United States Patent

[11] **3,587,095**

[72] Inventor **Leonard E. Earling**
Tecumseh, Mich.

[21] Appl. No. **727,234**
[22] Filed **June 7, 1968**
[45] Patented **June 22, 1971**
[73] Assignee **The Gray Manufacturing Company**

[54] **SUPERVISED ANNUNCIATOR**
11 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **340/409,** 340/412
[51] **Int. Cl.** **G08b 29/00**
[50] **Field of Search** 340/409

[56] **References Cited**

UNITED STATES PATENTS

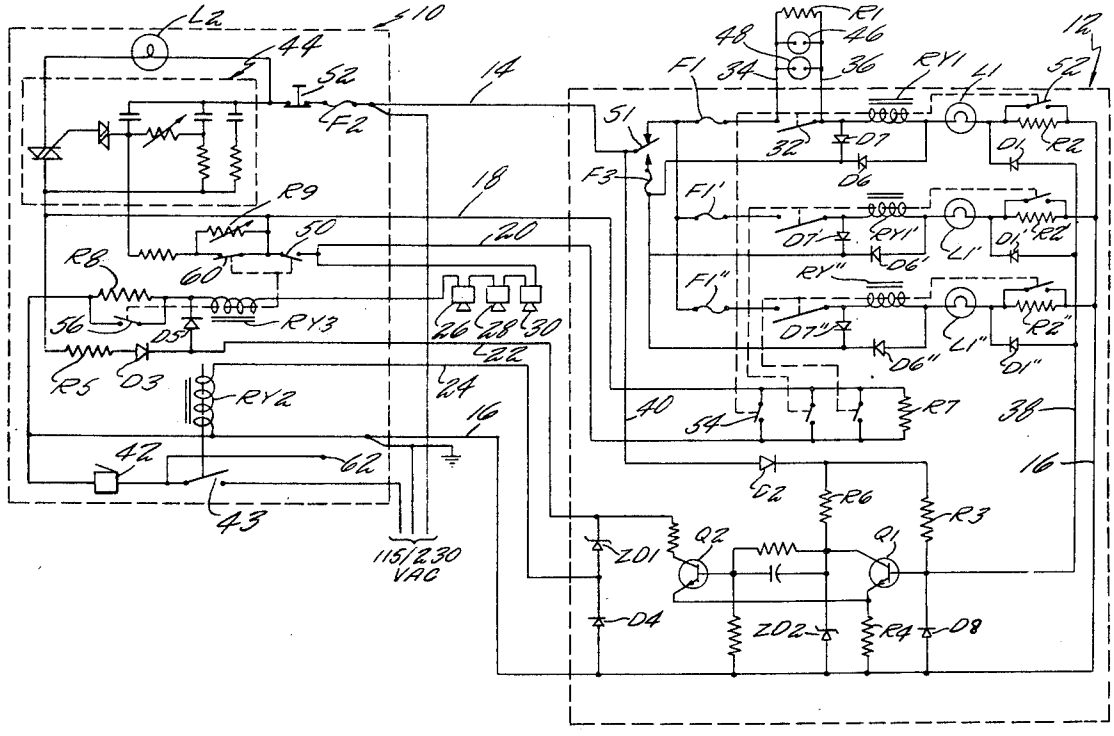
3,138,792	6/1964	Jenkins	340/409
3,430,231	2/1969	Weld	340/409
3,448,447	6/1969	Tetherow	340/409
3,478,352	11/1969	Eisenberg	340/409

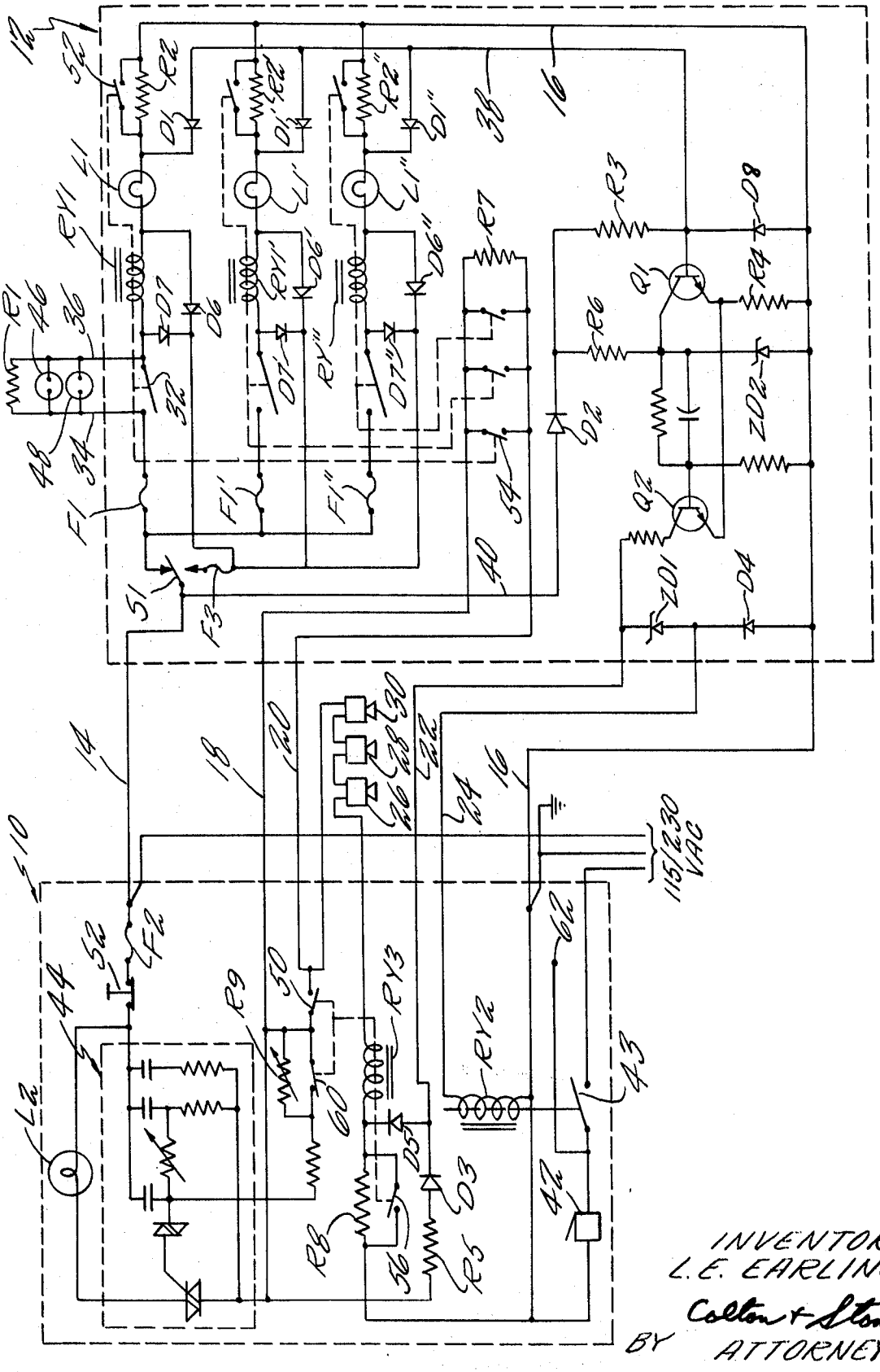
FOREIGN PATENTS

954,192	4/1964	Great Britain	340/409

Primary Examiner—Thomas B. Habecker
Attorney—Colton & Stone

ABSTRACT: A completely supervised alarm system having an alarm panel and a remote annunciator unit which is interconnected to the alarm panel. The alarm system is characterized by a memory capability, the ability to add additional circuits to be monitored without additional wiring between the main alarm and remote annunciator panels and without disturbing preexisting supervisory wiring. The system is also characterized by employment of a bidirectional silicon controlled rectifier for supplying energization for audible warning devices and by use of a single relay for the monitoring for open and ground conditions on all interconnecting wiring and on the annunciator internal circuitry.




115/230 VAC
INVENTOR
L.E. EARLING
BY Colton & Stone
ATTORNEYS

SUPERVISED ANNUNCIATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to alarm systems. More particularly, the present invention is directed to the provision of a completely supervised, multicircuit annunciated alarm system having an annunciator unit and a main alarm board which are located remote from one another. Accordingly, the general objects of the present invention are to provide novel and improved methods and apparatus of such character.

2. Description of the Prior Art

While not limited thereto in its utility, the present invention is particularly well suited for employment as a fire alarm system. Previously available fire alarm systems of the type which had a main alarm panel and an annunciator panel have either ignored the necessity of supervising the interconnecting wiring between the control or alarm panels and the remote annunciators or have employed at least one relay and its associated circuitry to supervise each line interconnecting the two units. As is well known, electromechanical devices such as relays are susceptible to failure and/or faulty performance due to such causes as contact pitting or corrosion. Accordingly, prior art alarm systems of the type being discussed have, from the standpoint of reliability, been suspect.

An additional problem which has plagued the prior art has been an inability to provide an alarm system characterized by ease of isolation and analysis of fault conditions. The desire for ease of maintenance is necessitated by the need to enable maintenance by personnel with limited technical knowledge.

A further deficiency of prior art alarm systems has been the inability to add detector circuits without providing additional interwiring between the main alarm panel and remote annunciators and without disturbing existing supervisory wiring. Thus, in the prior art, the modification of an alarm system to enable it to exercise supervision over an additional detector circuit, as might for example be required by a building addition, has been possible only through the extensive rewiring of the alarm panel and/or the annunciator panel and the interconnecting wiring between the two.

SUMMARY OF THE INVENTION

The present invention comprises a completely supervised, multicircuit, annunciated alarm system which employs a single supervisory relay for supervising an unlimited number of external circuits as well as internal annunciator circuits. The system of the present invention also has a memory capability and therefore will maintain an annunciated alarm condition even though the detector which originally called for the sounding of the alarm is completely destroyed. As an added feature, the present system employs a bidirectional, silicon controlled rectifier as ballast for audible alarm devices which are located on the alarm panel thereby providing for increased perceptibility of the alarms. The present invention is also characterized by flexibility in that additional detector circuits may be added merely through the addition of a supervisory diode to the annunciator panel internal circuitry.

It is therefore an object of the present invention to provide a completely supervised multicircuit annunciated fire alarm system.

It is another object of the present invention to provide a completely supervised multicircuit annunciated alarm system employing a minimum of relays.

It is a further object of the present invention to provide a multicircuit annunciated alarm system characterized by a minimum amount of interconnecting wiring between the alarm or signal control panel and the annunciator.

It is yet another object of the present invention to provide a multicircuit, annunciated fire alarm system having a memory capability.

It is still another object of the present invention to provide a multicircuit, annunciated alarm system employing a single supervisory relay in the alarm panel to supervise an unlimited number of external circuits and the internal annunciator circuits for open or ground faults.

It is another object of the present invention to provide a supervised, multicircuit annunciated alarm system which is sensitive to open circuits and ground faults within the annunciator panel circuitry or on external, interconnecting wiring.

It is also an object of the present invention to provide a completely supervised multicircuit annunciated alarm system characterized by ease of maintenance.

It is yet another object of the present invention to provide a multicircuit alarm system which will accept additional detector circuits without disturbing existing supervisory wiring.

It is still another object of the present invention to provide a multicircuit, supervised, annunciated alarm system to which additional detector circuits may be added without additional interwiring between the alarm and annunciator panels.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing and other objects and advantages of the present invention will become readily apparent to those skilled in the art by reference to the accompanying drawing which is a schematic diagram of a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, the supervised annunciated alarm system of the present invention comprises a fire alarm unit or panel, indicated generally at **10**, and an annunciator unit or panel, indicated generally at **12**. Power, from a standard 115/230 volt alternating current source is supplied to the alarm panel as shown. The alarm and annunciator units are interconnected by means of conductors **14**, **16**, **18**, **20**, **22** and **24**. Conductors **14** and **16** respectively connect one side and the neutral of the alternating current source to the annunciator panel **12** thus furnishing power for the annunciator. A plurality of audible alarm devices, shown as series connected horns **26**, **28** and **30** are connected to the alarm panel **10**, the horns being physically located at appropriate watch stations.

Current supplied to annunciator panel **12** via conductor **14** is delivered, via the normally closed contacts of switch **S1**, through fuse **F1** to a first pair of normally open contacts **32** of relay **RY1**. Under normal conditions, with the solenoid of relay **RY1** deenergized, current will flow via an external conductor **34** from the line side contact of normally open contacts **32** to an end-of-line resistor **R1** before passing through the solenoid of relay **RY1**. Current passing through the solenoid of relay **RY1** also passes through an annunciator lamp **L1**, resistor **R2** and thence back to the neutral of the AC supply via conductor **16**. The above-described complete circuit for current from the external power supply through the annunciator panel provides a small supervisory current through all the elements previously described in the annunciator circuit and it is to be noted that duplicate parallel circuitry is provided for annunciator panel relays **RY1'** and **RY1''**. In practice, there may be any number of parallel connected relay circuits. It is to be noted that, in the interest of clarity, the external detector circuits and their end-of-line resistors have not been shown for the **RY1'** and **RY1''** relay circuits.

Any open condition due to failure of any of the previously described components a failure of or at the power supply source, or any ground condition on external lines which would cause the fuse **F1** to open will disrupt the current flow through resistor **R2**. In order to accomplish supervision of the **RY1** annunciator relay circuits, normally reverse biased **D1** diodes have their cathodes connected to the junction between resistor **R2** and lamp **L1**. The anodes of the **D1** diodes are connected, via conductor **38**, to the base of a transistor **Q1**. The reverse biasing of the **D1** diodes is accomplished as follows. When the polarity of the power supply source is such that a positive potential appears on conductor **14**, a diode **D2**, which has its anode connected to switch **1** by means of conductor **40**,

will be forward biased. Diode D2 will thus conduct and a secondary current path will be provided back to the neutral terminal of the source (conductor 16) via the base to emitter circuit of normally conductive transistor Q1 and its emitter resistor R4. Under normal conditions, the voltage drop across resistor R2 will provide a reverse bias on Diode D1.

Restated, the circuit parameters are chosen so that the voltage drop across resistor R2 is slightly greater than the voltage appearing between neutral conductor 16 and the base of transistor Q1 and thus diode D1 cannot conduct under normal conditions. However, should there be any disruption of the current through the resistor R2, diode D1 will no longer be reverse biased and will conduct. Conduction of diode D1 provides a shunt path from the base of transistor Q1 through resistor R2 to neutral conductor 16. The establishment of this shunt path by the removal of the reverse bias on diode D1 causes a decrease in the forward bias applied to the base of transistor Q1 thus causing transistor Q1 to be gated off. In the manner to be described below, the turning off of transistor Q1 will cause energization of a warning buzzer on the alarm panel.

As should now be obvious, by tracing parallel paths through the similar circuits of relays RY1' and RY1'', a disruption of normal conditions in any of the circuits will cause a shunt condition for the forward bias on the base of transistor Q1. Thus, it may be seen that a theoretically unlimited number of similar circuits may be supervised for open and/or ground fault conditions since any circuit can provide a shunt path through its respective resistor R2 to decrease the forward bias on transistor Q1.

Turning now to fire alarm panel 10, the operation of warning buzzer 42 upon the shunting of the bias on transistor Q1 will first be described. Current is supplied to buzzer 42 from the alternating current source via the contacts 43 of relay RY2. It is to be noted that the solenoid of relay RY2 is normally energized and thus the circuit from the power supply to buzzer 42 is normally interrupted. Energizing current for relay RY2 is supplied as follows. Current from the side of the alternating current source which is of the opposite polarity to the side which is connected to the line side of the contacts 43 of relay RY2 is delivered to the alarm panel as previously described and flows through fuse F2 and the normally closed contacts of test and reset switch S2. The thus delivered current then passes through lamp L2 and a bidirectional, silicon controlled rectifier or Triac indicated generally at 44. From Triac 44, assuming the source polarity to be proper, current will pass through resistor R5 and series connected diode D3 and then, via external conductor 22, to the annunciator panel. In the annunciator circuit, the current delivered via conductor 22 will be passed by Zener diode ZD1, will be delivered back to the alarm panel via conductor 24 and will flow through the solenoid of relay RY2 and back to the neutral of the alternating current source.

On opposite half cycles of the AC supply voltage, that is when the polarity at the line side of fuse F2 is negative, current flow through the relay RY2 energization circuit is blocked by diode D3 which will now be reverse biased. However, during this time the magnetic field collapse of the solenoid of relay RY2 generates a voltage of such polarity as to cause current to flow from the neutral or grounded terminal of the solenoid through external line 16 to the annunciator panel and thence through diode D4 which will be forward biased at this time. Current passed by diode D4 will be delivered back to the solenoid of relay RY2 in the alarm panel by conductor 24 therefore maintaining current through the relay coil and thus preventing energization of buzzer 42.

It is especially to be noted that a break in either of lines 16 or 24 will open the above-described field collapse circuit thereby causing relay RY2 to chatter since it will then be energized every half cycle of the alternating current supply voltage. The chattering of the contacts of relay RY2 will cause buzzer 42 to sound thereby providing an indication of trouble. Similarly, the accidental grounding of conductor 24 will also disrupt current flow to relay RY2 causing it to drop out and complete the circuit to buzzer 42 thereby causing the warning buzzer to sound.

As mentioned above, transistor Q1 is normally in a conducting state. The voltage drop across the collector circuit resistor R6 of transistor Q1 will limit the forward bias on transistor Q2 thus maintaining this transistor in a nonconductive state. However, if a fault condition occurs in the circuitry for supplying current to the annunciator lamp circuits, transistor Q2 will be turned on. Restated, when the voltage drop across resistor R2 decreases indicating a drop in the current through an annunciator L1 lamp, transistor Q1 will be turned off and the thus decreased voltage drop across resistor R6 will forward bias transistor Q2. Under these conditions, with the power supply voltage polarity being such that a positive potential appears on conductor 14, current flow through the previously described circuit including resistor R5 in the alarm panel will be shunted to neutral via transistor Q2 and resistor R4. This, in turn, limits the current flowing through the solenoid of relay RY2 causing the relay to drop out and warning buzzer 42 to sound. By proper choice of the voltage rating of Zener diode ZD1 and the base and collector resistors associated with the transistor Q2, the current through the solenoid of relay RY2 under the shunt condition above described may be reduced to zero since the voltage across Zener diode ZD1 will be less than the Zener conducting rating. In the same manner, any open or ground condition on conductor 22 which interconnects the alarm and annunciator panels will also cause relay RY2 to drop out and the warning buzzer 42 to sound.

Again assuming a positive potential applied to conductor 14 from the power source, current may flow through the alarm panel via fuse F2, the normally closed contacts of test and reset switch S2, and through lamp L2 and the Triac 44. The current may then pass, via external conductor 18, from the alarm panel to the annunciator panel. In the annunciator panel, conductors 18 and 20 are interconnected via resistor R7 and current passing through this resistor will be applied, via conductor 20, to one terminal of a first set of normally open contacts 50 of relay RY3. The line side terminal of contacts 50 of relay RY3 is connected to the external horn circuit and the current will thus flow through the series connected horns 30, 28 and 26 and thence through the solenoid of relay RY3, series connected resistor R8 and back to the neutral terminal of the power source. The voltage drop across resistor R8 provides a reverse bias voltage for diode D5 which is connected between the solenoid of relay RY3 and external conductor 22. Under any of the fault conditions previously described, or if a ground should occur in the external horn circuits, there will be voltage drop across resistor R8 and diode D5 will conduct to shunt current normally flowing through resistor R5 and diode D3 to ground or neutral via resistor R8. In the manner previously described, this action will also cause relay RY2 to drop out resulting in sounding of warning buzzer 42.

The above description has concentrated on the supervisory features of the present invention. However, the present invention also comprises an alarm system; for example a fire alarm employing a plurality of detectors such as detectors 46 and 48. Detectors 46 and 48 may be heat detectors, smoke detectors, manual stations, or the like. From an electrical standpoint the detectors normally present an open circuit. However, when they are subjected to the condition to which they are responsive, the detectors close thereby short circuiting conductors 34 and 36. Thus, considering a fire alarm system, the sensing of a condition commensurate with fire by any of the external detectors will cause that detector to shunt the end of line resistor R1 thereby causing increased current flow in the annunciator components. This increased current through the solenoid of an annunciator RY1 relay will cause the relay to pick up thereby closing its contacts. In the case of relay RY1, the relay includes three pair of normally open contacts 32, 52 and 54. The closing of contacts 32 "locks up" the external detector circuit by establishing a current path internally of the an-

nunciator panel between conductors 34 and 36. Relay RY1 thus becomes self-latching and total destruction of the detector which initially caused the energization of relay RY1 will have no effect on the operation of the circuit. The closing of contacts 52 will place a shunt across resistor R2 causing diode D1 to conduct and, in the manner previously described, warning buzzer 42 in the alarm panel to sound. The shunting of the end-of-line resistor R1 and resistor R2 by the closing of contacts 32 and 52, respectively, of relay RY1 applies full line voltage to the series connected solenoid of relay RY1 and annunciator lamp L1 thereby causing the annunciator lamp to light thus providing an indication of which detector circuit had been subjected to the unusual condition to which it is responsive. The closing of contacts 54 of relay RY1 shunts resistor R7 thus causing an increase in current flow in the external horn circuit. Increased current flow in this circuit, which includes the solenoid of relay RY3, causes this relay to pick up. The closing of contacts 56 of relay RY3 shunts resistor R8 whereas the closing of contacts 50 of relay RY3 short circuits conductors 18 and 20 and thereby causes relay RY3 to become latched. The latching of relay RY3 by the closing of contacts 50 results in maintaining the shunt across resistor R7 in the annunciator panel and thereby provides sufficient current to the horn circuit to result in the sounding of horns 26 and 28 and 30. The current supplied to the horns is furnished from the Triac assembly 44 and the magnitude of the current is preadjusted by means of potentiometer R9 which is placed in the circuit by the opening of a pair of normally closed contacts 60 of relay RY3.

Once an alarm has been sounded, means must be provided to restore normal operating conditions. This, of course, requires the unlatching of relay RY3 and one of the annunciator panel RY1 relays. This may be accomplished by operating switch S1 on the annunciator panel to momentarily break the circuit between the power source and the solenoids of the RY1 relays. This causes the latched relay to drop out and to accept supervisory current upon reclosing of the normally closed contacts of switch S1. Thereafter, reset switch S2 on the fire alarm panel may be depressed momentarily disrupting current to the solenoid of relay RY3 thereby causing this relay to drop out thereby returning its contacts to normal, the relay solenoid accepting normal supervisory current upon reclosure of switch S2. Thus, it may be seen that an alarm condition will be maintained even if the alarm initiating device and annunciator control panels were damaged by spreading fire prior to response to the alarm.

Even though sufficient current will not normally flow through the filaments of the annunciator panel L1 lamps the filaments in these lamps will ultimately burn out or break. This, of course, will result in the forward biasing of the associated D1 diode and the sounding of the warning buzzer 42 in the manner above-described. When this happens, visual observation of the annunciator panel will not, of course, provide an indication as to the circuit in which the trouble is occurring. However, the particular lamp which is opened may be isolated immediately by momentarily operating switch S1 to complete a circuit which will energize all of the annunciator panel lamps. Assuming that the source polarity is such that a negative potential is applied to conductor 14, with the normally open contacts of switch S1 closed a current path is provided from the neutral or ground conductor 16 to all of the D1 diodes via diode D8 and conductor 38. Each of the annunciator circuit D1 diodes will thus provide current to the lamp associated with its circuit, current being provided via fuse F3 and the D6 diodes which are connected between the annunciator L1 lamps and fuse F3. Thus, all good lamps will light at half brilliance, current being blocked by the D6 diodes during positive half cycles of the supply voltage, and the open lamp may be isolated immediately. Upon replacement of the fault lamp, the warning buzzer 42 will cease operating indicating restoration of normal conditions on all circuits.

A D7 diode is provided in each of the annunciator circuits to prevent an alarm condition if external conductor 36 of the detector circuits should inadvertently become grounded. Normally, such a ground condition would cause a trouble signal and the normal response of a technician would be to operate switch S1 momentarily to check the annunciator lamps. However, with conductor 36 grounded, the closing of switch S1 to its lower (normally open) contact will provide a path from ground to the source via the solenoid of an RY1 relay, a D6 diode and fuse F3. Current flowing through such a circuit could cause an annunciator relay to pick up and lock up the fire alarm panel in an identical manner as previously described in the case of an actual alarm. To prevent this occurring, diodes D7 are provided in the circuit to establish a current path from ground to source which bypasses the solenoid of the RY1 relay, the current passed by the D7 diodes generally being sufficient to blow the F3 fuse which protects the diodes. It should also be noted that a Zener diode ZD2 is provided to protect transistors Q1 and Q2 from transients or overvoltage conditions on the alternating current supply line.

Returning again to a consideration of the alarm panel 10, a particularly unique feature of this circuit is the provision of lamp L2 in series with the Triac 44 to compensate the Triac phase shift gating network for line voltage variations. It has been discovered that the temperature coefficient characteristic of the tungsten filament in lamp L2 provides an additional voltage drop between the phase shift network and the Triac emitter to thereby stabilize Triac signal current under varying conditions of supply line voltage.

From the foregoing description, it will be apparent to those skilled in the art that the supervised annunciator alarm system of the present invention can be expanded and integrated wit other common alarm features such as external trouble signals, for which a terminal 62 is provided, trouble re-ring circuits, auxiliary relays for city tie, zone coding transmitters which may be tripped by annunciator relay contacts, additional horn circuits, presignal circuits and other concepts which are old in the art.

It is to be noted that the circuitry discussed above has been specifically described for alternating current supply applications. However, the system of monitoring or supervising and controlling multiple circuits of the present invention is also applicable to direct current applications as well. In the case of direct current supply, the Triac alternating current control would be replaced by a transistor, variable resistor, or other ballast means.

To summarize the operation and advantages of the present invention, in the supervisory circuits the neutral terminal 16 will be at ground potential and any ground or open in the annunciator or alarm panel circuitry will cause relay RY2 to drop out and energize warning buzzer 42. In addition, an open in the conductor 16 between the annunciator and alarm panels will cause relay RY2 to chatter thereby also providing an audible warning. Thus, all lamps, fuses, external wiring and interwiring between the panels are supervised for functional capability. This supervision for opens and grounds of multiple circuits is accomplished with the single RY2. Also, the supervision of the remote annunciator panel 12 is accomplished with a minimum of interconnecting conductors between the annunciator panel and the main fire alarm panel 10.

An additional advantage of the present invention, as previously noted, is the use of a solid state Triac ballast for the external horn circuits thereby achieving a brightening of the tone of the horns due to the high harmonic content of the output wave form of the Triac.

A particularly advantageous feature of the present invention is that additional detector circuits may be added later without providing for additional interwiring between the main fire alarm panel and the annunciator panel and such detector circuits may be added without disturbing existing supervisory wiring within the annunciator. For example, an additional D1 diode is all that is required to supervise an additional circuit and such a diode may be added without disrupting or breaking the lines of any previously existing circuits.

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

What I claim is:

1. An annunciated alarm system comprising:
condition responsive means;
normally inoperative annunciator means connected in a series with said condition responsive means;
means for supplying supervisory current to said annunciator means;
first switch means electrically connected to said annunciator means and responsive to a failure of the supervisory current flow, said switch means normally presenting an open circuit to current flow;
malfunction warning means; and
means electrically connected to said switch means and to said warning means for energizing said warning means upon operation of said switch means in response to a failure of supervisory current flow.

2. The apparatus of claim 1 wherein said warning means is located on an alarm panel and said annunciator means comprises a remotely located annunciator panel, said panels being interconnected by a plurality of conductors, and wherein said energizing means comprises:
normally open second switch means connected in series with said warning means, said second switch means being in a normally energized state whereby operation of said first switch means or a malfunction in the wiring interconnecting the panels will cause deenergization of said second switch means and coincident closing thereof to complete a circuit to said warning means.

3. The apparatus of claim 2 further comprising:
alarm means;
means for supplying current to said alarm means; and
means connecting said current supply means to said alarm means, said connecting means including first current limiting means connected in series with said alarm means.

4. The apparatus of claim 1 wherein said means for supplying supervisory current to said annunciator means comprises:
second current limiting means connected in parallel with said condition responsive means.

5. The apparatus of claim 4 wherein said condition responsive means normally presents an open circuit and wherein said annunciator means comprises:
self-latching relay means, a first set of normally open contacts of said relay means establishing a short of circuit across said condition responsive means and said second current responsive means upon energization of said relay means in response to operation of said condition responsive means to create a temporary shunt across said second current limiting means.

6. The apparatus of claim 3 wherein said means for supplying supervisory current to said annunciator means comprises:
second current limiting means connected in parallel with said condition responsive means.

7. The apparatus of claim 6 wherein said condition responsive means normally presents an open circuit and wherein said annunciator means comprises:
self-latching relay means, a first set of normally open contacts of said relay means establishing a short circuit across said condition responsive means and said second current responsive means upon energization of said relay means in response to operation of said condition responsive means to create a temporary shunt across said second current limiting means.

8. The apparatus of claim 7 wherein said annunciator means further comprises:
a second set of normally open contacts, said second set of contacts being connected in parallel with said first current limiting means whereby energization of said relay means short circuits said first current limiting means and said alarm means are energized by the increased current.

9. The apparatus of claim 1 wherein said first switch means comprises:
a first normally conducting transistor,
normally reverse biased diode means connected between said annunciator and the base of said first transistor, a decrease in supervisory current causing said diode to conduct, conduction of said diode causing a decrease in the forward bias voltage on said first transistor whereby said first transistor is switched to a nonconductive state; and
means connected to said energizing means and responsive to the switching of said first transistor for deenergizing said energizing means.

10. The apparatus of claim 8 wherein said first switch means comprises:
a first normally conducting transistor,
normally reverse biased diode means connected between said annunciator and the base of said first transistor, a decrease in supervisory current causing said diode to conduct, conduction of said diode causing a decrease in the forward bias voltage on said first transistor whereby said first transistor is switched to a nonconductive state; and
means connected to said energizing means and responsive to the switching of said first transistor for deenergizing said energizing means.

11. The apparatus of claim 10 wherein said means for supplying current to said alarm means includes:
a bidirectional silicon controlled rectifier.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,587,095 Dated June 22, 1971

Inventor(s) Leonard E. Earling

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Filing Date: Change "June 7, 1968" to --May 7, 1968--.

Col. 2, line 64: Change "components" to --components,--.

Col. 4, line 51: Change "be voltage" to --be no voltage--.

Col. 5, line 71: Change "fault" to --faulty--.

Col. 6, line 30: Change "wit to --with--.

Col. 7, line 49: Change "a short of circuit" to --a short circuit--.

Signed and sealed this 16th day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
U.S. GOVERNMENT PRINTING OFFICE 1969 O - 366-334