April 17, 1956 I. GROSS 2,742,595

CONTROL CIRCUITS

Filed Dec. 8, 1952

FIG. 1

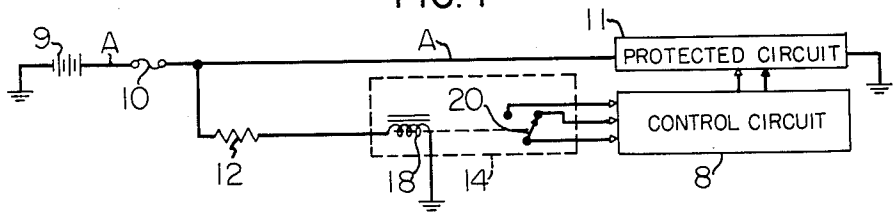


FIG. 2

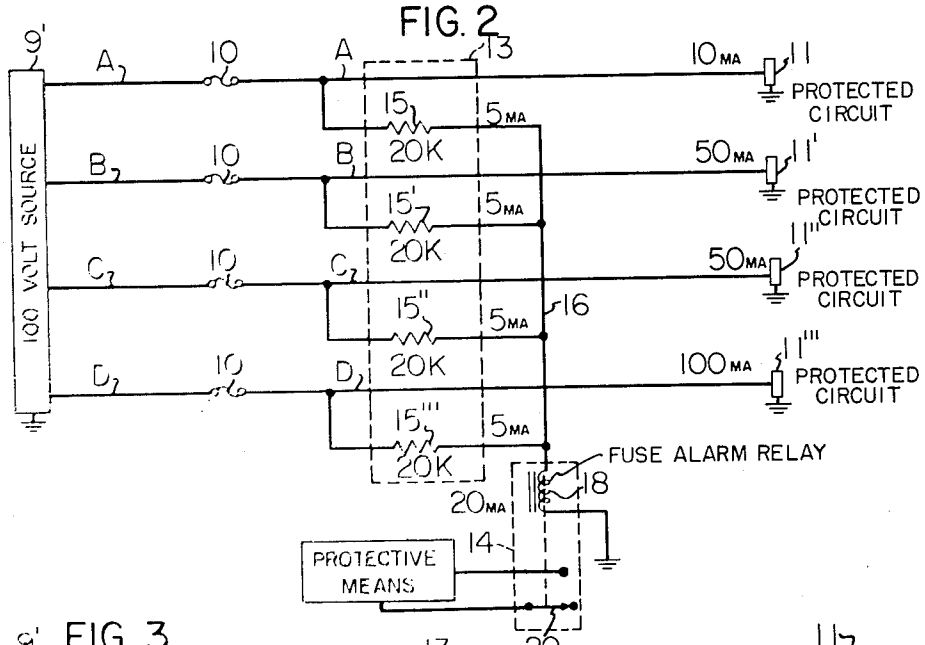
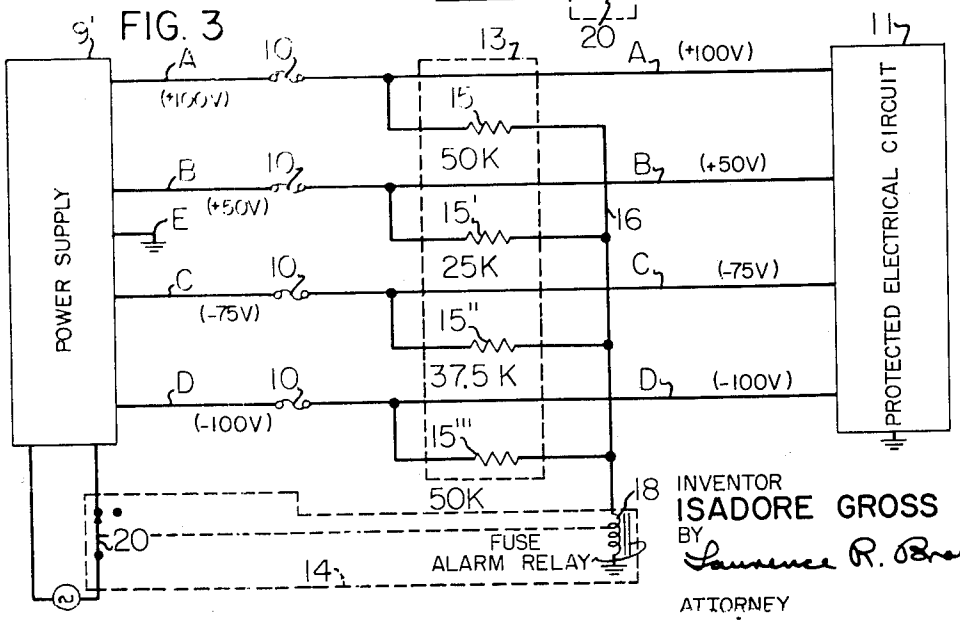


FIG. 3



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CONTROL CIRCUITS

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4 Claims. (Cl. 317—46)

This invention relates to electrical control systems and particularly to systems in which individual fuses are employed for different circuits of a system and wherein control relay means is provided to protect delicate instruments or tubes in event of fuse failure in any one of the fused circuits.

Because the load conditions of several electrical circuits connected to a single power supply and the time delay requirements for protective devices connected in the several circuits may be different, it is desirable to separately fuse different circuits in accordance with the most desirable protection parameters. When the circuits are separately fused, however, the failure of one fuse may remove bias potentials from tubes or otherwise cause too much current to flow in other types of delicate instruments. Accordingly, an associated relay or similar circuit opening means is desired to afford proper protection where needed by removing the potential from those circuits requiring protection or otherwise actuating protective circuits.

Three-terminal safety type fuses are available in the art which may be adapted to connect one fuse terminal to an alarm bus when the fuse fails to actuate a relay operated alarm system as described in the copending application of Isadore Gross entitled "Control Systems," Serial No. 317,938 filed October 31, 1952 and assigned to the same assignee as this application, now Patent No. 2,707,779. It has, in the past, been difficult to actuate a relay in response to failure of one of a group of standard two-terminal fuses and the three-terminal safety type fuses are generally not suitable for use with standard two-terminal insulated fuse posts and may subject an operator to shock hazard upon replacement.

To obtain the maximum protection in the minimum time, a relay is selected that will respond quickly. It is generally desirable to provide a corresponding relay actuation network circuit for obtaining fast response of the relay upon fuse failure in any one circuit by the selection of proper circuit parameters to maintain at a minimum any time lag between the fuse failure and the relay operation. Also in the interest of circuit economy, it is desirable to provide a single control relay operable by fuse failure in any one of several fused circuits.

It is, therefore, a general object of the invention to provide improved electrical control systems.

It is another object of the invention to provide an improved control system operable upon failure of a standard two terminal fuse.

It is still another object of the invention to provide improved control systems with a single relay protective device.

It is a further object of the invention to provide an improved control circuit for separately protected circuits, actuated by fuse failure in any one of a plurality of power supply leads, to disconnect other power supply leads from the protected circuits.

In accordance with the teachings of the present invention, there is, therefore, provided a fused alarm system

utilizing a control relay circuit causing the control relay to be actuated by a current change through the relay winding due to fuse failure in any one of several fused circuits.

Other objects and features of advantage of the present invention will be found throughout the following more detailed description of the invention particularly when considered in connection with the accompanying drawings; in which:

Fig. 1 is a schematic circuit diagram showing the operation of a simplified embodiment of the invention;

Fig. 2 is a schematic circuit diagram of a control circuit showing a further embodiment of the invention; and

Fig. 3 is a schematic circuit diagram of another control circuit.

Throughout the drawings like reference characters will be used to designate like circuit elements to facilitate comparison.

Referring now in particularity to Fig. 1, a circuit interrupting device such as a fuse **10** is shown in a direct current line A, with an impedance network made up of current determining resistor **12**, and relay means **14**. The voltage source in this case comprises the battery **9** which also supplies energy to the protected circuit **11**. The relay means has its relay coil **18** de-energized by a current change caused by failure of fuse **10**, whereby the relay contact **20** is operated to actuate the control circuit **8**.

The circuit of Fig. 2 shows an embodiment whereby each protected circuit of the group **11**—**11'''**, inclusive, is supplied 100 volts from the power supply source **9'**. Each of the power supply leads A, B, C and D to the protected circuits includes a separate fuse **10**. An impedance network **13**, comprises a branched circuit having each branch thereof connected to a supply lead between the protected circuit and the fuse. The network **13**, includes a plurality of current proportioning resistors **15**, **15'**, etc. respectively connected in the several branches thereof, said branches having a common junction at the distribution bus **16**. The relay coil **18** is connected in a common portion of the branched network circuit between the distribution bus and ground, which represents a common reference potential for similar poles of the protected circuits and the 100 volt source and the protective means is actuated by changes of current through the coil.

The relay comprising coil **18**, operates on a marginal basis. In this case it has been selected to attain one operating state with 20 milliamperes and the other when the current falls to 15 milliamperes. The network has been proportioned to maintain 20 milliamperes through the relay coil under normal operating conditions when all fuses are intact. Neglecting the impedance of the relay coil **18**, each resistive branch of the network has a resistance of 20,000 ohms and therefore passes 5 milliamperes of current from the 100 volt source as long as the fuse is intact. Therefore, it is readily seen that upon fuse failure in any one supply line the current through the relay coil will drop to 15 milliamperes and the relay contact **20**, will then actuate the protective means.

The load required by each protected circuit has been selected to illustrate the adaptability of the present invention to systems requiring long and short time delays in fuse failure for various circuits. The circuit connected to the lead A, has been selected to require 10 milliamperes, the one connected to lead B, 50 milliamperes, the one connected to lead C, 50 milliamperes and to lead D, 100 milliamperes. It is readily seen that fuses selected for protection of supply leads A and D would differ due to the load requirements. Taking, for example, supply leads B and C, where the load current requirements are identical, it is foreseeable that the type of equipment to be protected in each circuit would be radically different so

as to require a fast operating fuse in one and a slow operating one in the other. Therefore, the disadvantage of having a simple protective fuse for several circuits requiring the same potential or current is readily apparent. However, the protective relay is actuated by failure of any one fuse to afford greater overall protection in accordance with the present invention.

A circuit as shown in Fig. 3, which likewise has a plurality of differently fused circuits, is an embodiment wherein the power supply **9'**, is disconnected from the protected electrical circuit **11**, upon a change of current through the relay coil, **18**, which results in opening contact **20**. The power supply leads A, B, C and D have potentials both positive and negative with respect to the ground potential lead E, and each supply lead is connected to the protected circuit **11**, through a separate fuse **10**. A branched resistive network **13**, made up of a plurality of current proportioning resistors **15**, **15'**, etc. is connected to each lead between the protected circuit and the fuse, each resistor being individual to one of the branches respectively connected to the supply leads. A distribution bus **16**, which provides a common junction for the several resistive branches of the network, electrically connects the fuse alarm relay coil with each of the resistors. The relay coil is therefore arranged in a common portion of the circuit between the junction of the several branches and ground. The resistive network is designed to maintain the voltage across the relay coil at zero potential by establishing a current balance in the network during normal operation to keep lead **16**, at zero potential.

To illustrate the operation of the relay, the following circuit parameters have been selected in the typical circuit shown:

A	volts	+100
B	do	+50
C	do	−75
D	do	−100
E	do	0
R15	ohms	50,000
R15'	do	25,000
R15''	do	37,500
R15'''	do	50,000

The relay is energized by 1 milliampere of current and 2 milliamperes of bleeder current pass through each resistor during normal conditions. The 1 milliampere of current was selected for the relay so that it will be as sensitive as possible and thereby actuate its contact **20**, in a minimum of time. Therefore, it is readily seen that due to the fuse failure in any one supply line, the current to one of the branches of the network will be cut off resulting in an unbalance of current in the relay coil of about 2 milliamperes. The current unbalance, being greater than 1 milliampere, will actuate the relay contact and in this case remove the power from each lead of the protected circuit. This is done by connecting relay contact **20**, in the supply lead to the power supply **9'**.

It is, therefore, clear from the foregoing description that the present invention by providing an electrical control system, wherein a single relay is operable by current change effected by the failure of one of a plurality of two terminal fuses, has improved the state of the art so that circuit economy and fast protective action may be realized along with the many other features of advantage.

Having therefore described detailed embodiments of the invention, setting forth its organization and its mode of operation, those features believed descriptive of the nature of the invention are defined with particularity in the appended claims.

What is claimed is:

1. In means for protecting the remainder of the circuits of a group commonly connected to voltage means as to one pole thereof in the event of the interruption of the supply of voltage to one or more circuits of the group

the combination of voltage means having a terminal thereof maintained at a reference potential, a group of protected circuits each having one terminal thereof at said reference potential, individual circuit means supplying voltage to said protected circuits from said voltage means, each comprising a lead connecting a terminal of a protected circuit other than said one terminal with a terminal of the supply maintained at other than reference potential and including circuit interrupting means serially connected therein, a branched network having the branches thereof respectively connected to said several leads intermediate an interrupting means and a protected circuit and having a common portion connecting the junction of said branches with a terminal at reference potential, resistors individual to said branches, and a relay having the operating winding thereof serially connected in said common portion of the network for marginal operation of the relay responsive, respectively, to a normal value of the current in said winding determined by an uninterrupted condition of all said leads and a current value selectively departing therefrom, said relay controlling protective means for the protected circuits.

2. In means for protecting the remainder of the circuits of a group commonly connected to a source of voltage as to one pole thereof in the event of the interruption of the supply of voltage to one or more circuits of the group due to overload the combination of a source of voltage, a group of protected circuits, common conducting means directly connecting each protected circuit with the source as to one pole thereof and individual circuit means connecting each protected circuit with the source as to the other pole there, said individual means each comprising a lead having circuit interrupting means connected therein adapted to disconnect the protected circuit from the source of voltage responsive to overload, a branched network having the branches thereof respectively connected to said several leads intermediate an interrupting means and a protected circuit and having a common portion connecting the junction of said branches with a terminal at the potential of said one pole of the protected circuits, resistors individual to said branches, and a relay having the operating winding thereof connected in the common portion of said network for marginal operation of the relay responsive, respectively, to a normal value of the current in said winding determined by an uninterrupted condition of all said leads and a current value selectively departing therefrom, said relay controlling protective means for the protected circuits.

3. In means for protecting the remainder of the circuits of a group commonly connected to a common terminal of plural sources of voltage as to one pole thereof in the event of the interruption of the supply of voltage to one or more circuits of the group the combination of a plurality of voltage sources having a common terminal maintained at a reference potential, a group of protected circuits having a common terminal conductively maintained at said reference potential, individual circuit means connecting said protected circuits with said sources each comprising a lead connecting a non-common terminal of a protected circuit with a terminal of a source maintained at other than reference potential and including circuit interrupting means therein, a branched network having the branches thereof respectively terminally connected to said leads intermediate an interrupting means and a protected circuit and having a common portion connecting the junction of the branches with a terminal at reference potential, resistors individual to said branches, and a relay having the operating winding thereof connected in said common portion of the control circuit for marginal operation of the relay responsive, respectively, to a normal value of the current in said winding determined by an uninterrupted condition of all said leads and a current value selectively departing therefrom, said relay controlling protective means for the protected circuits.

4. The combination defined in claim 3 wherein said

protective means for the protected circuits includes means simultaneously deactivating said plural sources of voltage upon operation of said relay under the second of said defined conditions.

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