

March 22, 1949.

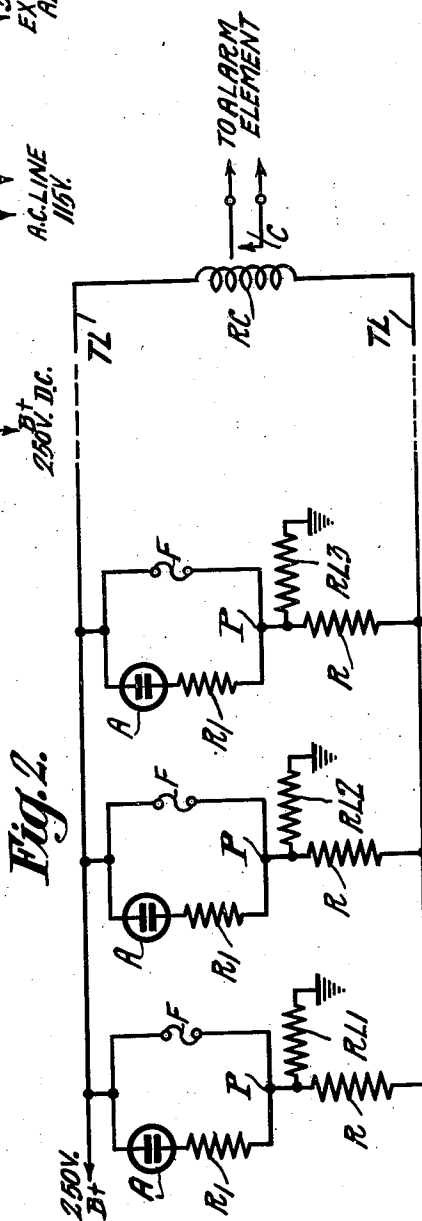
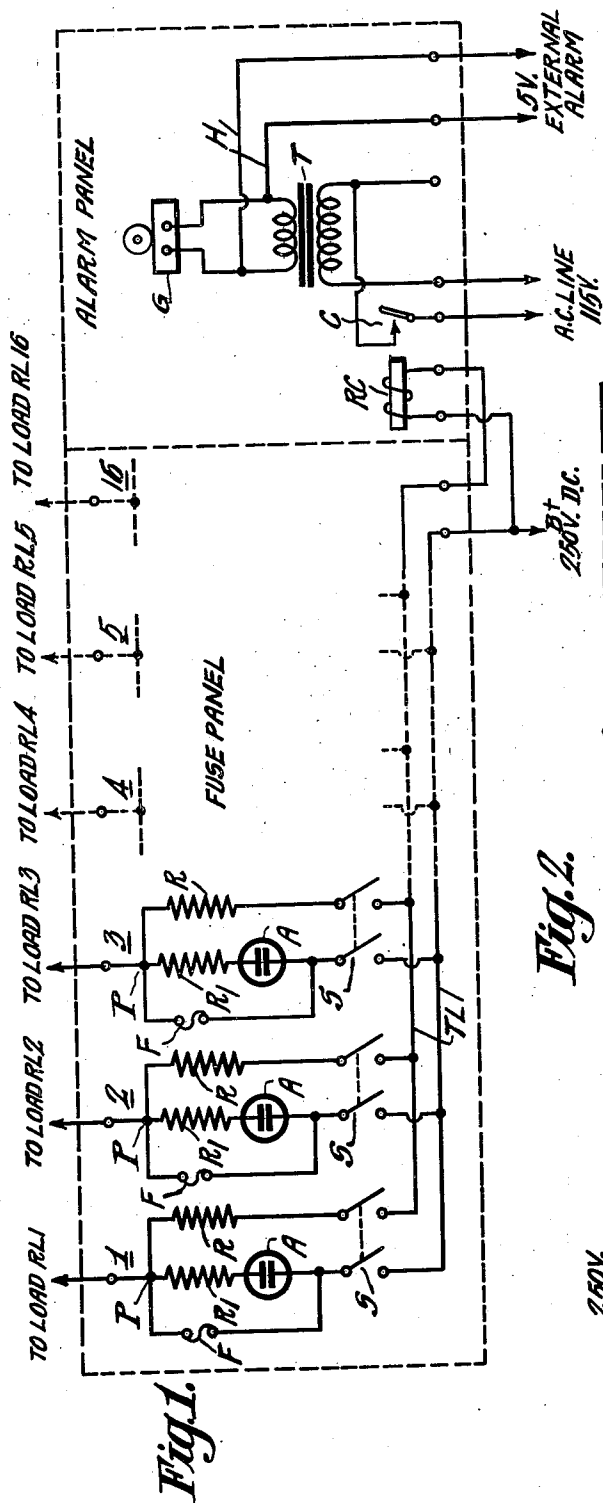
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2,464,848

FUSE INDICATING SYSTEM

Filed Jan. 3, 1947

2 Sheets-Sheet 1



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Fig. 3d.

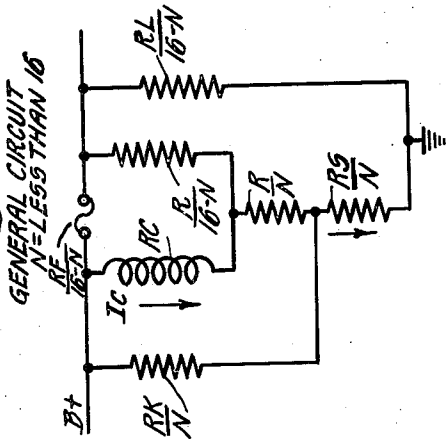


Fig. 3c.

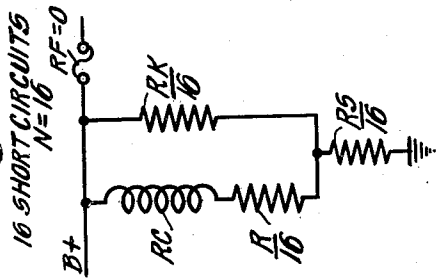


Fig. 3b.

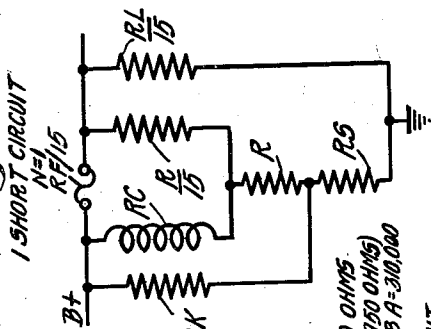
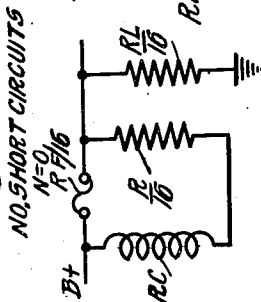


Fig. 3a.



N = NUMBER OF FUSES BLOWN
 RL = AVERAGE LOAD RESISTANCE PER CIRCUIT
 R = BALANCING RESISTOR = 62,000 OHMS
 RC = RESISTANCE OF RELAY COIL (1450 OHMS)
 RK = $R + \text{RESISTANCE OF NEON BULB } A = 30,000 \text{ OHMS}$
 RS = RESISTANCE OF SHORT CIRCUIT
 $RS \text{ MAX.} = \frac{225}{125} = 2000 \text{ OHMS}$
 $RS \text{ MIN.} = 0 \text{ OHMS}$
 RF = FUSE RESISTANCE

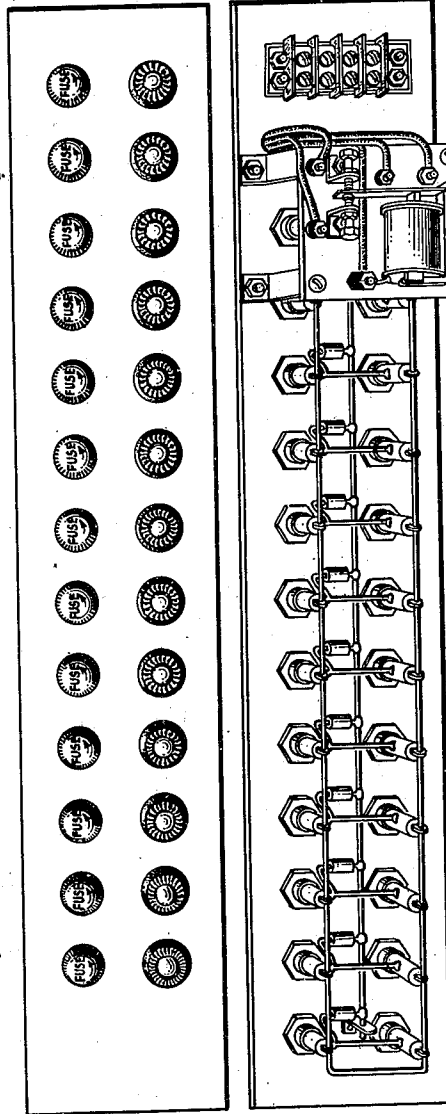


Fig. 4a.

Fig. 4b.

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FUSE INDICATING SYSTEM

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1 Claim. (Cl. 177-311)

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This invention relates to a protective system having aural and visual alarms.

An object of the invention is to provide an improved and compact low-drain protective system incorporating aural and visual indication of circuit failure for each of a group of low voltage circuits.

In the system of the invention, each load circuit is protected by a fuse and is provided with a glow lamp for visual indication. Aural alarm is obtained by a relay-actuated bell or buzzer. The load circuit may be any suitable low voltage utilization circuit, as for example the anode circuit of an electron discharge device system.

A more detailed description of the invention follows in conjunction with a drawing, wherein

Fig. 1 illustrates the protective system of the invention for a plurality of loads;

Fig. 2 is a simplified schematic circuit diagram of the system of Fig. 1;

Figs. 3a, 3b, 3c and 3d illustrate schematically the resulting effective circuits of the protective system of the invention under different short circuit conditions; and

Figs. 4a and 4b illustrate front and rear views respectively of a mechanical layout which the protective alarm system of the invention may take.

Referring to Fig. 1, there are shown a plurality of protective circuits 1, 2, 3 up to 16 for sixteen different low voltage loads RL1 to RL16 respectively. Only three of these protective circuits have been shown in detail, inasmuch as the other protective circuits are similar in construction. The loads RL1 to RL16 may comprise suitable vacuum tube anode circuits. Each protective circuit includes a $\frac{1}{8}$ ampere fuse F, and in shunt to this fuse a series circuit constituted by a resistor R1 and a $\frac{1}{4}$ watt glow lamp A (neon bulb for example). The junction point P of this parallel circuit of F, R1 and A is connected to the load RL1 and also to one end of resistor R. The other ends of the parallel circuit and resistor R are connected to a pair of conductors TL extending to opposite ends of a relay winding RC. A source of 250 volts positive potential, designated B+ is connected in common to the protective circuits as shown. It should be noted that this single relay RC is common to all 16 protective circuits. Each protective circuit of Fig. 1 has a double pole-single throw switch S whose purpose is to remove the 250 volts from the fuse clips when it is desired to replace a blown fuse. These switches are not essential to the practice of the invention and may be eliminated, particularly where an extractor type of fuse holder is employed for the fuse F.

Relay RC is normally unoperated in the ab-

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sence of a blown fuse and is provided with a pair of contacts C one of which is directly connected to one terminal of the primary winding of iron core transformer T. The other contact C and the other terminal of the primary winding are connected to different leads of the 115 volt A. C. line. The secondary winding of transformer T is connected to a bell or buzzer G, and, if desired, to an external alarm over leads H.

The general protective electrical circuit of Fig. 1 may be better understood by referring to the simplified electrical diagram of Fig. 2, wherein the same elements as those of Fig. 1 have been given the same reference characters.

The system of the invention is designed to operate relay RC and furnish both an aural indication (by means of bell or buzzer G) and a visual indication (by means of glow lamp A) of a short circuit in any one of the sixteen 250 volt load circuits RL1 to RL16. The presence of a short circuit in any load will cause the glow lamp A in its associated circuit to light up, and will cause the common aural alarm G to operate by virtue of a flow of current over a path including source B+, relay winding RC, resistor R in the particular protective in which the fuse is blown, and the short circuited load.

Figs. 3a, 3b, 3c and 3d show different resulting electrical circuits for various short circuit conditions. Fig. 3a shows the equivalent electrical circuit of the system of Figs. 1 and 2 in the absence of any short circuit through any of the loads RL1 through RL16. Fig. 3b shows the equivalent electrical circuit when there is a short circuit in only one of the sixteen loads. Fig. 3c shows the equivalent electrical circuit when there are short circuits in all sixteen loads. Fig. 3d shows the equivalent electrical circuit for the general condition encountered in use in the presence of one or more short circuits in the different loads. In these figures N represents the number of fuses blown.

RL is the average load resistance per fuse circuit.

R is the balancing resistor=62,000 ohms

RC is the relay resistance, and where a Kurman electric relay 210C38 is used=1959 ohms

R1 is 220,000 ohms

RK=R1+glow lamp resistance=310,000 ohms

RS=Resistance of short circuit

RS maximum = $\frac{250}{.125} = 2000$ ohms

RS minimum=zero ohms

RF=Fuse resistance

A=Neon lamp $\frac{1}{4}$ watt

It should be noted that the resistance of winding RC is considerably less than RK (the series circuit of R1+the glow lamp).

When any one protective fuse circuit draws more than 125 milliamperes, the fuse pertaining to that circuit blows, and approximately 90 volts, depending on the value of the short circuit resistance, is developed across the neon bulb A causing it to glow. The relay coil RC is shunted by a resistance of $R/16-N=R/15$, and the side of the relay coil that is not connected to B+ is connected to ground through $R+R_s$. The value of I_c (current through relay coil winding) is a minimum when $N=1$ and when R_s has its maximum value of 2000 ohms.

The general expression for the current through the relay coil when $N \neq 0$, is

$$I_c = \frac{250}{R + R_c(16-N) \frac{R_k + R_s}{NRK} + \frac{R_s}{NR} + R_c + \frac{R_s R_c}{RK}}$$

which can be readily calculated by reference to Fig. 3d.

When $N=16$ and $R_s \neq 0$ all the neon lights glow and the expression for I_c becomes

$$R_c + \frac{R}{N} + \frac{R_s}{N} + \frac{R_s}{RK} + R_c$$

With $N=16$ and $R_s=0$, I_c has its maximum value of

$$\frac{250}{R_c + \frac{R}{N}}$$

To effect the desired layout of parts on the fuse panel, the resistor has to be kept to a $\frac{1}{2}$ watt size. The maximum dissipation in R occurs when $N=1$ and $R_s=0$. This stipulation together with the minimum current through R_c provide the calculation of R and the choice of relay.

The following table indicates the current taken by the alarm system, and the current through the relay coil for four representative values of N. The alarm system current I is calculated with $R_s=0$ (assuming a complete short circuit in the load) to show its maximum value, while I_c is calculated with $R_s=2000$ ohms to indicate its minimum value.

N	I($R_s=0$) ma. (current taken by alarm system)	$I_c(R_s=2000 \text{ ohms})$ ma. (current through relay coil)
0	0	0
1	3.95	2.6
8	26.9	20.9
16	42.7	42.0

wherein N represents the number of fuses blown, I represents the current taken by the alarm system, and I_c represents the current through the winding R_c of the relay.

The alarm bell will operate if any one or a number of protective circuits has a blown or defective fuse, providing the resistance of the circuit or circuits is of the order of 50,000 ohms (corresponding to a load current of 5 ma. at 250 volts under operating conditions). This factor enables the operator to determine improper fus-

ing of any circuit even though a short circuit does not necessarily exist in the circuit.

Figs. 4a and 4b indicate the mechanical features of a protective system of the invention actually built and successfully tried out for thirteen low-voltage load circuits. Fig. 4a is the front view and Fig. 4b the rear view of the system. The fuses were of the tubular or cartridge type and were easily replaceable; hence there was no need for the switches S of Fig. 1. The glow lamp in each individual fuse circuit is shown placed directly beneath its associated fuse. The resistor R₁ for each fuse circuit was incorporated in the base of the glow lamp and is shown in the rear view, Fig. 4b. The resistors R are shown vertically arranged and spaced from each other.

The invention may be used in numerous circuit systems, for example in carrier multiplex equipment.

Obviously, the system of the invention is not limited to the precise values of the elements given above.

What is claimed is:

- A compact, low-drain protective system with aural and visual alarm for a plurality of loads, a plurality of fuse circuits, there being one such fuse circuit for each load, each fuse circuit comprising the parallel combination of a fuse and a series circuit of glow lamp and resistor in shunt to the fuse holder, a connection from one terminal of said parallel combination to one side of a source of unidirectional potential common to all fuse circuits, a connection from the other terminal of said parallel combination to its particular load, resistors each connected to said last terminal, and a single relay common to all fuse circuits and having a winding connected across the terminals of said parallel combinations through said last resistors, the resistance of the relay winding being appreciably smaller than the resistance of the series circuit of the glow lamp and resistor in the parallel combination of each fuse circuit when not shunted by the fuse, said relay having a pair of contacts in circuit with an audible alarm system, said contacts being conditioned by the operation of said relay to operate said audible alarm, whereby the presence of a short-circuit in any load will cause the fuse to blow in its associated fuse circuit and current to flow through the glow lamp in this associated fuse circuit and through the common relay winding to thereby light said glow lamp and operate said relay to produce both visual and audible indications.

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