United States Patent [19]

Ive

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[54] **PROTECTIVE SYSTEMS AND APPARATUS THEREFOR**

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Related U.S. Application Data

[63] Continuation of Ser. No. 883,375, Dec. 9, 1969, abandoned.

[52] **U.S. Cl.** **340/276,** 340/409

[51] **Int. Cl.** **G08b 13/08**

[58] **Field of Search** ..... 340/274, 276, 409; 317/148.5, DIG. 1, DIG. 5

[56] **References Cited**

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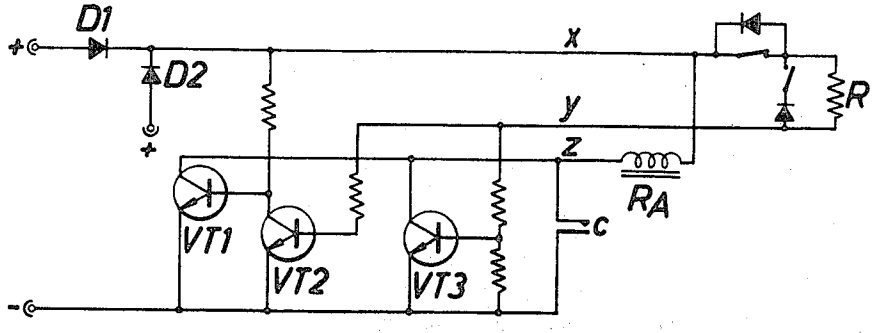
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Primary Examiner—John W. Caldwell
Assistant Examiner—Scott F. Partridge
Attorney, Agent, or Firm—Davidson C. Miller

[57] **ABSTRACT**

The invention relates to a protective loop system having a two-wire loop terminated by an impedance. The invention is a modification of that forming the subject of copending Patent Application No.818,860, now U.S. Patent 3,626,403. In this prior invention, a bistate control device was included in a protective loop; the device comprising a relay having associated contacts in an alarm circuit which are arranged to be actuated whenever the relay is energised. In the past, in order to nullify or render inoperative a two-wire loop system having an end-of-line impedance and an alarm relay circuit, it has been known to connect a second impedance across the line or in series with the end-of-line impedance in order to maintain an alarm relay connected to the other end of the loop in the non-alarm condition despite the actuation of intruder detection contacts associated with the alarm relay. In the present invention, the bistate control device, i.e. the relay is arranged to have a quiescent range determined by selected values of the relay and the loop impedance, and the impedance means connected across the termination of the loop has a value within the quiescent range such that the relay is energised whenever a whole or partial short circuit or open circuit condition occurs in the loop.

6 Claims, 4 Drawing Figures



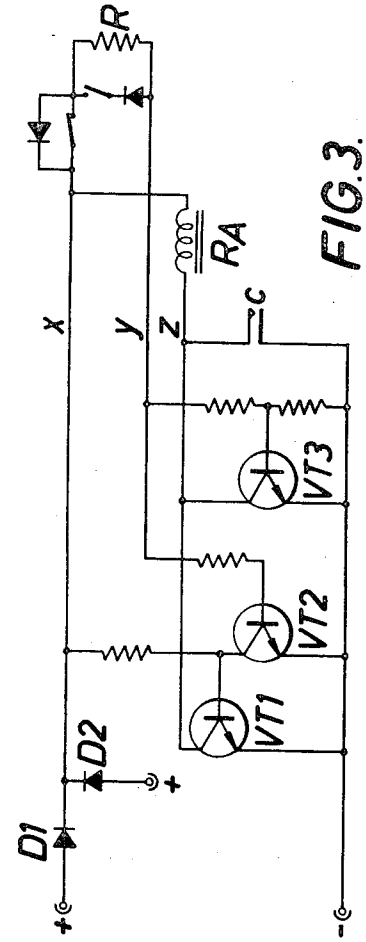


FIG.3.

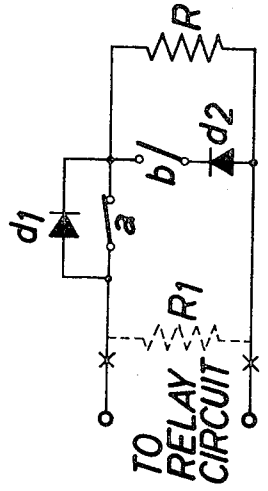


FIG.1.

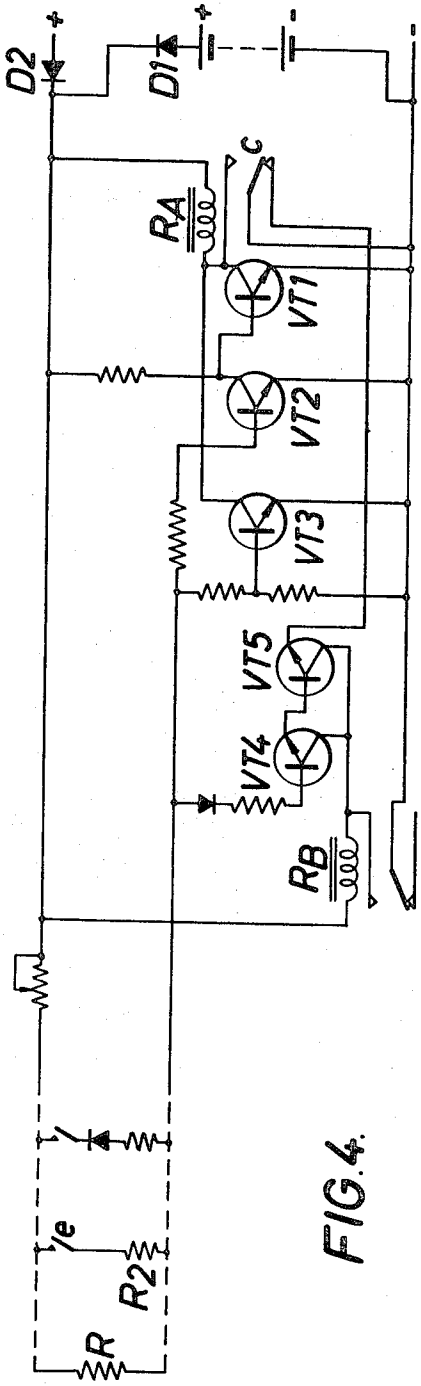


FIG.4.

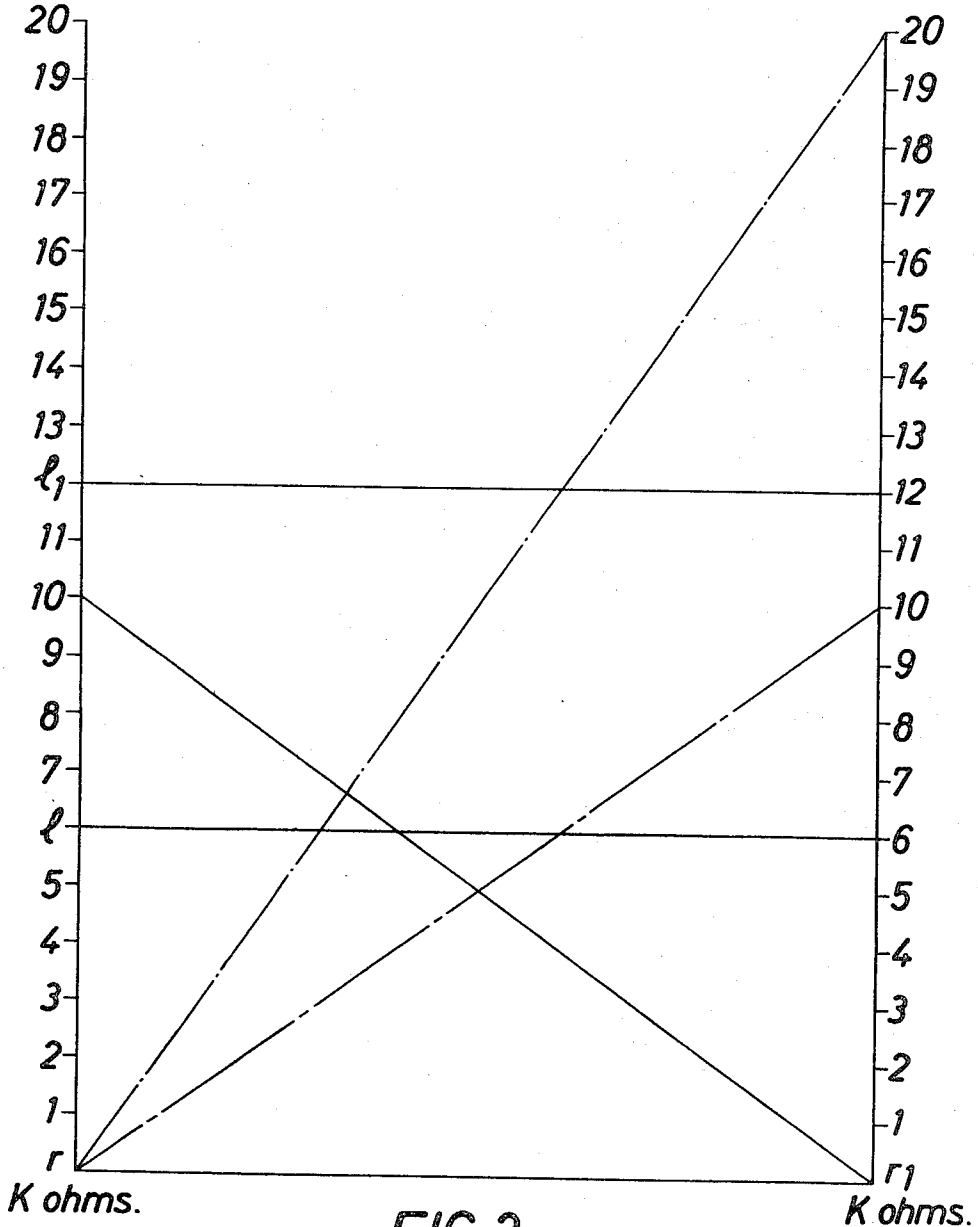

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FIG. 2.

PROTECTIVE SYSTEMS AND APPARATUS THEREFOR

This invention is a continuation of application Ser. No. 883,375, filed Dec. 9, 1969, now abandoned.

This invention relates to protective systems and apparatus therefor and is a modification of the invention forming the subject of copending Patent Application No. 818,860 now U.S. Pat. No. 3,626,403.

In said co-pending Patent Application, there is described a protective system comprising a single electrical loop including a bistate control device having means associated with an alarm circuit and arranged to be actuated in response to a change in the operative state of said bistate control device, the loop being connected to a voltage source and also including a plurality of contacts arranged to be actuated whenever an abnormal situation against which protection is required, occurs, and the loop being arranged to operate in accordance with two alternative operating modes during one of which the current flowing through the loop is sufficient to allow said bistate control device to operate in accordance with a first operative state despite actuation of any of said contacts, and during the second mode, the current through the loop being such as to cause the bistate control device to change to the other of said operative states whenever a contact is actuated.

As indicated in said co-pending Patent Application the protective system provides complete 24 hour monitoring and operates in accordance with two distinctive modes. In a preferred embodiment, unidirectional current conducting devices such as diodes are connected in series with or across selected contacts to allow any entry means protected by said contacts to be used during the day time or when a building is normally occupied. Thus, during the day or during working hours when a building is occupied, it is possible to open and close selected doors or windows without setting off the alarm mechanism, whilst for night operation, the alternative mode of operation takes effect to provide protection at all entry points of the building.

The protective system of the present invention is a modification of that described in said copending Patent Application and the loop comprises only two wires terminated by an impedance. In order to nullify or render inoperative two-wire loop systems having an end-of-line impedance and an alarm relay circuit, it has been known to connect a second impedance across the line or in series with the end-of-line impedance in order to maintain an alarm relay connected to the other end of the loop, in the non-alarm condition despite the actuation of intruder detection contacts associated with the alarm relay.

An object of the present invention is to provide a two wire loop system wherein it is virtually impossible to nullify or render inoperative the alarm system by connecting a second impedance in the line circuit.

A further object of the present invention is to provide a two-wire protective loop capable of providing an alarm indication whenever the two wires are wholly or partially short circuited or one or other or both 'open circuited.'

Thus, according to one aspect of the present invention there is provided a protective loop system as described in the aforementioned U.S. Pat. No. 3,626,403 having a two wire loop terminated by impedance means and connected to a bistate control device having means

associated with an alarm circuit and arranged to be actuated in response to a change in the operative state of said bistate control device, the loop being connected to a voltage source and also including a plurality of contacts having associated unidirectional current conducting devices, the contacts being arranged to be actuated whenever an abnormal situation against which protection is required occurs, and the loop being arranged to operate in accordance with two alternative operating modes, during one of which the direction of current flow through the loop is such as to allow said bistate control device to operate in accordance with a first operative state despite actuation of any of said contacts, and during the second mode the direction of current flow through the loop being such as to cause the bistate control device to change to the other of said operative states whenever a contact is actuated, the bistate control device having a quiescent range determined by selected values of the control device and the loop impedance, and the impedance means having a value within the quiescent range such that the bistate control means is actuated whenever a whole or partial short circuit or open circuit condition occurs in the loop.

According to a further aspect of the invention there is provided a protective loop system as described above wherein second bistate control means available to provide second channel operation, is included in circuit with the loop.

The invention will now be described by way of example only with particular reference to the accompanying drawings wherein:

FIG. 1 is a diagram of a two-wire loop illustrating the principles of the present invention;

FIG. 2 is a diagram for the determination of the sum of two resistors connected in parallel in the loop of FIG. 1;

FIG. 3 is a circuit diagram of a two-wire loop system of the present invention controlling a single relay and

FIG. 4 is a circuit diagram utilising two relays for intruder and fire detection purposes.

Referring to FIG. 1, the protective loop system of the present invention comprises two conductors only connected at one end to a suitable relay circuit (not shown in FIG. 1) and terminated at the opposite end by a resistor R of selected value, chosen by a method hereinafter described. Between the two ends of the loop, series-connected contacts such as *a* are located with diodes d_1 connected across the contacts *a* and/or parallel connected contacts such as *b* may be connected across the terminating resistor R in series with diodes d_2. Such an arrangement of series and/or parallel connected contacts and associated diodes is described fully in U.S. Pat. No. 3,626,403 together with the switching means necessary to reverse the direction of current flow through the loop to effect the two alternative operative modes of the system.

In FIG. 1, resistor R_1 represents a resistance connected across the loop by an intruder in an attempt to nullify or render inoperative the alarm system. In the present invention, the value of resistance of resistor R in relation to the constant of the control relay is chosen such that it is virtually impossible to select a resistance value for such a 'cheat' resistor R_1 which, when connected across the loop, will not set off the alarm by so doing or when a contact is actuated. The value of the relay and/or components in the relay circuit is chosen

such that when the loop resistance is above or below upper and lower limits respectively, the relay is actuated to provide an indication of the presence of an intruder. The state of the relay when the loop resistance lies between the two limits is hereinafter referred to as the quiescent state of the relay.

The upper and lower limits are derived from the graph of FIG. 2. Ordinates r and r_1 represent the resistance of end of line resistor R and the resistor R_1 respectively; the latter being connected across the line as shown by the dotted lines in FIG. 1 in an attempt to nullify the alarm circuit. If diagonals are drawn for given values of the resistors R, R_1, i.e., from the respective ordinates to the origin of the other ordinate, the point of intersection read off on either ordinate indicates the total resistance R_T for individual values of resistors R, R_1. Thus, for the values shown, the sum of resistors R, R_1, for values of 10 Kilohms and 20 Kilohms respectively is 6.6 Kilohms approximately and for values of 10 Kilohms each is 5 Kilohms.

If two values of resistance are chosen, as depicted by the horizontal lines l, l_1, and a relay is designed to remain stable or quiescent, e.g. in the 'OFF' or deenergized state, between these lower and upper limits of resistance, then the following conditions prevail:

The relay switches to the alarm 'ON' state whenever the total resistance of the loop falls below value l i.e., 6 Kilohms in FIG. 2, or above value l_1 i.e., 12 Kilohms. Thus, if any one of the series contacts a opens or a parallel contact b closes, the relay will be energised to an alarm condition.

Now if it is assumed that a resistor R_1 is connected across the loop at positions X—X (FIG. 1) and it is also assumed that the value of this resistor R_1 is 10 Kilohms, then if a line is drawn from the 10 Kilohm point on the r_1 ordinate, to the origin of the r ordinate, and if it is assumed that the resistor R is of 10 Kilohms also, then it will be seen that the sum of the resistances R, R_1, will be 5 Kilohms, which is outside the quiescent range of the relay. Accordingly the relay will be energized to the alarm 'ON' state.

If, however, a higher value of 'cheat' resistor R_1 is connected across the line, e.g., 20 Kilohms, the cumulative resistance of R and R_1 will be approximately 6.6 Kilohms which is within the quiescent range of the relay. The relay will thus remain in the 'OFF' state but any actuation of the contacts a or b in response to a break-in by the intruder will bring the resistance of the loop outside the quiescent range of the relay and cause the latter to be energised to the alarm 'ON' state.

Similarly, if the loop is cut such that the end-of-line resistor R is effectively removed from the circuit, the resistor R will in effect have been replaced by the 20 Kilohm resistor R_1 giving a value of resistance outside the quiescent range of the relay causing the relay to be energized to the alarm 'ON' state.

It will thus be seen that by suitable selection of the quiescent range values l and l_1 of the relay and by suitable selection of the value of resistor R, it is possible to provide a two-wire loop protective system which in addition to the 24 hour monitoring facility, is virtually impossible to nullify or render inoperative by connecting a second resistor in the loop circuit. By suitable choice of the values l, l_1 and R, the connection of a second resistor R_1 in the loop circuit will either (a) cause the total resistance value to fall outside the quiescent range of the relay, in which case an immediate alarm will be given or (b) cause the total resistance value to remain within the quiescent range in which case the alarm will be given whenever an intruder detection contact is actuated or (c) by effectively removing from circuit the end-of-line resistor R, cause the total resistance value to fall within either of categories (a) or (b) above.

The values indicated above for l, l_1, R and R_1, are exemplary only. The essential feature of the invention is to select values for l, l_1 and R to provide an arrangement which is virtually impossible to nullify or render inoperative by connecting a second impedance in the loop circuit.

Many relay circuits and combinations may be designed to meet the essential requirements of the system described above. An example of a single relay circuit is illustrated in FIG. 3. The protective two-wire loop with contacts a and b and end of line resistor R is shown connected to a D.C. source via a relay control circuit including three transistors VT1, VT2, VT3. The relay coil R_A is connected between the positive and negative terminals of the D.C. source via terminal z and associated normally-open contacts c and to the collector of transistor VT1. The three transistors are connected as shown such that the transistors VT2, VT3 feed into common transistor VT1 which controls the energization of relay coil R_A. Transistor VT3 causes transistor VT1 to conduct to effect energisation of relay R_A to the alarm 'ON' condition, if the resistance of the loop across terminals x and y falls below the lower limit l (FIG. 2) of the relay quiescent range. Transistor VT2 causes transistor VT1 to conduct if the resistance of the loop exceeds the upper limit l_1. Under normal protective conditions transistor VT3 causes conduction of transistor VT1 and energisation of relay R_A if the loop is short circuited and transistor VT2 causes conduction of transistor VT1 and energisation of relay R_A if the loop is open circuited. The D.C. voltage source is preferably a 12 volt D.C. battery and diodes D1, D2, are connected as shown for the protection of the power supply.

The circuit of FIG. 4 is an example of a combined intruder and fire detection circuit for two channel operation. As previously described normally closed contacts are associated with doors, windows and like points of entry and the contacts are arranged to be held open when the door or window is closed. When a door is opened, the contact is closed to effectively short circuit the protective loop. Where diodes are connected in series with the contacts, if a resistor is connected in series with the diode, the short circuit current will be limited in value. The value of the resistance is chosen such as to prevent a first relay from operating but a second relay is arranged to operate to give second channel operation. By interlocking the two relays, the second one is prevented from operating under short circuit conditions.

Referring to FIG. 4 there is shown a two channel circuit for intruder and fire detection. The protective loop, relay R_A and transistors VT1, VT2, VT3 are virtually identical with those shown in FIG. 3 and perform the same functions as previously described. Transistors VT4 and VT5 are for the second channel operation. These transistors are rendered operative when the input resistance is approximately 3 Kilohms. This value is reached by the second channel contacts e closing to place a 4.7 Kilohm resistor R_2 in parallel with a 10 Kilohm end-of-line resistor R. Relay R_B connected to the

collectors of transistors VT4, VT5, will then be energised to actuate contacts *f* which are separate from the intruder alarm contacts *c* associated with relay R_A.

If the line resistance falls to 3 Kilohms (as required for second channel operation) relay R_A would also energise since 3 Kilohms is outside the quiescent range of relay R_A. This is prevented by a relay contact circuit such that if relay R_B is energised, operation of relay R_A is inhibited.

It will be appreciated that the invention is susceptible of considerable modification and is not to be deemed limited to the particular constructional or circuit details described by way of example only. For instance the contacts may be series-connected or parallel-connected as described in said co-pending Patent Application but parallel-connected contacts are preferable in view of the absence of any appreciable voltage drop across the diodes during daytime operation if doors or windows are left open.

What is claimed:

1. A protective loop system having a two wire loop terminated by impedance means and connected to a bistate control device having means associated with an alarm circuit and arranged to be actuated in response to a change in the operative state of said bistate control device, the loop being connected to a voltage source and also including a plurality of contacts having associated unidirectional current conducting devices, the contacts being arranged to be actuated whenever an abnormal situation against which protection is required, occurs, and the loop being arranged to operate in accordance with two alternative operating modes, during one of which the current flowing through the loop is sufficient to allow said bistate control device to operate in accordance with a first operative state despite actuation of any of said contacts, and during the second mode the current through the loop being such as to cause the bistate control device to change to the other of said operative states whenever a contact is actuated, the bistate control device having a quiescent range determined by selected values of the loop impedance, and the impedance means having a value within the quiescent range such that the bistate control device is actuated whenever a whole or partial short circuit or open circuit condition occurs in the loop.

2. A protective loop system as claimed in claim 1 wherein the quiescent range of the bistate control device and the value of the end-of-loop impedance means are chosen such that a given change in the loop impedance will cause the bistate control device to change from the quiescent state to an operative state either immediately as a consequence of the impedance change or whenever a contact is actuated.

3. A protective loop system having a two wire loop terminated by impedance means and connected to a first bistate control device having means associated with an alarm circuit and arranged to be actuated in response to a change in the operative state of said first bistate control device, the loop being connected to a voltage source and also including a plurality of contacts having associated unidirectional current conducting device the contacts being arranged to be actuated whenever an abnormal situation against which protection is required occurs, and the loop being arranged to operate in accordance with two alternative operating modes, during one of which the current flowing through the loop is sufficient to allow said first bistate control device to operate in accordance with a first operative state despite actuation of any of said contacts, and during the second mode the current through the loop being such as to cause the first bistate control device to change to the other of said operative states whenever a contact is actuated, the first bistate control device having a quiescent range determined by selected values of the loop impedance, and the impedance means having a value within the quiescent range such that the first bistate control device is actuated whenever a whole or partial short circuit or open circuit condition occurs in the loop, a second bistate control device connected in circuit with said two wire loop to provide second channel operation, said second bistate control device being rendered operative in response to a predetermined change in the loop impedance, and means associated with said second bistate control device and arranged to be actuated whenever said second bistate device is rendered operative.

4. A protective loop system as claimed in claim 3 wherein interlocking means associated with the two bistate control devices are included in the loop circuit to prevent operation of the first bistate control device when the predetermined change in the loop impedance brings the loop impedance outside the quiescent range of said first bistate control device.

5. A protective loop system having a two wire loop terminated by impedance means and connected to a first bistate control device having means associated with an alarm circuit and arranged to be actuated in response to a change in the operative state of said first bistate control device, the loop being connected to a voltage source and also including a plurality of contacts having associated unidirectional current conducting devices, the contacts being arranged to be actuated whenever an abnormal situation against which protection is required occurs, and the loop being arranged to operate in accordance with two alternative operating modes, during one of which the current flowing through the loop is sufficient to allow said first bistate control device to operate in accordance with a first operative state despite actuation of any of said contacts, and during the second mode the current through the loop being such as to cause the first bistate control device to change to the other of said operative states whenever a contact is actuated, the first bistate control device having a quiescent range determined by selected values of the loop impedance, said quiescent range and the value of the end-of-loop impedance means being chosen such that a given change in the loop impedance will cause the bistate control device to change from the quiescent state to an operative state either immediately as a consequence of the impedance change or whenever a contact is actuated, and the impedance means having a value within the quiescent range such that the first bistate control device is actuated whenever a whole or partial short circuit or open circuit condition occurs in the loop, a second bistate control device connected in circuit with said two wire loop to provide second channel operation, said second bistate control device being rendered operative in response to a predetermined change in the loop impedance, and means associated with said second bistate control device and arranged to be actuated whenever said second bistate device is rendered operative.

6. A protective loop system as claimed in claim 5 wherein interlocking means associated with the two bistate control devices are included in the loop circuit to prevent operation of the first bistate control device when the predetermined change in the loop impedance brings the loop impedance outside the quiescent range of said first bistate control device.

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