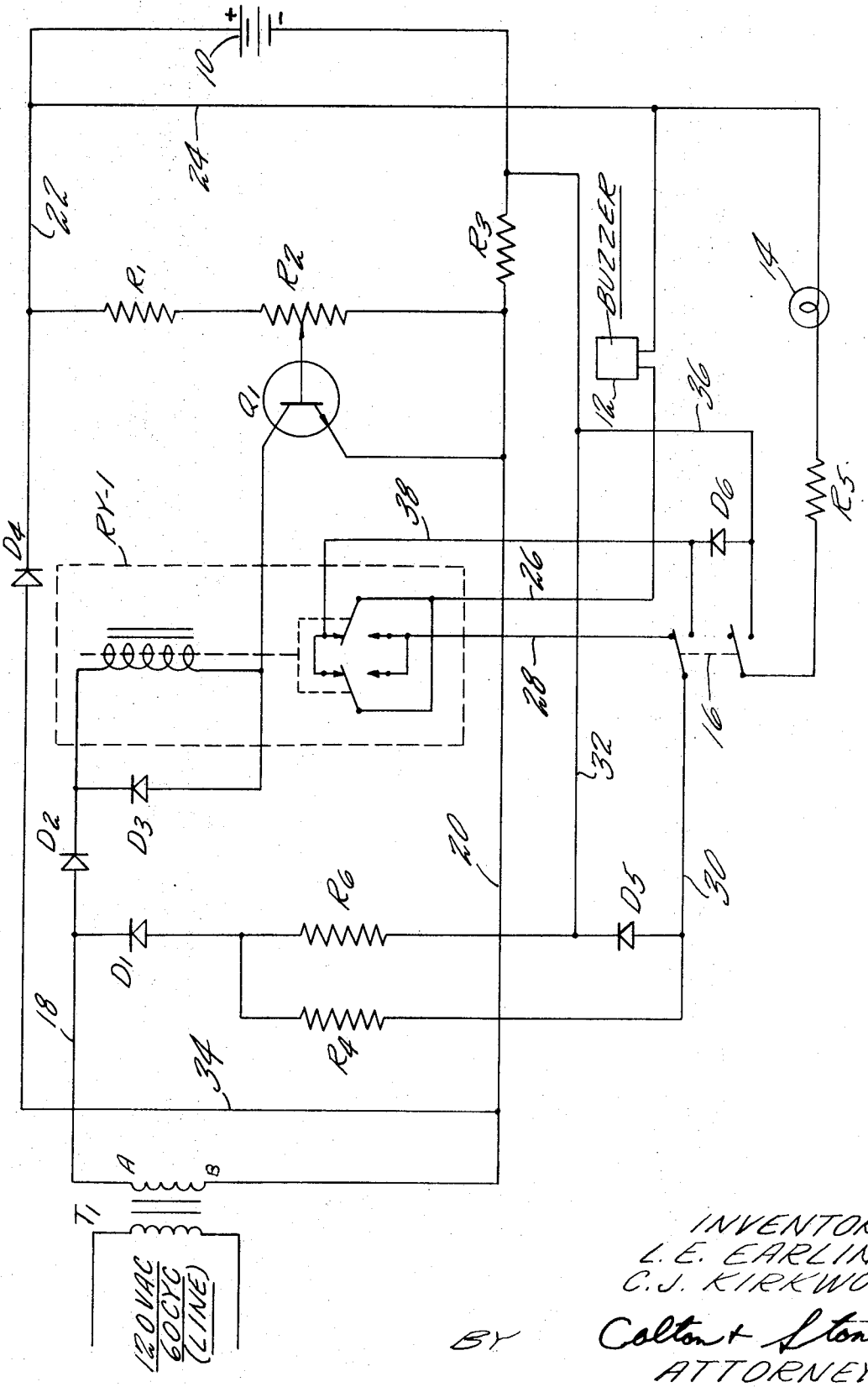
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AC POWER FAILURE ALARM

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AC POWER FAILURE ALARM

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ABSTRACT OF THE DISCLOSURE

A circuit for sensing the condition of an alternating current supply and for providing an indication of an AC power failure, the circuit being self-supervising with respect to a supplementary source of direct current employed to normally forward bias a semiconductor device connected in series with the solenoid of a relay which controls the operation of an alarm device. The alarm will also sound upon the interruption of the supply of direct current to the circuit and the circuit is characterized by the provision for either slow or rapid charging of the direct current supply and by the ability to constantly monitor the condition of the direct current supply.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to alarm circuits. More particularly, the present invention relates to the provision of an indication of a power failure on either an alternating current supply line or in the direct current supply of the alarm device itself. Accordingly, the general objects of the present invention are to provide new and improved methods and apparatus of such character.

Description of the prior art

Apparatus for indicating the disruption of power on an alternating current supply line are known in the art. Such prior art alarm circuits have, however, been characterized by one or more inherent deficiencies. Most serious among these deficiencies is the need for vigilant maintenance.

As is well known, an alternating current failure alarm must, in order for the alarm to sound when the circuit being monitored is deprived of current, be provided with a supplementary power source. The supplementary power source is typically a battery. Considering, for example, prior fire alarm systems, the condition of wet cells, when employed, must be periodically checked and when dry cells are utilized they must be replaced prior to the end of their normal shelf life. Prior art alternating current failure alarms have, in short, not been self-supervising and the inability to constantly monitor the condition of the self-contained supplementary power supplies has dictated excessive manual battery checking and/or replacement.

It should be pointed out that there have been prior art power failure alarm circuits which employed double supervision. That is, power failure alarm circuits have been known wherein a battery was monitored by an alarm circuit powered by the alternating current source being supervised and the alternating current source was, of course, monitored by an alarm circuit powered by the battery. However, such prior art double supervision systems have been unable to exercise supervision over the supplementary, self-contained direct current power supplies simultaneous with the continuous charging thereof since any previously charged circuit would look like a charged battery to the secondary monitoring circuit. For example, a conventional relay connected to sense the source of supplementary voltage would also respond to the charging voltage even if the battery were removed from the circuit completely. Accordingly, prior art circuits used to accomplish double supervision were disabled during battery charging intervals and, if the most desirable trickle charging of the batteries is to be employed, undesirable maintenance aspects of the prior art systems are again present.

In any power failure alarm system, it is desirable to provide readily discernable audible warning signals commensurate with the source of trouble. In attempting to achieve this end, the prior art has employed a pair of alarm devices, each with its own circuitry, which will respectively operate it from alternating and direct current sources. The provision of two alarms and associated circuitry, of course, adds to the complexity of the system and thus has a detrimental effect on system reliability.

SUMMARY OF THE INVENTION

The present invention overcomes the above-discussed deficiencies of the prior art and in so doing provides a novel and improved power failure alarm which constantly monitors the condition of its supplementary, self-contained battery power supply; even during intervals when the batteries are being charged. The improved power failure alarm of the present invention comprises a sensing transformer having its primary winding connected in the alternating current circuit which is to be monitored. The sensing transformer secondary winding is connected in series with the solenoid of a relay and a semiconductor device. The semiconductor device is normally biased on, the bias voltage being provided by a rechargeable battery, and latching current for the relay is thus supplied by the AC circuit under surveilance. Upon an AC power failure, the relay will become unlatched and an alarm will be energized. Similarly, upon failure of or in the bias voltage supply circuit, the relay will also become unlatched and the alarm will sound. The present invention also comprises means for silencing the alarm and circuitry by which the silenced alarm will be reenergized upon restoration of power to the alternating current circuit. In addition, under normal operating conditions, depending upon the state of the alarm silencing means, the direct current supply may be either trickle or quick charged, charging current being supplied by the alternating current source.

BRIEF DESCRIPTION OF THE DRAWING

The present invention may be better understood and its numerous advantages will become apparent to those skilled in the art by reference to the accompanying drawing which comprises a schematic diagram of a preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The disclosed, preferred embodiment of the present invention comprises a transformer T1, the primary winding of which is connected across a standard alternating current source. The device also comprises a source of direct

current 10 which typically will be a nickel cadmium battery. Depending upon the mode of operation, either a buzzer or alarm bell 12 or a warning light 14 will be energized to provide an indication of a malfunction in a supply of alternating current to the primary winding of transformer T1 or a failure of battery 10 or in its associated circuit. The preferred embodiment also compriess diodes D1–D6, transistor Q1, relay RY–1 and its associated contacts and a silencer switch 16.

Under normal operating conditions, with alternating current applied to the primary winding of transformer T1 and battery 10 in the charged condition and properly connected to the remainder of the circuit, current will flow through the solenoid of relay RY–1 thereby holding the contacts of the relay in the position shown. Current for energizing relay RY–1 is supplied by transformer T1 as follows. Assuming terminal A of the secondary winding of transformer T1 to be at a positive potential, current will flow via conductor 18, through forward biased diode D2 and the solenoid of relay RY–1. Current flowing through the solenoid of relay RY–1 will pass through transistor Q1 which, in a manner to be described below, is forward biased. The emitter of transistor Q1 is connected to the other end B of the primary winding of transformer T1 via conductor 20 and thus the circuit is completed. On the opposite half cycle of the supply voltage, when terminal A of the primary winding of transformer T1 is negative, diode D2 will be reverse biased and current will not flow from the main current source through the solenoid of relay RY–1. However, during the half cycle period that diode D2 is reverse biased, the magnetic field collapse of the solenoid of relay RY–1 is supported by diode D3 in the manner well known in the art and thus the contacts of the relay will remain in the normal operating condition shown in the drawing.

As noted above, transistor Q1 is normally maintained in a conductive state. The forward bias for transistor Q1 is supplied by battery 10, transistor base current flowing from the positive terminal of battery 10 via conductor 22 and through resistor R1 and potentiometer R2. The base current returns to the negaive terminal of battery 10 via the emitter of transformer Q1 and resistor R3. The bias voltage applied to the base of transistor Q1 is, of course, adjustable by means of potentiometer R2. A diode D4 is connected between the positive terminal of battery 10 and terminal B of the secondary winding of the transformer T1. Diode D4 prevents current from flowing from battery 10 back toward the source of alternating current and thus, in the sense of discharge of battery 10, isolates the battery from the alternating current source.

Under the conditions above described with alternating current applied to the primary winding of transformer T1, battery 10 being sufficiently charged to forward bias transistor Q1 and further with silencer switch 16 in the normal position shown, the buzzer 12 and lamp 14 will be deenergized by the combined action of relay RY–1 and switch 16.

If there is a failure in the alternating current power source connected across the primary winding of transformer T1, there will be no energizing current flow through the solenoid of relay RY–1 and the relay will thus drop out closing the movable arms to the lower pair of contacts. Upon the transfer of the relay contacts, a path is provided for direct current from battery 10 to flow through buzzer 12 causing it to sound. When operating on direct current, the buzzer will provide a first, distinct audible warning. The path of current from battery 10 is from the positive terminal of the battery, via conductor 24, through the buzzer, via conductor 26 and the movable contacts of relay RY–1 to the lower pair of stationary contacts of the relay and thence via conductor 28 to switch 16. Current will flow through the normally closed of the upper set of contacts of switch 16 and thence via conductor 30 and forward biased diode D5, back to the negative terminal of battery 10 via conductor 32. The buzzer 12 will thus be energized if for any reason the source of alternating current is disconnected from the primary winding of transformer T1. Buzzer 12 will continue to sound until such time as either the alternating current supply is restored or silencer switch 16 is operated thus opening the circuit between conductors 28 and 30 and interrupting the direct current circuit including the buzzer.

Should the circuit to battery 10 become open or should the output of the battery drop below a predetermined level, the forward bias on transistor Q1 will decrease. As the forward bias on the transistor decreases, the impedance presented by the semiconductor device will increase until it reaches a point where the total impedance in the circuit is such that insufficient current will flow through the solenoid of relay RY–1 to hold the relay in. The relay will then drop out and, as in the condition of an AC power failure, the movable contacts will be closed to the lower contacts of the relay. Under these conditions, and assuming a positive potential at terminal B of the primary winding of transformer T1, diode D4 will be forward biased and current will flow via conductor 34, through diode D4 and via conductor 24 to buzzer 12. From buzzer 12, the path for current flow back to terminal A of the secondary winding of transformer T1 is via conductor 26, the contacts of relay RY–1, conductors 28 and 30 (via switch 16), through resistor R4 and back to the AC source via diode D1 which will be forward biased at this time. Accordingly, current will flow from transformer T1 through the buzzer on alternate half cycles of the input alternating current and the buzzer will sound since it operates satisfactorily on half wave current. It is particularly noteworthy that, when operating from a half-wave alternating current source, the buzzer provides a second audible alarm which may easily be distinguished from the sound produced when direct current energization occurs. Prior art double supervision systems required two separate alarms and associated circuitry to provide an audible indication indicative of the type of circuit problem.

From the foregoing, it may be seen that in the case of a failure in either the alternating current or direct current supplies, the warning buzzer 12 will be energized. The incessant sounding of the buzzer until such time as restoration of power, either direct or alternating current, can be achieved may be a source of annoyance. However, it is desirable to provide for an indicator which will serve as a reminder that there has been an interruption of power until such time as power is restored. For this purpose, lamp 14 and silencer switch 16 are provided. The closing of the lower contacts of switch 16, when relay RY–1 has been deenergized and buzzer 12 sounded, will break the circuit between conductors 28 and 30 and thus, depending on the mode of operation, will prevent direct current from returning to battery 10 via diode D5 and conductor 32 or prevent alternating current from returning to terminal A of the secondary winding of transformer T1 via conductor 30, resistor R4 and diode D1. When power is restored and relay RY–1 again energized, its contacts will be pulled back to the position shown in the drawing and buzzer 12 will be reenergized by means of a rering circuit, the buzzer continuing to sound until silencer switch 16 is operated back to the normal position shown in the drawing. The rering circuit is well known in the art and is established by means of conductor 38 and the normally open contacts of the upper set of contacts of silencer switch 16, diode D5 being forward biased at this time.

Should a fault condition in the alternating current supply persist for a sufficient length of time, battery 10 may be discharged to a level where its output will not provide the necessary forward bias to transistor Q1 to permit the energization of relay RY–1 upon restoration of AC power. Under these conditions, and employing a rechargeable battery such as one comprised of nickel cadmium cells, the battery 10 may be quickly recharged by transferring silencing switch 16 to the off normal position (closing the

movable arms to the lower contacts). Accordingly, when terminal B of the secondary winding of transformer T1 is positive, charging current will flow via conductor 34 and forward biased diode D4 to the positive terminal of battery 10 and thence back to terminal A of the secondary winding from the negative terminal of the battery via diode D6, switch 16, conductor 30, resistor R4 and diode D1. It is to be noted that, from switch 16 (conductor 30), there is a parallel path for charging current flowing from the negative terminal of battery 10 back to terminal A of the secondary winding of transformer T1. That is, current could flow either through diode D5 and resistor R6 or through resistor R4. Resistor R4 is, however, typically on the order of 10 ohms whereas resistor R6 will typically be on the order of 390 ohms and thus charging current will flow through resistor R4. Thus, as will become obvious from the discussion below of the normal charging mode of battery 10, the substitution of resistor R4 for resistor R6 in the charging circuit by means of the operation of silencer switch 16 under the circumstance where the battery has been discharged to a low level, increases the charging rate of the battery. It is also to be noted that, when the battery has attained sufficient charge, forward bias will again be applied to transistor Q1 and during the next half cycle of the AC supply when terminal A of the secondary winding of the transformer is positive, relay RY–1 will be energized. Upon transfer of the contacts of relay RY–1, in the manner previously described, buzzer 12 will sound to indicate that the silencing switch 16 is in the off normal position. Upon transfer of silencing switch 16 back to the normal position shown in the drawing, all circuit conditions will return to normal, buzzer 12 will be silenced and battery 10 will be charged at a reduced or trickle rate in the manner to be described below.

One of the unique features of the present invention is that it permits charging of the battery 10 when the circuit is in a normal standby condition. With terminal B of the secondary winding of transformer T1 at a positive potential, charging current will flow via conductor 34 and forward biased diode D4 to the positive terminal of battery 10. Charging current will return to the source (terminal A of T1) from battery 10 via conductor 32 and, since diode D5 will be reverse biased, resistor R6 and diode D1. As mentioned above, the value of resistor R6 will be sufficiently large so as to limit the charging current and the battery will be charged at a reduced or trickle rate. During the half cycles of the AC supply voltage when charging current is being supplied to battery 10, diode D2 will be reverse biased and current may not flow through the solenoid of relay RY–1 from the AC source. Thus, since current flow to the solenoid of relay RY–1 from the transformer T1 is blocked by diode D2 when terminal B of the secondary winding of transformer T1 is positive, the forward bias voltage generated by the charging current and applied to the base of transistor Q1 will not contribute to energizing relay RY–1. On the opposite half cycle when terminal A of the secondary winding of transformer T1 is positive, diodes D1 and D4 oppose current flow to the base circuit of transistor Q1 from the transformer. Thus, transistor Q1 senses the condition of battery 10 during half cycles of the input alternating current when the battery is not being charged, and relay RY–1 cannot be held in by forward bias on transistor Q1 by the battery charging current. Since nickel cadmium cells are preferred for battery 10, overcharging of the battery is not a problem.

While a peferred embodiment has been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of this invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.

What is claimed is:

1. Apparatus for indicating the interruption of the supply of alternating current to a circuit comprising:

means for sensing the flow of current in the circuit under surveillance and for generating a signal commensurate therewith, said sensing means including a transformer having at least a primary and a secondary winding, said transformer primary winding being connected in the circuit under surveillance;

relay means having a current responsive element and switch means operatively connected thereto, said switch means having at least three contacts and two circuit establishing conditions, said switch means being operated from one of said conditions to the other in response to energization of said current responsive element;

means connecting said switch means current responsive element to a first end of said sensing means transformer secondary winding;

a variable impedance device having input and output terminals and a control signal input terminal, said impedance device being connected in series with said relay means current responsive element and said sensing means transformer secondary winding to form a relay energizing circuit;

means for generating and applying a direct current control signal to the control signal input terminal of said variable impedance device, said control signal generating means including a rechargeable battery, whereby said impedance device will normally present a low impedance to current flowing through said relay means current responsive element and said switch means will be latched in a first condition in response to the signal generated by said sensing means;

alarm means, said alarm means having an operating signal input terminal connected to a first polarity terminal of said control signal generating means and an operating signal output terminal connected to a first contact of said switch means; and

means connecting a second contact of said switch means to a second polarity terminal of said control signal generating means, said first and second switch contacts normally being open whereby interruption of current to the circuit under surveillance will deenergize said relay means and cause closing of said first and second switch contacts thereby energizing said alarm means from said control voltage generating means.

2. The apparatus of claim 1 further comprising:

means connecting a first end of the secondary winding of said transformer to a first polarity terminal of said battery; and

first means including a first resistance element connecting the second polarity terminal of said battery to the other end of the secondary winding of said transformer whereby said battery will be charged at a first rate.

3. The apparatus of claim 2 wherein said means connecting a first polarity terminal of said battery to said secondary winding comprises:

diode means connected between said first polarity terminal of said battery and said first end of the secondary winding of said transformer.

4. The apparatus of claim 3 wherein said impedance device comprises:

a transistor having its collector and emitter connected in series with said current responsive element and the secondary winding of said transformer.

5. The apparatus of claim 4 wherein said alarm means comprises:

means responsive to the passage of current therethrough for sounding an audible alarm.

6. The apparatus of claim 5 further comprising:

means for interrupting the circuit between said battery and alarm means to thereby disable said alarm means.

7. The apparatus of claim 6 wherein said interrupting means comprises:

a visual alarm device, said visual device being normally deenergized; and

silencer switch means for interrupting the audible alarm circuit and simultaneously completing a path for current flow through said visual device.

8. The apparatus of claim 4 further comprising:

second means including a second resistance element for connecting the second polarity terminal of said battery to said other end of said secondary winding, said second means having less impedance than said first connecting means whereby said battery may be charged at a second rate.

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