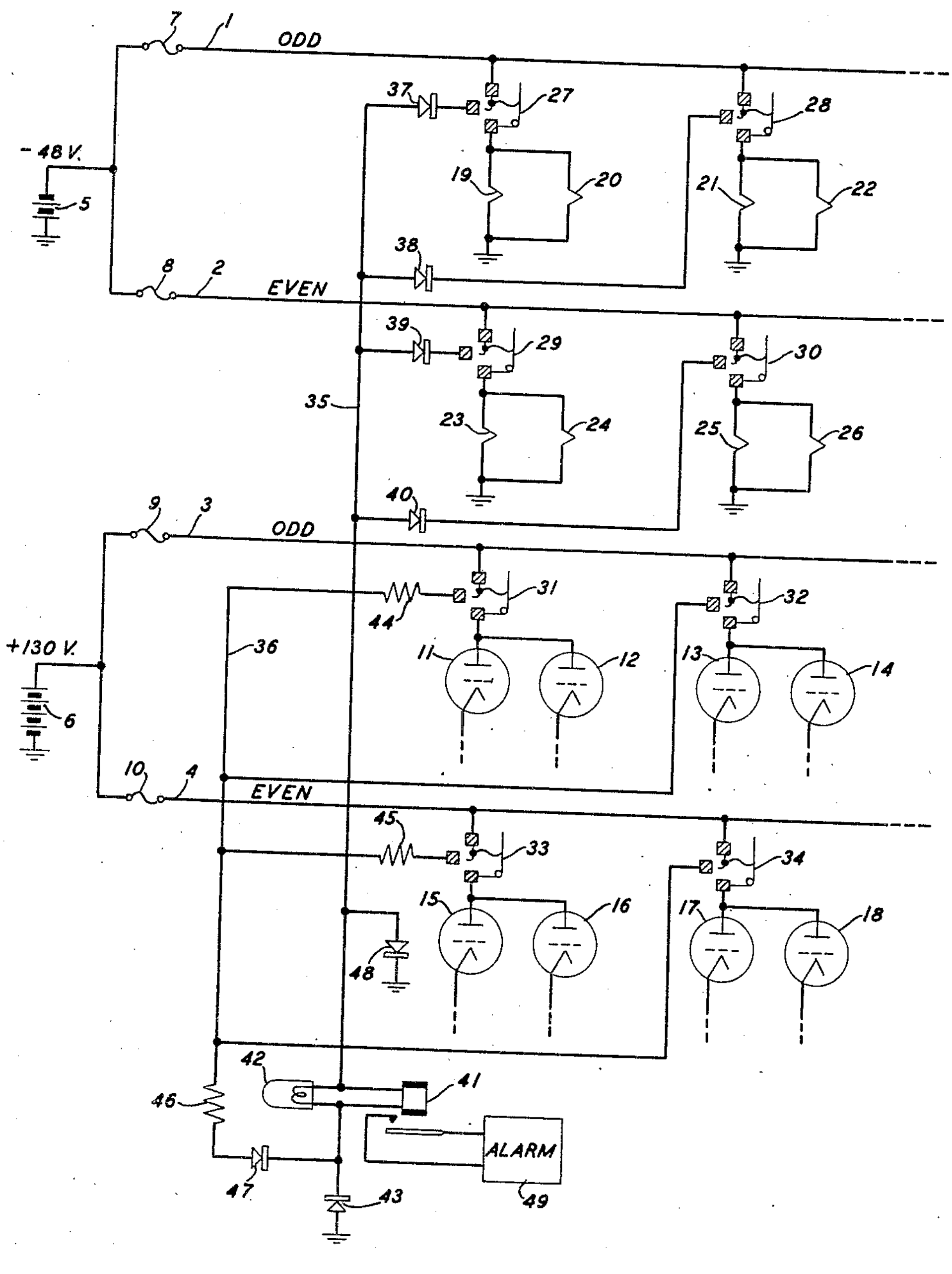
Jan. 28, 1958

F. A. MINKS

FUSE ALARM SYSTEMS

Filed May 29, 1956

2,821,697



INVENTOR
F. A. MINKS
BY R. B. Ardis
ATTORNEY

United States Patent Office 2,821,697
Patented Jan. 28, 1958

2,821,697

FUSE ALARM SYSTEMS

Floyd A. Minks, Chester, N. H., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 29, 1956, Serial No. 588,106

6 Claims. (Cl. 340—250)

This invention relates generally to fuse alarm systems and more particularly, although in its broader aspects not exclusively, to fuse alarm systems for use in connection with supplying direct operating potentials to the electron tube heater and anode circuits of voice and carrier frequency telephone repeaters and terminal equipment.

In installations of telephone repeater and terminal equipment, it is common practice to use common direct voltage sources along with feeder conductors or busses to energize electron tube heater circuits with either −24 or −48 volts and electron tube anode circuits with +130 volts. In large installations, separate busses (termed "odd" and "even") are often used to supply each potential to alternate bays or banks of equipment and, in order to prevent the failure of one from removing from service all of the trunks between any two offices, a separate main feeder fuse is used for each bus. These main feeder fuses may, if desired, be of the so-called alarm type in order to provide an indication whenever one or more of them has blown. In order to provide more localized protection, however, both heater and anode circuits or small groups of each are connected to the respective feeder busses through individual fuses. These latter fuses are of the alarm type and, in the usual installation, a common alarm circuit is arranged to energize either a visible or an audible signaling device or a combination of both in response to the failure of any one or more of the individual alarm fuses.

Fuses of the so-called alarm type have been used in telephone equipment installations for a good many years, a typical example of such a fuse being disclosed in U. S. Patent 817,959, issued April 17, 1906, to E. B. Craft. When its fusible element fails, such a fuse operates not only to disconnect its load from the energized feeder bus but also to connect the feeder bus to a separate alarm bus. In the usual installation, a suitable signaling device is connected between the alarm bus and ground and is operated whenever one or more of the individual alarm fuses fails.

While telephone repeater and terminal equipment fuse alarm systems of the type described have been found to work satisfactorily under most conditions, it has been found that in some installations certain combinations of individual alarm fuse and main feeder fuse failures tend to create fire hazards and marginal or unreliable operation of the signaling device in the common fuse alarm circuit. In some installations, for example, small resistors are used between each individual circuit alarm fuse and the alarm bus to prevent high circulating currents in the event that alarm fuses are blown on two feeder busses having slightly different voltage drops. It has been discovered, however, that if a main feeder fuse is removed and a heater circuit alarm fuse is blown on each heater circuit feeder bus, the relatively low impedances of the electron tube heater circuits permit large currents to flow through the resistors to ground, destroying the resistors and creating a possible fire hazard. In the same installations, moreover, the individual circuit alarm fuses on both the heater and the anode circuit feeder busses are connected to the same alarm bus, and the common alarm circuit signaling device is connected between that alarm bus and ground. It has been found in these installations that, in the event of simultaneous failure of both a heater and an anode circuit alarm fuse, the alarm currents through the common alarm circuit signaling device tend to cancel one another and make uncertain the prompt operation of the signaling device.

One important object of the present invention is, therefore, to prevent fire hazards and avoid circulating currents for all foreseeable combinations of individual circuit alarm fuse and main feeder fuse failure in a fuse alarm system of the type described.

Another equally important object of the invention is to avoid the possibility of marginal operation of the common alarm circuit signaling device in a fuse alarm system of the type described for all foreseeable combinations of individual circuit alarm fuse failure.

In accordance with a first feature of the invention, the fire hazards found in some prior art fuse alarm systems for certain combinations of individual circuit alarm fuse and main feeder fuse failure are eliminated by the connections of asymmetrically conducting devices such as diodes between each heater circuit alarm fuse and the alarm bus leading from the heater circuit alarm fuses to the alarm circuit signaling device. Each diode is poled to pass current from the heater circuit feeder bus to the signaling device in the direction of normal flow when only the associated alarm fuse is operated. As a result, the alarm circuit path to the other heater circuit feeder bus and from there through other low impedance heater circuits to ground which would exist upon simultaneous failure of a main feeder fuse and individual heater circuit alarm fuses on both heater circuit feeder busses is blocked. The entire alarm current is directed through the alarm circuit signaling device and possible fire hazards are avoided.

In accordance with a second important feature of the invention, the marginal alarm circuit operation occurring in some previous fuse alarm systems for certain combinations of individual circuit alarm fuse failure is avoided with the aid of two instead of one alarm busses and at least two asymmetrically conducting devices such as diodes. In accordance with this feature of the invention, the individual heater circuit alarm fuses and the individual anode circuit alarm fuses are connected to separate alarm busses. The separate alarm busses are connected to opposite sides of the common alarm circuit signaling device, and oppositely poled diodes are connected between the respective sides of the signaling device and ground in order to ensure that alarm currents from all main feeder busses not only pass through the signaling device but also pass through in the same direction. As a result, reliable operation of the common alarm circuit signaling device is provided whether a heater circuit alarm fuse, an anode circuit alarm fuse, or a combination of both, is blown.

Additional objects and features of the invention will become apparent upon study of the following detailed description of the specific embodiment of the invention illustrated in the single figure of the drawing.

The embodiment of the invention illustrated in the drawing is specifically adapted to supply direct operating potentials to the electron tube heater and anode circuits of negative impedance voice frequency telephone repeaters of the types shown in U. S. Patent 2,742,616, issued April 17, 1956, to J. L. Merrill, Jr., and in application Serial No. 417,650, filed March 22, 1954, by S. T. Meyers. In the specific embodiment shown, the electron tube heater circuits are supplied with a potential of −48 volts, while the electron tube anode circuits are supplied with a potential of +130 volts.

The illustrated embodiment of the invention includes a pair of heater circuit feeder busses 1 and 2 and a pair of anode circuit feeder busses 3 and 4. Feeder busses 1 and 3 are labeled "odd" to indicate that they supply the direct operating potentials to the repeaters in odd numbered groups, while feeder busses 2 and 4 are labeled "even" to indicate that they perform the same function for even numbered groups. Feeder busses 1 and 2 are joined at one end and energized with a −48 volt potential, as illustrated diagrammatically in the drawing by a battery 5 connected between the feeder busses and ground. Feeder busses 3 and 4 are similarly joined and energized with a +130 volt potential, as shown diagrammatically by a battery 6 connected between the busses and ground. Each feeder bus is separately fused in order, as explained above, to prevent the failure of one from removing from service all of the trunks between any two central offices. As illustrated, a first pair of main feeder fuses 7 and 8 are connected in series with feeder busses 1 and 2, respectively, and a second pair of main feeder fuses 9 and 10 are connected in series with feeder busses 3 and 4, respectively. Main feeder fuses 7 through 10 may themselves be of the alarm type, although this has no immediate bearing on the operation of the remainder of the illustrated fuse alarm system.

By way of example, the drawing shows electron tube heater and anode circuits for two repeaters in an "odd" group and for two repeaters in an "even" group. The "odd" group repeaters include a pair of electron tubes 11 and 12 and a pair of electron tubes 13 and 14, respectively, while the "even" group repeaters include a pair of electron tubes 15 and 16 and a pair of electron tubes 17 and 18, respectively. Tubes 11 and 12 contain a pair of respective heaters 19 and 20, tubes 13 and 14 contain a pair of respective heaters 21 and 22, tubes 15 and 16 contain a pair of respective heaters 23 and 24, and tubes 17 and 18 contain a pair of respective heaters 25 and 26.

In the illustrated embodiment of the invention, heaters 19 and 20 are connected to ground from "odd" heater circuit feeder bus 1 through an individual alarm fuse 27. Heaters 21 and 22 are similarly connected through an alarm fuse 28. Heaters 23 and 24 and heaters 25 and 26 are returned to ground from "even" heater circuit feeder bus 2 through respective alarm fuses 29 and 30. Each heater combination has a resistance of the order of 100 ohms or less. The impedances presented by the various vacuum tube anode circuits are much greater, however, and therefore do not provide extraneous paths to ground for alarm currents under any possible fuse conditions. For this reason, the anode circuits are shown only in sketchy fashion, with no complete showing of impedance elements other than the tubes themselves in the paths from the individual anode circuit alarm fuses to ground. Tubes 11 and 12 and tubes 13 and 14 are, however, supplied from "odd" anode circuit feeder bus 3 through alarm fuses 31 and 32, respectively, and tubes 15 and 16 and tubes 17 and 18 are supplied from "even" anode circuit feeder bus 4 through alarm fuses 33 and 34, respectively.

As has already been briefly explained, each of the individual circuit alarm fuses 27 through 34 operates, when the fusible element fails, to disconnect its load from the feeder bus and to connect the feeder bus to a separate alarm circuit bus. The illustrated embodiment of the invention includes two separate alarm busses 35 and 36. In accordance with an important feature of the invention, the alarm electrodes of fuses 27 through 30 are connected directly to alarm bus 35 through respective diodes 37 through 40, all of which are poled for easy current flow from alarm bus 35 toward their respective alarm fuses. Alarm bus 35 is, in turn, connected to one side of the operating coil of an alarm circuit relay 41. The relay operating coil is shunted by an alarm circuit lamp 42 and its other side is connected to the reference potential, ground, through a diode 43. Diode 43 is poled for easy current flow in the direction from ground toward the operating coil of relay 41.

In accordance with another important feature of the invention, the alarm electrodes of alarm fuses 31 through 34 are all connected to the other alarm bus 36. A pair of small resistors 44 and 45 are connected between alarm bus 36 and alarm fuses 31 and 33, respectively, in order to minimize the circulating currents which tend to occur if the voltage drops on the anode circuit feeder busses 3 and 4 should be unequal. Alarm bus 36 is connected through a larger resistor 46 and a diode 47 to the side of the operating coil of relay 41 opposite from alarm bus 35, and a diode 48 is connected between the alarm bus 35 side of the operating coil and ground. Diode 47 is poled for easy current flow from resistor 46 toward the operating coil of relay 41 and diode 48 is poled for easy current flow from the operating coil toward ground. The armature of relay 41 is connected to open and close an alarm circuit 49 which may, if desired, contain audible signaling devices, more visible signaling devices, or a combination of both.

The operating advantages made possible by the various features of the invention may be understood most clearly if the illustrated embodiment is contrasted from the prior art. Consider, for example, the situation existing if diodes 37 through 40 were not connected between alarm bus 35 and alarm fuses 27 through 30 and simple resistors were so connected instead. If main feeder fuse 7 should be blown or removed and if heater circuit alarm fuses 27 and 29 were to blow simultaneously, a relatively low impedance path to ground would exist from battery 5 through main feeder fuse 8, feeder bus 2, alarm fuse 29, the resistor taking the place of diode 39, the resistor taking the place of diode 37, alarm fuse 27, feeder bus 1, alarm fuse 28, and the low impedance represented by vacuum tube heaters 21 and 22 to ground. Since the impedance of the operating coil of relay 41 is of the order of 2000 ohms and that of lamp 42 is even higher, most of the alarm current would flow through the resistors and heaters 21 and 22 to ground. As a result of these excessive currents, the resistors would most likely be destroyed and a possible fire hazard would be created.

The present invention eliminates such fire hazards in a comparatively simple and inexpensive manner. Consider the situation existing in the illustrated embodiment of the invention if the same fuses were blown. Electrons (electron flow is less awkward to trace than current flow because of the polarity of battery 5) would flow from battery 5 through main feeder fuse 8, feeder bus 2, alarm fuse 29, diode 39, lamp 42 and the operating coil of relay 41, and diode 43 to ground. Diode 37 prevents electrons from getting through to alarm fuse 21 and feeder bus 1 for return to ground through alarm fuse 28 and the low impedance path provided by heaters 21 and 22. In this manner, alarm currents are confined to their intended paths and possible fire hazards are avoided, regardless of the combination of main feeder fuses and heater circuit alarm fuses blown.

The other principal advantage over the prior art afforded by the invention may also be best appreciated if the illustrated embodiment is contrasted from the prior art. Consider, for example, the situation obtaining if, as is usual, anode circuit alarm fuses 31 through 34 were connected to alarm bus 35 instead of to alarm bus 36 and diode 43 were shorted out. Alarm bus 35 could then be energized by either the heater circuit feeder busses 1 and 2 or the anode circuit feeder busses 3 and 4. As long as a heater circuit alarm fuse did not blow simultaneously with an anode circuit alarm fuse, operation would be normal, with current from the feeder bus associated with the blown alarm fuse energizing alarm bus 35, lamp 42, and alarm relay 41. If, however, a heater circuit alarm fuse and an anode circuit alarm fuse (such as alarm fuses 27 and 31, respectively) should blow simultaneously, the operation of alarm relay 41 would be only marginal. The alarm currents from oppositely poled batteries 5 and 6 would oppose each other in the operating coil of relay 41 and, if relay 41 would operate at all, it would operate with a considerably weaker action. If the voltage drop in the feeder bus associated with the blown anode circuit alarm fuse should be sufficiently great, the two alarm currents could even cancel each other to an extent sufficient to keep relay 41 from operating at all and to keep lamp 42 from burning with anything but a very dim light.

The present invention not only prevents such marginal or unreliable alarm circuit operation when individual circuit alarm fuses fail on both heater circuit and alarm circuit feeder busses, but also makes operation stronger and more affirmative. In accordance with a principal feature of the invention, the two alarm busses 35 and 36 are connected to opposite sides of the operating coil of relay 41 and diodes 43 and 48 are connected to insure that alarm currents from both sets of feeder busses not only pass through the coil but also pass through it in the same direction. If, for example, alarm fuses 27 and 31 were blown in the illustrated embodiment of the invention, electrons from battery 5 would pass through main feeder fuse 7, heater circuit feeder bus 1, alarm fuse 27, diode 37, lamp 42 and the operating coil of relay 41, and diode 43 to ground. The current flow through lamp 42 and the operating coil of relay 41 would be from bottom to top in the drawing. The polarity of diode 48 prevents any electrons from battery 5 from leaking off to ground before reaching lamp 42 and relay 41. Current from battery 6, on the other hand, would flow through main feeder fuse 9, anode circuit feeder bus 3, alarm fuse 31, resistor 44, resistor 46, diode 47, lamp 42 and the operating coil of relay 41, and diode 48 to ground. As before, the current flow through lamp 42 and the operating coil of relay 41 would be from bottom to top in the drawing. The polarity of diode 43 prevents current from battery 6 from reaching ground before coming to lamp 42 and relay 41.

The embodiment of the invention shown in the drawing is thus substantially foolproof. Undesirable and possibly dangerous currents are blocked by the configuration of diodes 37 through 40 and the arrangement of alarm busses 35 and 36 and diodes 43, 47, and 48 forces alarm currents always to traverse lamp 42 and the operating coil of relay 41 in the same direction, regardless of the number and combination of blown fuses.

What is claimed is:

1. In combination, a pair of feeder busses each supplying a direct potential of one polarity to a plurality of low impedance loads, a pair of main feeder fuses connected in series with respective ones of said pair of feeder busses and carrying the combined currents of the loads associated therewith, a third feeder bus supplying a direct potential of the opposite polarity to a plurality of other loads, a separate alarm fuse connected between each of said loads and the associated one of said feeder busses, each of said alarm fuses being adapted when blown to disconnect its load from the feeder bus and connect the feeder bus to an alarm bus, a common alarm circuit for all of said alarm fuses including at least one signaling device and a pair of alarm busses, a first of said alarm busses being connected between the alarm fuses associated with said pair of feeder busses and one side of said signaling device and the second of said alarm busses being connected between the alarm fuses associated with said third feeder bus and the other side of said signaling device, oppositely poled asymmetrically conducting devices connected between respective sides of said signaling device and a point of predetermined reference potential to ensure that alarm currents from all of said feeder busses not only pass through said signaling device but also pass through in the same direction, and a separate asymmetrically conducting device connected between each alarm fuse associated with said pair of feeder busses and said first alarm bus to prevent alarm currents from flowing through some of said low impedance loads when one of said pair of main feeder fuses is open and an alarm fuse is blown on each of said pair of feeder busses.

2. In combination, a pair of feeder busses, a first source of direct potential connected between each of said pair of feeder busses and a point of predetermined reference potential, a plurality of low impedance loads connected between each of said pair of feeder busses and said point of reference potential, a pair of main feeder fuses connected in series with respective ones of said pair of feeder busses between said first source of direct potential and the respective low impedance loads, a third feeder bus, a second source of direct potential opposite in polarity to said first source connected between said third feeder bus and said point of reference potential, a plurality of other loads connected between said third feeder bus and said point of reference potential, a separate alarm fuse connected between each of said loads and the associated one of said feeder busses, each of said alarm fuses being adapted when blown to disconnect its load from the feeder bus and connect the feeder bus to an alarm bus, a common alarm circuit for all of said alarm fuses including at least one signaling device and a pair of alarm busses, a first of said alarm busses being connected between the alarm fuses associated with said pair of feeder busses and one side of said signaling device and the second of said alarm busses being connected between the alarm fuses associated with said third feeder bus and the other side of said signaling device, oppositely poled asymmetrically conducting devices connected between respective sides of said signaling device and said point of reference potential to ensure that alarm currents from both of said sources not only pass through said signaling device but also pass through in the same direction, and a separate asymmetrically conducting device connected between each alarm fuse associated with said pair of feeder busses and said first alarm bus to prevent alarm currents from flowing through some of said low impedance loads when one of said pair of main feeder fuses is open and an alarm fuse is blown on each of said pair of feeder busses.

3. In combination, a first feeder bus supplying a direct potential of one polarity to a plurality of loads, a second feeder bus supplying a direct potential of the opposite polarity to a plurality of other loads, a separate alarm fuse connected between each of said loads and the associated one of said feeder busses, each of said alarm fuses being adapted when blown to disconnect its load from the feeder bus and to connect the feeder bus to an alarm bus, a common alarm circuit for all of said alarm fuses including at least one signaling device and a pair of alarm busses, one of said alarm busses being connected between the alarm fuses associated with said first feeder bus and one side of said signaling device and the other of said alarm busses being connected between the alarm fuses associated with said second feeder bus and the other side of said signaling device, and oppositely poled asymmetrically conducting devices connected between respective sides of said signaling device and a point of predetermined reference potential to ensure that alarm currents from both of said feeder busses not only pass through said signaling device but also pass through it in the same direction.

4. In combination, a first feeder bus, a first source of direct potential connected between said first feeder bus and a point of predetermined reference potential, a plurality of loads connected between said first feeder bus and said point of reference potential, a second feeder bus, a second source of direct potential opposite in polarity to said first source connected between said second feeder bus and said point of reference potential, a plurality of other loads connected between said second feeder bus and

said point of reference potential, a separate alarm fuse connected between each of said loads and the associated one of said feeder busses, each of said alarm fuses being adapted when blown to disconnect its load from the feeder bus and to connect the feeder bus to an alarm bus, a common alarm circuit for all of said alarm fuses including at least one signaling device and a pair of alarm busses, one of said alarm busses being connected between the alarm fuses associated with said first feeder bus and one side of said signaling device and the other of said alarm busses being connected between the alarm fuses associated with said second feeder bus and the other side of said signaling device, and oppositely poled asymmetrically conducting devices connected between respective sides of said signaling device and said point of reference potential to ensure that alarm currents from both of said sources not only pass through said signaling device but also pass through in the same direction.

5. In combination, a pair of feeder busses supplying substantially the same direct potential to respective low impedance loads, a pair of main feeder fuses connected in series with respective ones of said feeder busses and carrying the combined currents for the loads associated therewith, a separate alarm fuse connected between each of said loads and the associated one of said feeder busses, each of said alarm fuses being adapted when blown to disconnect its load from the feeder bus and to connect the feeder bus to an alarm bus, a common alarm circuit for all of said alarm fuses including at least one signaling device and an alarm bus, said alarm bus being connected between said alarm fuses and one side of said signaling device and the other side of said signaling device being connected to a point of predetermined reference potential, and a separate asymmetrically conducting device connected between each alarm fuse and said alarm bus to prevent alarm currents from flowing through some of said low impedance loads when one of said pair of feeder fuses is open and an alarm fuse is blown on each of said feeder busses.

6. In combination, a pair of feeder busses, a source of direct potential connected between each of said feeder busses and a point of predetermined reference potential, a plurality of low impedance loads connected between each of said feeder busses and said point of reference potential, a pair of main feeder fuses connected in series with respective ones of said feeder busses between said source of direct potential and the respective said low impedance loads, a separate alarm fuse connected between each of said loads and the associated one of said feeder busses, each of said alarm fuses being adapted when blown to disconnect its load from the feeder bus and to connect the feeder bus to an alarm bus, a common alarm circuit for all of said alarm fuses including at least one signaling device and an alarm bus, said alarm bus being connected between said alarm fuses and one side of said signaling device and the other side of said signaling device being connected to said point of reference potential, and a separate asymmetrically conducting device connected between each alarm fuse and said alarm bus to prevent alarm currents from flowing through some of said low impedance loads when one of said pair of main feeder fuses is open and an alarm fuse is blown on each of said feeder busses.

References Cited in the file of this patent

UNITED STATES PATENTS

2,329,518	Dimond	Sept. 14, 1943
2,464,848	Collins	Mar. 22, 1949
2,769,970	Kratville	Nov. 6, 1956