 of Figure 1 are gaseous electron discharge devices of the "RCA 2050" type. In their stead may be used gaseous electron discharge devices of the "RCA 2D21" type which are provided with external leads to the opposite ends of their shield grids.

Figure 3 shows how the "RCA 2D21" device is connected into the circuit. Thus the cathode heaters of the devices 15' and 16' are connected in series with their shield grids to the transformer secondaries Ts3 and Ts4, and the cathodes of the two devices are connected to the adjustable contacts 24 and 25 of resistors 26 and 27 which are connected respectively across the secondary Ts3 and the secondary Ts4. With these connections, any break of the shield grid circuit deenergizes the device so that the system fails safe (with a red light showing).

Figure 3 also shows a 1 k. resistor in series with

the 8 microfarad condenser shunted across the relay RL1. This relay is also shunted by a glow lamp 28 connected in series with a 50 k. resistor. The connections of the relay RL2 are similar to those of the relay RL1, the glow lamp in this case being denoted by the numeral 29. Otherwise, the connections of the modification of Figure 3 are similar to those of Figure 1. The operation of the modification of Figure 3 is the same as that of Figure 1 with the exception that failure of a shield grid circuit of Figure 3 deenergizes the defective device.

In the modification of Figure 1, a danger signal is produced by interruption of the alternating potential supply, failure of the electron emission of either of the devices 15 or 16, a break in any of the control grid resistors which permits the shield grid to deenergize the device, and failure of the rectifier which deenergizes the device 16. The modification of Fig. 3 affords the added protection that a danger signal is produced by interruption of the shield grid circuit which terminates electron emission and deenergizes the device.

Important advantages of the present invention are that it is insensitive to impedance changes within a normal range but is sensitive to impedance without such range and that it produces a danger signal (1) in response to any inter-conductor impedance without the normal range and (2) in response to failure of the protective system itself.

I claim as my invention:

1. The combination of a pair of electron discharge devices connected in push-pull relation and each having a cathode, an anode and control and shield grids, means for applying alternating potentials of opposite polarities to the anode and shield grid of each of said devices, a pair of conductors, and means interconnecting said conductors with each other and with said control grids for deenergizing one of said devices when the impedance between said conductors assumes a predetermined relatively low value and for deenergizing the other of said devices when said impedance assumes a relatively high value.

2. The combination of a pair of electron discharge devices connected in push-pull relation and each having a cathode, cathode-heater, an anode and control and shield grids, means for applying through the cathode heater to the shield grid of each of said devices an alternating potential of a polarity opposite to that of its anode, a pair of conductors, and means interconnecting said conductors with one another and with said control grids for deenergizing one of said devices when the impedance between said conductors assumes a relatively low value and for deenergizing the other of said devices when said impedance assumes a relatively high value.

3. The combination of a pair of electron discharge devices connected in push-pull relation and each having a cathode, an anode and control and shield grids, means for applying alternating potentials of opposite polarities to the anode and shield grid of each of said devices, a pair of conductors, a rectifier connected between said conductors at one of their ends, a resistor and alternating potential input means connected in series between said conductors at the other of their ends, and means interconnecting said conductors and said control grids for deenergizing one of said devices when the impedance between said conductors assumes a relatively low value and for

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deenergizing the other of said devices when said impedance assumes a relatively high value.

4. The combination of a pair of electron discharge devices connected in push-pull relation and each having a cathode, an anode and control and shield grids, means for applying alternating potentials of opposite polarities to the anode and shield grid of each of said devices, and means interconnecting said conductors with one another and with said control grids for deenergizing one of said devices during a positive half cycle of its anode potential in response to a relatively low impedance between said conductors and for deenergizing the other of said devices during a negative half cycle of its anode potential in response to a relatively high impedance between said conductors.

5. The combination of a pair of electron discharge devices connected in push-pull relation and each having a cathode, an anode and control and shield grids, means for applying alternating potentials of opposite polarities to the anode and shield grid of each of said devices, and means interconnecting said conductors with one another and with said control grids for deenergizing one of said devices during a positive half cycle of its anode potential in response to a relatively low impedance between said conductors and for deenergizing the other of said devices during a negative half cycle of its anode potential in response to a relatively high impedance between said conductors, and relay means for producing an effect in

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response to deenergization of either of said devices.

6. The combination of a pair of electron discharge devices connected in push-pull relation and each having a cathode, an anode and control and shield grids, means for applying alternating potentials of opposite polarities to the anode and shield grid of each of said devices, a pair of conductors, a rectifier connected between said conductors at one of their ends, a resistor and alternating potential input means connected in series between said conductor at the other of their ends, means connecting one of said conductors to the cathodes of said devices, and alternating potential bias means connected between the other of said conductors and said control grids.

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