



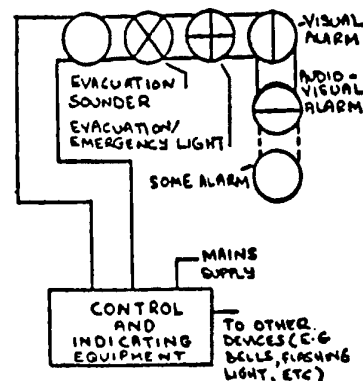
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : G08B 25/00, 27/00, 17/00	A1	(11) International Publication Number: WO 94/23402 (43) International Publication Date: 13 October 1994 (13.10.94)
(21) International Application Number: PCT/AU94/00151 (22) International Filing Date: 29 March 1994 (29.03.94) (30) Priority Data: PL 8040 29 March 1993 (29.03.93) AU (71)(72) Applicants and Inventors: GARRICK, Gilbert, Alain, Lindsay [AU/AU]; 8 Penton Place, Gilmore, ACT 2905 (AU). GARRICK, Marie, Jeanette, Corinne [AU/AU]; 8 Penton Place, Gilmore, ACT 2905 (AU). (74) Common Representative: GARRICK, Gilbert, Alain, Lindsay; 8 Penton Place, Gilmore, ACT 2905 (AU).		(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, ES, FI, GB, GE, HU, JP, KG, KP, KR, KZ, LK, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report. With amended claims.

(54) Title: VERSATILE FIRE ALARM, EVACUATION AND EMERGENCY LIGHTING SYSTEM

(57) Abstract

A fire alarm, evacuation and emergency lighting system comprising of battery eliminators/field device controllers fitted or connected to smoke alarms, single point evacuation sounders, single point evacuation/emergency lights, single point visual alarm devices, audio-visual alarm devices, all the above devices being connected to a control and indicating equipment through two common conductors to provide common alarm communication so that if one smoke alarm on a circuit detects smoke, and latches into alarm mode, sounders and lights of all other devices connected to the circuit wiring, including sounders of other smoke alarms, are activated. The system incorporates the following features: (A) common alarm communication between all circuit devices, (B) smoke alarm latched alarm indication, (C) smoke alarm remote latched alarm indication, (D) smoke alarm remote testing and remote silencing facilities, (E) indications for alarm and open circuit fault conditions of the circuit at the control and indicating equipment, (F) further indications at the control and indicating equipment of a 3 conductor wiring system to indicate which smoke alarm on the circuit has latched into alarm mode.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

VERSATILE FIRE ALARM, EVACUATION AND EMERGENCY LIGHTING SYSTEM

This invention relates to a versatile Fire Alarm, Evacuation, and Emergency Lighting System which can be wired using two or three common conductors. The System consists of the following:

(1) **BATTERY ELIMINATOR/FIELD DEVICE CONTROLLER AND SMOKE ALARMS**

The Battery Eliminator/Field Device Controller is a device which can be incorporated into an internally energised, externally energised or internally and externally energised smoke alarm to make it operational on a central power supply without the use of battery/batteries internal to the smoke alarm and with little or no modification to the alarm device. The smoke alarms referred to previously are those of the stand alone or interconnectable types which are commercially available.

The Battery Eliminator/Field Device Controller consists of terminals/connectors for incoming and outgoing wiring, resulting in the smoke alarms being interconnectable on a common circuit with other similar smoke alarms fitted with Battery Eliminators/Field Device Controllers, and battery snaps or connectors for connection of each Battery Eliminator/Field Device Controller to its corresponding smoke alarm. Alternatively the Battery Eliminator/Field Device Controller can be connected to the smoke alarm through soldered joints or terminals/connectors.

The Battery Eliminator/Field Device Controller can be installed inside the smoke alarm in the battery space or in any available space, or incorporated into a separate base attached or adjacent to the smoke alarm, or built into the smoke alarm as part of its internal electronic circuit, or remotely mounted from the smoke alarm with wiring between the alarm device and the Battery Eliminator/Field Device Controller.

The Battery Eliminator/Field Device Controller may include any or all of the following additional features:

- (A) A power available light or led indication. The indication may be constant, or flashing to reduce power consumption.
- (B) A latching light or led indication to indicate that the smoke alarm is or has been in alarm condition. The latching indication may be coupled to a time delay circuit to prevent latching of the indication in case of short false alarms or when the smoke alarm is powered up.

If the power available indication as described in section (a) above is of the flashing type, this indication and the latching indication as described in this section can be through a common led or light which would be permanently lit under an alarm condition.

The latching light or led indication is mounted at the battery Eliminator/Field Device Controller or at a location remote from the Battery Eliminator/Field Device Controller. Alternatively, two simultaneous latching indications can be provided, one at the Battery Eliminator/Field Device Controller and another one at a remote location.

- (C) A signalling circuit which provides a signal to the control and indicating equipment through the system wiring to indicate that the last smoke alarm on the circuit is operating normally and that there is no open circuit fault in the wiring system. When this signal is no longer provided, as in the case of an open circuit condition on the wiring system or the last smoke alarm on the circuit being faulty, the control and indicating equipment would then display a fault and/or carry out any other function associated with this condition.

Alternatively, the signalling circuit may be installed external to the last smoke alarm on the circuit as a separate end-of-line device to allow monitoring of the wiring for open circuit faults.

The fault monitoring signal is transmitted over the 2 conductor wiring system if the signalling circuit is integral to the Battery Eliminator/Field Device Controller. If a 3 conductor wiring system is preferred, the third conductor is then used to transmit the signal for fault monitoring and the signalling circuit is an end-of-line device external to the last smoke alarm on the circuit.

- (D) A signalling circuit which provides a signal to the control and indicating equipment through the system wiring when a smoke alarm is in alarm condition. The signal transmission can be immediate or delayed in time to prevent transmission of an alarm signal in the case of short false alarms or when the smoke alarm is powered up.

This alarm signal is transmitted over the system 2-conductor wiring or, if a 3-conductor wiring system is preferred, over the third conductor.

- (E) A signal processing circuit which, on receipt of a signal from the control and indicating equipment through the system wiring, causes the sounders or lights of all smoke alarms on the circuit to be activated, all the circuit smoke alarms being fitted or connected to Battery Eliminators/Field Device

Controllers incorporating the signal processing circuit as described in this sub-section.

The signal from the control and indicating equipment is transmitted through the circuit wiring only if an alarm has been registered at the control and indicating equipment for that particular circuit.

- (F) A smoke alarm silencing facility if the Battery Eliminator/Field Device Controller is mounted remotely from the smoke alarm. An example of this situation is when a smoke alarm is mounted on the ceiling and the battery eliminator/field controller is located on the wall with control wiring run between both devices. In this case, the common wiring system is brought to the Battery Eliminator/Field Device Controller and not directly to the smoke alarm.

The silencing of the smoke alarm is achieved by turning off the power to the smoke alarm for period which, generally, does not exceed 15 minutes. The silencing facility is automatically reset after the off period so that the smoke alarm is restored to its full operational condition. The silencing of the smoke alarm at the remote location is through a non-latching switch such as a momentary push button or toggle switch.

- (G) A smoke alarm testing facility if the Battery Eliminator/Field Device Controller is remotely mounted from the smoke alarm and if the smoke alarm has provision for a test facility to electrically simulate the presence of smoke in the sensing assembly. The testing of the smoke alarm at the remote location is through a non-latching switch such as a momentary push button or toggle switch.

(2) CONTROL AND INDICATING EQUIPMENT

The control and indicating equipment consists of the following components:

- (A) An extra low voltage power supply, normally 10-12V DC, derived from the mains supply system through a step down transformer, a rectifying circuit and a voltage regulator circuit. This extra low voltage power supply is the main power source for all alarm, evacuation and emergency lighting circuits connected to the control and indicating equipment.
- (B) A battery charger which is used to charge a battery or a set of batteries, normally of the 12V type, the stored energy being used to power the system in the event of a loss of mains supply.
- (C) An alarm signal processing circuit, one for each alarm, evacuation and emergency lighting circuit connected to the control and indicating

equipment. The alarm signal processing circuit registers circuit alarm conditions and provides indications, visual, aural or both, to enable the circuit in alarm condition to be traced back.

If a 3-conductor wiring system is used, an indication is also provided at the control and indicating equipment to identify which detector is or was in alarm condition.

- (D) A fault signal processing circuit, one for each alarm, evacuation and emergency lighting circuit, to enable the control and indicating equipment to recognise the following conditions:
 - (i) That the last smoke alarm of a two conductor circuit wiring is operating normally and that there is no open circuit fault on the wiring system. In this case, the fault monitoring signal is provided by a signalling circuit incorporated into the Battery Eliminator/Field Device Controller of the last smoke alarm on the circuit.
 - (ii) That there is no open circuit fault on the 2 or 3 conductor wiring system. In this case, the fault monitoring is provided by an end-of-line device which is external to the last smoke alarm on the circuit.
- (E) A signalling circuit which provides a signal on the circuit wiring system when an alarm has been registered at the control and indicating equipment for that particular circuit. This signal causes all lights, sounders and flashing lights of all single point evacuation sounders, single point evacuation/ emergency lights, single point visual alarms, audiovisual visual alarms, and smoke alarms fitted with Battery Eliminators/Field Device Controllers which are connected on the circuit to be activated.

Alternatively, the signal can also be fed to other alarm, evacuation and emergency lighting circuits so as to alert occupants in a large area of the protected premises of an alarm being registered at the control and indicating equipment for a circuit covering a smaller area of the protected premises.
- (F) Optional additional control circuits for carrying out other ancillary functions namely the activation of audio, visual, or audiovisual devices such as sirens, bells or flashing lights under alarm condition; the control of magnetic doorholders, sliding doors, and the automatic dialling of an emergency telephone number through an auto-dialler.
- (G) Optional additional circuits for the provision of mimic outputs to allow the remote monitoring of all displayed indications of the control and indicating equipment.

- (H) Indications for low battery supply, power available, circuit/last detector fault or circuit alarm conditions.
- (I) Test switches for testing the battery system and for testing the fault and alarm monitoring functions of the control and indicating equipment.
- (J) Optional additional circuits for muting and/or isolating alarm, evacuation and emergency lighting circuits.
- (K) Optional reset switches, one for each circuit, for restoring alarmed or activated circuits to their quiescent condition.

(3) SINGLE POINT EVACUATION SOUNDERS

A single point evacuation sounder consists of the following components:

- (A) Terminal/connectors for incoming and outgoing circuit wiring.
- (B) A signal processing circuit which, on receipt of a signal from the control and indicating equipment through the system wiring causes the sounder incorporated into the device to be activated.
- (C) A test switch to test the operation of the single point evacuation sounder.
- (D) A battery and battery charger. The battery is kept fully charged until an alarm is registered at the control and indicating equipment when the stored energy of the battery is used to power the sounder.

This feature of a local battery/battery charger has the advantage that more powerful sounders may be installed without imposing a huge current draw on the central power supply under alarm conditions.

Single point evacuation sounders incorporating a battery/battery charger can only be connected to a 3 conductor wiring system.

Single point evacuation sounders not equipped with batteries may be installed on both a 2 conductor and 3 conductor wiring system.

(4) SINGLE POINT EVACUATION/EMERGENCY LIGHTS

The single point evacuation/emergency light is similar to the single point evacuation sounder described in section (3) above except that the unit incorporates a light instead of a sounder.

(5) **SINGLE POINT VISUAL ALARM DEVICES**

The single point visual alarm device is similar to the single point evacuation sounder described in section (3) above except that the unit incorporates a flashing light or rotating light instead of a sounder.

(6) **AUDIOVISUAL VISUAL ALARM DEVICES**

The audio-visual alarm device incorporates the features of single point evacuation sounders and single point visual alarm devices described in sections (3) and (5) above in one unit.

An embodiment of the invention using a two conductor wiring system as well as another embodiment of the invention using a three conductor wiring system are described in detail in the following sections and are supported by the accompanying drawings. The drawings illustrate how the invention may be put into effect, so that the specific form and arrangement of the various features as shown is not understood as limiting on the invention.

(7) **TWO-CONDUCTOR WIRING SYSTEM**

Drawings Nos 1,2,3 show three of the various forms of Battery Eliminators/Field Device Controllers.

Drawing No 4 shows the general arrangement of a typical fire alarm, evacuation and emergency lighting circuit using a two-conductor wiring system. Drawing No 5 is a schematic diagram showing some of the various types of circuits which can be connected to and controlled by the control and indicating equipment.

The system operation is as follows:

- (A) Referring to Drawing No 6 which is the wiring diagram of one form of the Battery Eliminator/Field Device Controller, the circuit wiring is connected to the Battery Eliminator/Field Device Controller at the positive terminal 3 and negative (common) terminal 4. The circuit quiescent voltage, normally 10 volts DC derived from the power supply/voltage stabiliser of the control and indicating equipment, is applied to the smoke alarm through transistors Q6 and Q1 and resistor R1. The voltage drop across each transistor is approximately 0.6V whereas the drop across R1 is negligible under quiescent or no alarm condition. The voltage effectively applied to the smoke alarm under quiescent condition is therefore approximately equal to 8.8V, voltage which is within the operational range of the 9V smoke alarm.

Under quiescent circuit conditions, transistors Q1 conducts so that the 3V zener diode Z1 has little effect on the voltage drop across Q1 and R1.

Resistors R2 and R12 provide base current to transistors Q1 and Q6 respectively so that they are both maintained in the conducting mode under quiescent conditions.

Because the voltage drop across R1 is negligible when there is no alarm, transistor Q10 is turned off so that practically no voltage exists across C1. The darlington pair made up of transistors Q3 and Q4 is turned off resulting in the LED 1 and the remote LED being turned off as well.

- (B) When smoke is detected by the smoke alarm and its sounder operates, the voltage drop across resistor R1 is no longer negligible and is sufficient to turn transistor Q10 fully on. Transistor Q10 in turn charges capacitor C1 through resistor R6. The discharge rate of capacitor C1, mainly governed by resistor R7, is such that the darlington pair, Q3 and Q4, remain in the conducting mode even though the current drawn by the smoke alarm and sensed by resistor R1 fluctuates with the intermittent beeping of the smoke alarm sounder. As a result of this, LED 1 and the remote LED are permanently lit when smoke is detected by the smoke alarm.
- (C) The operation of the smoke alarm sounder and the led's when smoke is detected results in the circuit current increasing well above the circuit quiescent current. This current is detected at the control and indicating equipment, and if the high level of current is maintained for a period of time, normally between 5 and 10 seconds, the alarm is registered at the control and indicating equipment. At the same time, control circuits of the control and indicating equipment cause the circuit line voltage to increase from 10V DC to approximately 12V DC.
- (D) The higher circuit line voltage causes sufficient voltage to be dropped across R9, in series with the 10V zener diode Z2, to turn transistor Q5 on. This causes the voltage across R15 to go high, turning transistor Q2 on.

When transistor Q2 is turned on, base current to transistor Q1 is diverted to ground, causing Q1 to turn off. The current drawn by the smoke alarm is then through the 3V zener diode Z1 only. Thus, under alarm conditions, the voltage applied to the smoke alarm is the line voltage, 12V DC, less the voltage drops across Q6 and Z1. The voltage then applied to the smoke alarm is therefore approximately equal to 8.4V DC which is within the operating voltage range of the smoke alarm.

The rise in voltage across R15 also has the following additional effects:

- (i) The voltage at terminal 2 goes high.
- (ii) The voltage at terminal 1 goes low and is nearly equal to ground potential.

- (iii) As Q2 is turned on, current also flows to ground through Z1, R4 and D2 to maintain the zener voltage drop around 3V.
 - (iv) Voltage is fed back to the base of transistor Q3 through optocoupler IC1, R5 and D4 to cause the led indications of the smoke alarm where smoke was detected to latch.
 - (v) Since Q1 is turned off by the operation of Q2, no current flows through R1 resulting in transistor Q10 of all Battery Eliminators/Field Device Controllers to be turned off. This ensures that the led indications of all Battery Eliminators/Field Device Controllers are turned off except those of the Battery Eliminator/Field Device Controller fitted or connected to the smoke alarm where smoke was detected.
- (E) Under alarm conditions, the sounders of all smoke alarms on the circuit in alarm are activated. This is achieved in the following manner:
- (i) Connecting terminal 2 or 1 of the Battery Eliminators/Field Device Controllers to the interconnect terminal of their corresponding smoke alarm as explained below.

Smoke alarms with interconnect terminals for common alarm communication operate in one of two possible ways, namely:

- (a) the interconnect terminal is grounded to achieve common alarm communication. Thus, if terminal 1 of the Battery Eliminator/Field Device Controller is connected to this interconnect terminal, when transistor Q2 is turned on under an alarm condition, this effectively grounds the interconnect terminal through D3 and Q2 resulting in common alarm communication.
- (b) the interconnect terminal is brought to a voltage near or at the positive supply rail potential to achieve common alarm communication. Thus, if terminal 2 of the Battery Eliminator/Field Device Controller is connected to this interconnect terminal, the voltage of this terminal goes high under an alarm condition resulting in common alarm communication. If common alarm communication is achieved by connecting either of terminals 1 or 2 of the Battery Eliminator/Field Device Controller to the smoke alarm interconnect terminal, then no modification of the smoke alarm device is required.

- (ii) Simulating the closure of the smoke alarm test switch if the smoke alarm is provided with a test facility to electrically simulate the presence of smoke in the smoke sensing assembly.

Smoke alarms with a test facility to electrically simulate the presence of smoke in the sensing assembly operate in one of two possible ways, namely:

- (a) by closing the switch to ground, the smoke alarm sounder is activated. Thus, if Terminal 1 of the Battery Eliminator/Field Device Controller is connected to the appropriate side of the switch, the required grounding is achieved under an alarm condition resulting in the sounder of the smoke alarm to be activated
 - (b) by closing the switch to the positive supply rail, the smoke alarm sounder is activated. Thus if Terminal 2 of the Battery Eliminator/Field Device Controller is connected to the appropriate side of the switch, the closure of the switch is simulated resulting in the sounder of the smoke alarm to be activated under an alarm condition.
- (F) If the Battery Eliminator/Field Device Controller is remotely mounted, such as on a wall, a remote silencing facility can be provided which operates as follows:
- (i) By closing the momentary action, normally open push-button PB1, capacitor C2 is charged to the positive supply rail potential. Transistor Q8 then receives base current through R13 so that the darlington pair consisting of transistors Q8 and Q7 is turned on. This diverts base current from transistor Q6 which turns off. This effectively turns off the power to the smoke alarm connected to the Battery Eliminator/Field Device Controller.
 - (ii) When the push button is released, the stored energy of capacitor C2 drives transistor Q7 and Q8 for a period of time which generally does not exceed 15 minutes. During that period, the smoke alarm is silenced as its power supply is interrupted.
- (G) If the Battery Eliminator/Field Device Controller is remotely mounted, such as on a wall, a remote test facility can be provided if the smoke alarm has a test facility to electrically simulate the presence of smoke in the smoke sensing assembly. The operation of the remote testing facility is as follows:

- (i) By closing the momentary action, normally open push-button PB2, terminal 2 of the Battery Eliminator goes high. If terminal 2 is connected to the appropriate side of the test switch by wiring run between the Battery Eliminator/Field Device Controller and the smoke alarm, the method described in section E(ii)(b) above can be used to remotely test the smoke alarm.
 - (ii) Closure of the push-button also supplies base current to transistor Q9 through resistor R14 resulting in the transistor being turned on. This effectively grounds terminal 1 of the Battery Eliminator/Field Device Controller. If terminal 1 is connected to the appropriate side of the test switch by wiring run between the Battery Eliminator/Field Device Controller and the smoke alarm, the method described in section E(ii)(a) above can be used to remotely test the smoke alarm.
- (H) Referring to Drawing No 7, which gives the schematic diagrams for single point evacuation sounders, single point evacuation/emergency lights, audio-visual alarm devices and single point visual alarm devices, the operation of these devices is as follows:
- (i) Under quiescent conditions, the voltage applied between terminals 3 and 4 is 10V DC resulting in practically no voltage being dropped across resistor R2 in series with a 10V zener diode Z1. Transistor Q1 is turned off so that the evacuation/emergency light, the visual alarm device, the evacuation sounder, or the audio-visual alarm device does not operate.
- Under an alarm condition, the voltage between terminals 3 and 4 is increased to 12V DC resulting in sufficient voltage drop across R2 to turn transistor Q1 fully on. This results in the operation of the evacuation/emergency light, the visual alarm device, the evacuation sounder or the audiovisual alarm device.
- (I) Referring to Drawing No 9, which is a schematic diagram of the control and indicating equipment, the operation of the control and indicating equipment is as follows:
- (i) Mains supply voltage is transformed by transformer T1 into an extra low voltage which is used to supply the rectifier/voltage regulator circuits. Thus, a regulated supply of 10V DC is made available to power field devices under quiescent conditions. A 13.8V DC regulated supply is also available to charge the 12V battery through current limiting resistor R1.

If there is a mains failure, the battery voltage is applied to the voltage regulator VR1 through diode D3 to maintain the 10V DC quiescent supply voltage to field devices.

- (ii) The voltage developed across R2 by the circuit current is applied to the (+) pin of comparator IC1. This voltage is less than that applied to the (-) pin of IC1 under quiescent conditions so that the output of IC1 is low.

Under alarm conditions, the voltage across resistor R2 increases, making the (+) pin of IC1 more positive than the (-) pin. The output of IC1 goes high, thus charging capacitor C1 through R7 and D11. Values of R7 and C1 are chosen to give a delay of 5 to 10 seconds before the (+) pin of IC2 become more positive than the (-) pin. When this occurs, the output of IC2 goes high driving the relay REL and LED1 alarm indication. The high output voltage of IC2 is also fed back to its (+) input terminal making transistor Q1 latch in conduction mode.

If the alarm current flows through R2 for less than the set delay time of 5 to 10 seconds, the output of IC1 goes low and capacitor C1 is rapidly discharged through diode D10. Thus the charging cycle is interrupted before IC2 latches into high output mode.

- (iii) As an alarm is registered at the control and indicating equipment and transistor Q1 latches on, the normally open contacts of the relay REL close. Thus, the supply voltage to field devices increases to approximately 12V since the battery voltage is then applied directly to the positive supply rail through diode D4 and closed relay contact RC1. Relay contact RC2 also closes, avoiding any unnecessary voltage drop across R2 when all the field devices are activated.
- (iv) Fault monitoring at the control and indicating equipment is achieved in the following manner:
 - (a) The quiescent current of a smoke alarm is very small and at intervals of no more than 60 seconds, the smoke alarm tests its own battery by briefly increasing the battery current draw and detecting if the voltage under load is above a certain value.

Referring to Drawing No 6, this brief test current is sensed by resistor R1 causing LED1 and the remote LED to flash indicating that power is available to the smoke alarm. The brief surge of current, although detected by IC1 at the

control and indicating equipment, is too brief to activate an alarm.

- (b) By changing the value of capacitor C1 and resistor R7 of the Battery Eliminator/Field Device Controller of the last smoke alarm on the circuit, and by decreasing the value of resistor R8 in series with the remote LED and LED1, a current pulse of one second is achieved which is detected by IC1 at the control and indicating equipment. Although this current pulse is not long enough to cause IC2 to latch in alarm, it is used for fault monitoring in the following manner.
- (c) The fault monitoring current pulse from the last smoke alarm on the circuit causes the output of IC1 to go high for one second. This charges capacitor C3 through R13, the voltage across capacitor C3 becoming more positive than that of the (-) pin of IC3 after 0.8 second. Therefore, for a period of 0.2 second the output of IC3 goes high and capacitor C2 is almost instantly charged through diode D13 and resistor R11 of relatively low resistance value.
- (d) The charge on capacitor C2 is applied to the (-) pin of IC4 and is sufficiently positive to send the output of IC4 low. This results in LED2 being extinguished indicating that the last smoke alarm is operating normally and that there is no open circuit fault on the circuit wiring.
- (e) The discharge resistor R10 is of such resistance value than more than 60 seconds are required for the voltage across C2 to drop below the voltage at the (+) pin of IC4. Since the last smoke alarm generates the fault monitoring current pulses at intervals not exceeding 60 seconds, the fault indication will not operate unless the fault monitoring pulse is no longer received because of the last smoke alarm being faulty or because the circuit wiring has an open circuit fault.
- (v) After the control and indicating equipment has registered an alarm for any circuit, the circuit can be reset by operating switch S1 which discharges capacitor C1 to ground through resistor R18.

8. THREE-CONDUCTOR WIRING SYSTEM

Drawing Nos 10, 11, 12 show three of the various forms of Battery Eliminators/Field Device Controllers.

Drawing No 13, shows the general arrangement of a typical fire alarm, evacuation and emergency lighting circuit using a three conductor wiring system. Drawing No 14 is a schematic diagram showing some of the various types of circuits which can be connected and controlled by the control and indicating equipment.

The system operation is as follows:

- (A) Referring to Drawing No 8 which is the wiring diagram of one form of Battery Eliminator/Field Device Controller.

The operation of the Battery Eliminator/Field Device Controller is essentially the same as that of the Battery Eliminator/Field Device Controller described for a 2-conductor wiring system except for the following:

- (i) The values of resistors R6 and R9 and the value of capacitor C1 are chosen so that the darlington pair consisting of transistors Q3 and Q4 is not turned on unless the sounder of the smoke alarm has been operating for a period of time, normally between 5 and 10 seconds. Therefore, if smoke is sensed by the smoke alarm for that period of time, Q3 and Q4 are turned on to drive LED1 and the remote LED. The current drawn by the LED's causes a voltage drop across resistor R8 which turns transistor Q11 on.
- (ii) When transistor Q11 is turned on, an output from its collector is used to cause the led indications to latch by supplying base current to transistor Q3 through R5 and D4.
- (iii) The collector voltage of Q11 goes high when Q11 is turned on so that a fixed voltage, equal to the rated voltage of zener diode Z3, is applied to R17 and D8, one end of which is connected to a terminal to which the third conductor of the wiring system is joined.

The resistance value of resistor R17 is different for each Battery Eliminator/Field Device Controller connected to the circuit resulting in a unique voltage value being developed across the fixed resistor R2 of the control and indicating equipment (refer to Drawing No 15) for each smoke alarm on the circuit when the smoke alarm detects smoke for the specified period of 5 to 10 seconds. It should be noted that, under quiescent conditions, the voltage across Z3 zener diodes of all Battery Eliminators/Field Device Controllers on the circuit is practically zero volt.

- (iv) The voltage across resistor R2 of the control and indicating equipment is fed to the input of a dot-graph display IC. Thus, under

latched alarm condition of any smoke alarm on the circuit, a voltage is applied to the input of the dot-graph display which is unique to that particular smoke alarm and the IC then displays an alarm for that particular smoke alarm at the control and indicating equipment.

- (v) Once an alarm has been registered at the control and indicating equipment for any smoke alarm on the circuit, control circuits of the control and indicating equipment operate a relay which increases the voltage supplied to the circuit from 10V DC to approximately 12V DC. This higher voltage results in transistor Q10 of all Battery Eliminators/Field Device Controllers connected to the circuit to turn off. Thus, only the smoke alarm where smoke was detected will be latched in alarm mode and have its LED indications operating.
- (vi) Open circuit fault monitoring is achieved using an end-of-line device external to Battery Eliminators/Field Device controllers. Referring to Drawing No 16, the diode section of the optocoupler IC1 will conduct only if there is no open circuit on the positive and negative supply rails. Under this condition, a voltage is applied to the third conductor of the wiring system through the photo-transistor of the opto-coupler, resistor R1, and diode D1. This voltage is detected at the control and indicating equipment which is designed to display a fault when this voltage is lost.

The fault indication operates if an open circuit exists on any of the three conductors of the wiring system.

The fault monitoring voltage detected at the control and indicating equipment is very small and therefore does not affect the operation of the dot-graph display IC.

- (B) Referring to Drawing No 15, the circuit diagram of the 3 conductor system control and indicating equipment.

The operation of the control and indicating equipment for a three conductor wiring system is essentially the same as that described for a two conductor wiring system except for the following:

- (i) Detection of open circuit fault

When all three conductors are sound and no open circuit exists on the three conductor wiring, a small voltage is present across R2 through the action of the end-of-line device as described previously. This small voltage is applied to the (-) input terminal of IC1 and is greater than the voltage of the (+) input terminal. Thus, the output

of IC1 is low when no open circuit fault exists on the wiring resulting in transistor Q2 being turned off. Consequently, the fault indication does not operate LED12 is turned off.

If any of the circuit three conductors develops an open circuit fault, the voltage across R2 is lost and the (+) input terminal of IC1 now becomes more positive than the (-) input terminal. This causes the output of IC1 to go high, driving transistor Q2 and operating the fault led indication.

(ii) Detection of an alarm condition

When a smoke alarm latches into alarm mode after smoke had been detected for the specified period of 5 to 10 seconds, the voltage drop across R2 is applied to the input terminal 5 of the LM3914 dot-graph display IC2. The unique voltage associated with each smoke alarm causes a led corresponding to that particular smoke alarm to be activated to indicate that the smoke alarm has detected smoke. The circuit diagram of the control and indicating equipment shows ten such indications, however, a much larger display can be achieved by cascading two or more LM3914 dot-graph display IC's.

Whenever an alarm is displayed for any smoke alarm on the circuit, the diode section of optocoupler IC3 conducts to turn the photo-transistor of the optocoupler fully on. The photo-transistor supplies base current to transistor Q1, through resistor R10 to operate relay REL and the circuit alarm indication, LEDII.

Relay REL, when operated, raises the circuit voltage to 12V in a manner which has already been described for the control and indicating equipment of the two conductor wiring system.

- (C) Single point evacuation sounders, single point evacuation/emergency lights, audio-visual alarm devices and single point visual alarm devices as described for the two conductor wiring system may be used on the three conductor wiring system. Their operation is identical to that previously described for the two conductor wiring system. (refer to Drawing No 7). However, a three conductor wiring system offers the added advantage that these devices can be fitted with a battery and battery charger to activate more powerful sounders and lights under alarm conditions without the inconvenience of a heavy current being drawn from the central power supply (refer to Drawing No 17). The operation of such devices fitted with batteries/battery charger is as follows:

- (i) Under quiescent condition the power supply of the control and indicating equipment is used to charge the local battery.
- (ii) Under alarm conditions, transistor Q1 is turned on and the charged battery supplies current to activate the lights and/or sounders.

The purpose of this invention is to provide a much improved and versatile system of fire detection, evacuation and emergency lighting which overcomes a number of the limitations of currently available systems. These limitations are as follows:

- (a) Available systems which provide common alarm communication to operate sounders of all smoke alarms on a circuit, use a minimum of three conductors. This invention allows the same facility over a 2 conductor wiring.
- (b) If individual alarm indications are required at the control and indicating equipment for each smoke alarm in a building, currently available systems can fulfil this requirement in one of the following two ways:
 - ◆ By wiring the smoke alarms individually, that is one smoke alarm per circuit.
 - ◆ By wiring the smoke alarm using two common conductors for power and separate conductors, one for each smoke alarm, which are wired back to the control and alarm indicating equipment. Both the above methods are inefficient, costly and complicated when compared to the three common conductor wiring system which is the subject of this invention.
 - ◆ Currently available systems have no provision for remotely testing or remotely silencing the smoke alarms. Therefore, if someone decides to operate these facilities, he or she has to reach the smoke alarm in order to do so.

Since most households do not possess a proper ladder, most people have to resort to climbing on a chair or a piece of furniture in order to reach the alarm device. This can prove dangerous and can result in very serious accidents/injuries through falls.

Furthermore, in the case of the handicapped or the elderly, a remote silencing/testing facility such as that installed on a wall can be the only way that such persons can operate the test and/or silencing facility.

- ◆ The provision of remote indicators is a useful feature of this invention as this facility is lacking with current systems. Furthermore, the latching of the local and/or remote indications as achieved by this invention provides an easy and reliable way of tracing the source of smoke/fire.
- ◆ This invention allows the use of sounders, emergency lights, and audiovisual alarms on a circuit with smoke alarms to provide a fully blown fire alarm, evacuation and emergency lighting system. Currently available systems are limited to the provision of sounders and lights at the locations of smoke alarms only. Furthermore, the wattage of the smoke alarm lights of currently available systems are quite low and very often does not provide a functional illumination level, especially in buildings with high ceilings.

With this invention, a system can be provided with lights in any location, high or low, where they are required. Furthermore, if the lights or sounders are fitted with local batteries, powerful sounders and lights can be provided to achieve any level of sound/illumination required.

- ◆ The remote testing and silencing facilities provided by this invention allows these facilities to be activated even though the smoke alarms themselves may be inaccessible or hard to reach. Examples of such cases are:
 - (a) smoke alarms installed in concealed locations.
 - (b) smoke alarms installed in high ceiling areas, eg at apex of a raked ceiling or above a landing in a staircase.

DRAWING SCHEDULE1 Figure No 1

Showing one form of Battery Eliminator/Field Device Controller with power available and alarm led indication, terminals for incoming and outgoing wiring, and battery snaps for connection of device to smoke alarm.

2 Figure No 2

Showing Battery Eliminator/Field Device Controller with printed circuit incorporated in an enclosure.

3 Figure No 3

Showing Battery Eliminator/Field Device Controller incorporated in a base attached to the smoke alarm.

4 Figure No 4

Showing various type of field devices connected to the control and indicating equipment through a two common conductor wiring.

5 Figure No 5

Showing some of the various types of circuits that can be connected to the control and indicating equipment of a two conductor wiring system.

6 Figure No 6

Showing circuit diagram for one form of Battery Eliminator/Field Device Controller suitable for a two conductor wiring system.

7 Figure No 7

Showing circuit diagram of a field device incorporating a light and/or sounder without battery back-up.

8 Figure No 8

Showing circuit diagram for one form of Battery Eliminator/Field Device Controller suitable for a three conductor wiring system.

9 Figure No 9

Showing circuit diagram of control and indicating equipment for a two conductor wiring system.

10 Figure No 10

Showing Battery Eliminator/Field Device Controller remote from smoke alarm.

11 Figure No 11

Showing Battery Eliminator/Field Device Controller installed in a separate base adjacent to smoke alarm.

12 Figure No 12

Showing Battery Eliminator/Field Device Controller installed on a wall mounted plate and incorporating a test switch, a silence switch and a led indicator.

13 Figure No 13

Showing some of the various types of devices that can be connected to the control and indicating equipment of a three conductor wiring system.

14 Figure No 14

Showing some of the various types of circuits that can be connected to the control and indicating equipment of a three conductor wiring system.

15 Figure No 15

Showing circuit diagram of control and indicating equipment for a three conductor wiring system.

16 Figure No 16

Showing circuit diagram of an end-of-line device of a three conductor wiring system.

17 Figure No 17

Showing circuit diagram of a field device incorporating a light and/or sounder which is fitted with battery charger and local battery.

CLAIMS

- (1) A Fire Alarm, Evacuation and Emergency Lighting System comprising of Battery Eliminators/Field Device Controllers fitted or connected to smoke alarms, single point evacuation sounders, single point evacuation/emergency lights, single point visual alarm devices, audio-visual alarm devices, all the above devices being connected to a control and indicating equipment through two common conductors to provide common alarm communication so that if one smoke alarm on a circuit detects smoke, and latches into alarm mode, sounders and lights of all other devices connected to the circuit wiring, including sounders of other smoke alarms, are activated;
- (2) A system according to Claim 1, which, in combination with a third common conductor, provides an additional indication at the control and indicating equipment to indicate which smoke alarm on the circuit has latched into alarm mode;
- (3) A system according to Claims 1 and 2 which also provides a latching alarm indication at the smoke alarm or at a location remote from it, the latching indication being provided at the smoke alarm where smoke was detected;
- (4) A system according to Claims 1 and 2 which also provides remote testing of smoke alarms if the smoke alarms have provision for a test facility to electrically simulate the presence of smoke in the sensing assembly;
- (5) A system according to Claims 1 and 2 which also provides a remote silencing facility to cancel nuisance alarm;
- (6) A system according to Claims 1 and 2 which also provides indications at the control and indicating equipment for circuit alarm condition and circuit open-circuit fault condition.

AMENDED CLAIMS

[received by the International Bureau on 12 September 1994 (12.09.94);
original claims 1-6 replaced by new claims 1-7 (1 page)]

- (1) A Fire Alarm, Evacuation and Emergency Lighting System comprising of Battery Eliminators/Field Device Controllers fitted or connected to smoke alarms, single point evacuation sounders, single point evacuation/emergency lights, single point visual alarm devices, audio visual alarm devices, all the above devices being connected to a Control and Indicating Equipment through two common extra low voltage conductors, said two conductors being used for both power and communication, to provide common alarm communication so that if one smoke alarm on a circuit detects smoke, and latches into alarm mode, sounders and lights of all other devices connected to the circuit wiring, including sounders of other smoke alarms, are activated.
- (2) A system according to Claim 1 wherein the control and indicating equipment changes the d.c. voltage of the two extra low voltage power/communication conductors, when an alarm condition exists, so that the change in voltage can be detected by all circuit devices which are then activated.
- (3) A system according to Claims 1 and 2, which, in combination with a third common conductor, provides an additional indication at the control and indicating equipment to indicate which smoke alarm on the circuit has latched into alarm mode.
- (4) A system according to Claims 1, 2 and 3 which also provides a latching alarm indication at the smoke alarm or at a location remote from it, the latching indication being provided for the smoke alarm where smoke was detected.
- (5) A system according to Claims 1, 2 and 3 which also provides remote testing of smoke alarms if the smoke alarms have provision for a test facility to electrically simulate the presence of smoke in the sensing assembly.
- (6) A system according to Claims 1, 2 and 3 which also provides a remote silencing facility to cancel nuisance alarm.
- (7) A system according to Claims 1, 2 and 3 which also provides indications at the control and indicating equipment for circuit alarm condition and circuit open-circuit fault condition.

AMENDED SHEET (ARTICLE 19)

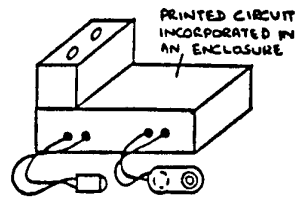


FIG 1

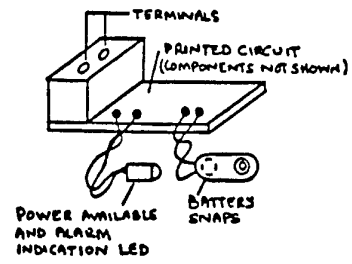


FIG 2

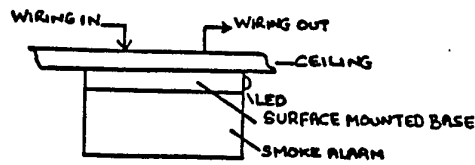


FIG 3

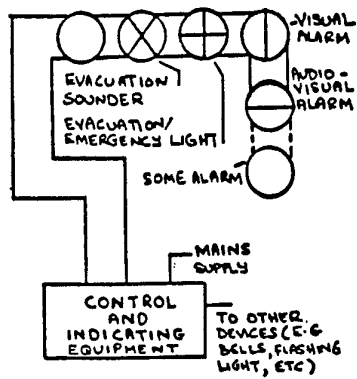


FIG 4

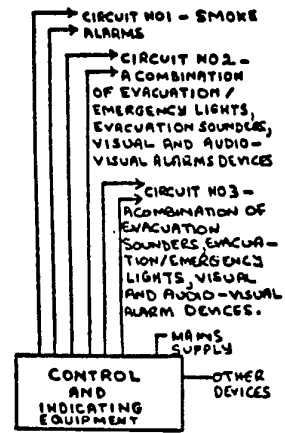


FIG 5

2/7

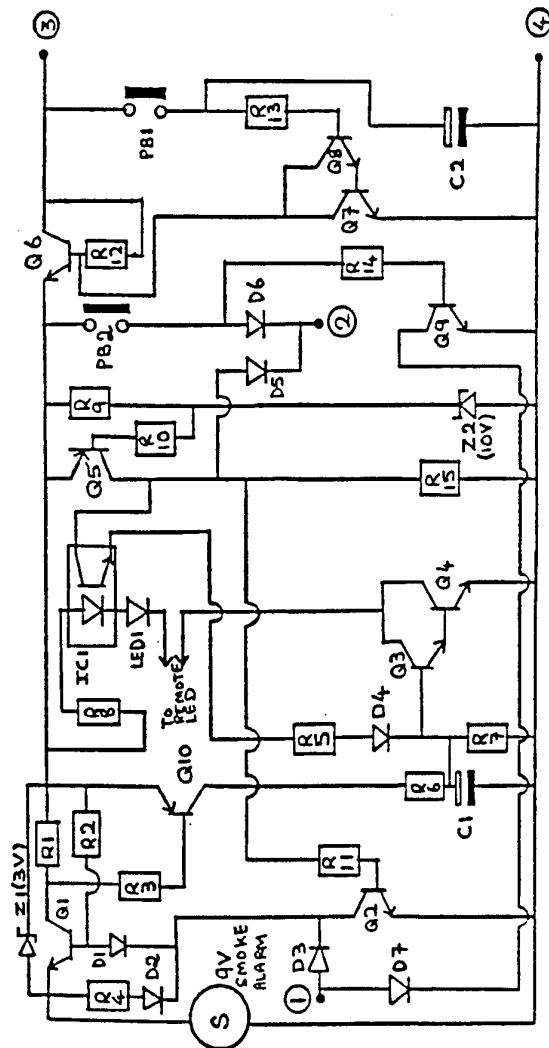


FIG 6

3/7

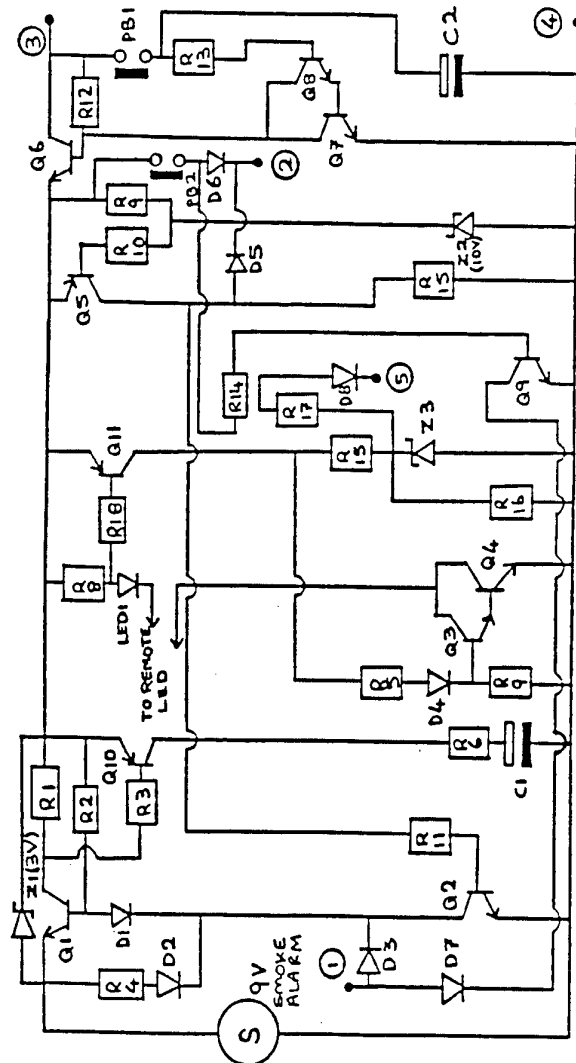


FIG 8

4/7

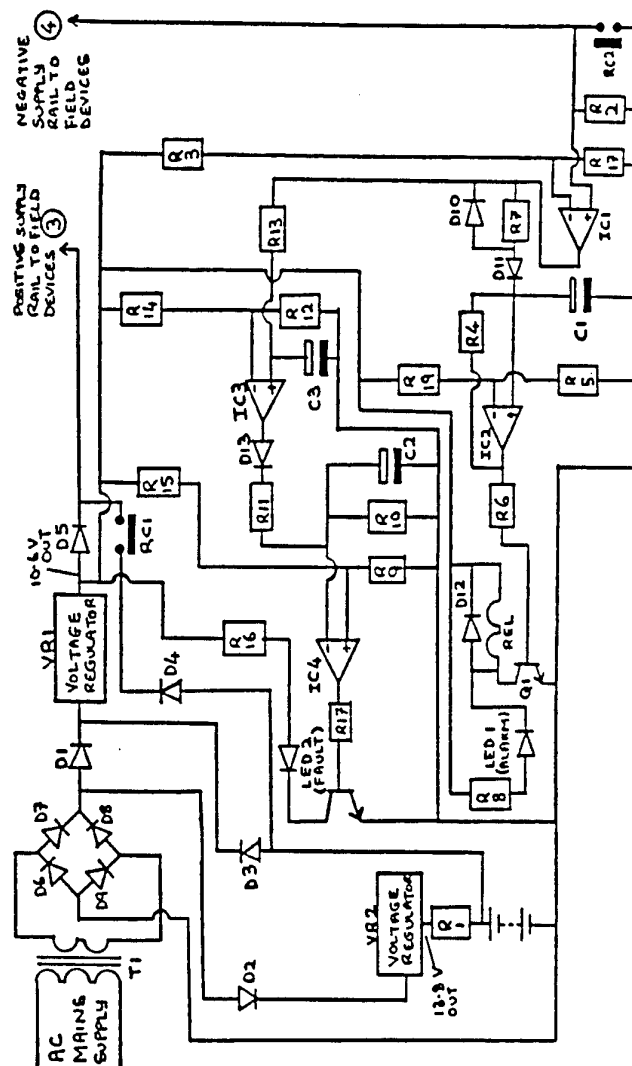


FIG 9

5/7

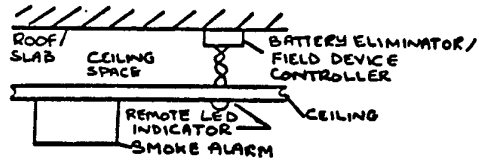


FIG 10

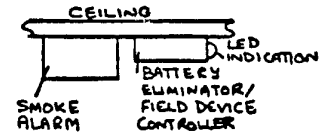


FIG 11

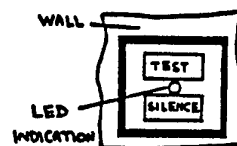


FIG 12

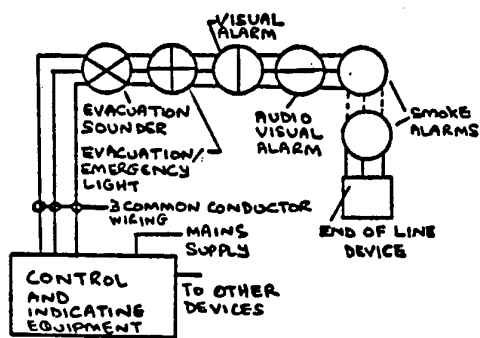


FIG 13

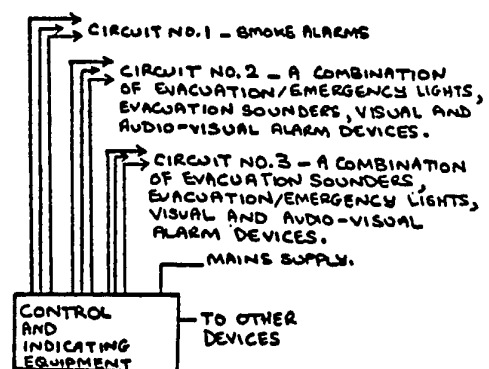


FIG 14

6/7

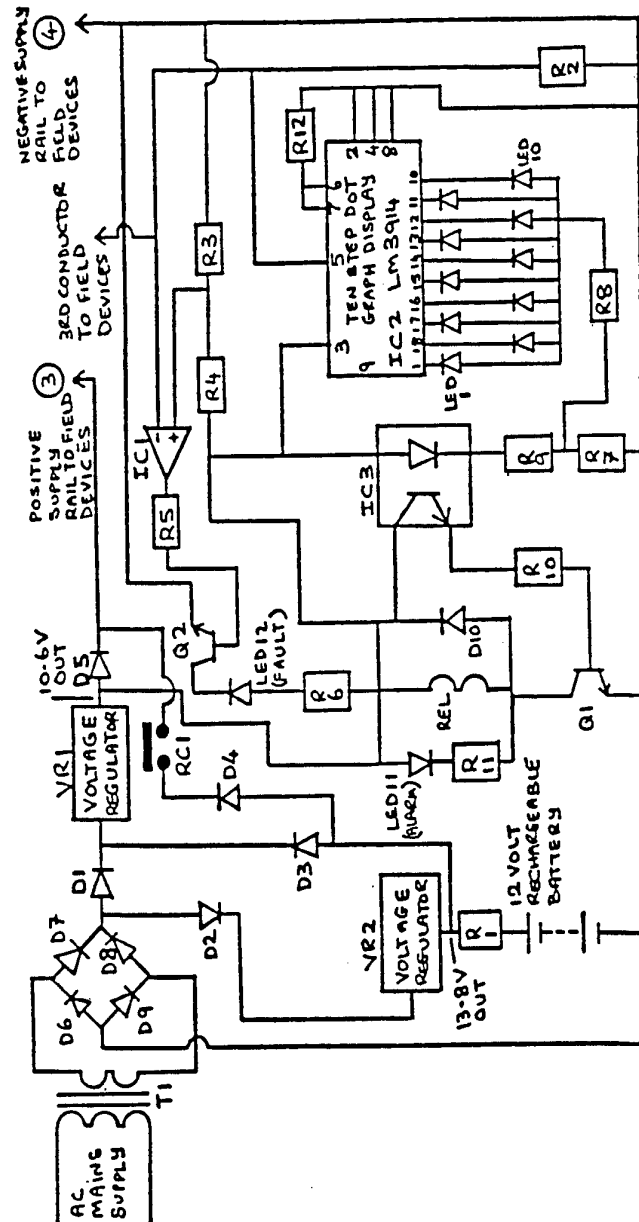


FIG 15

7/7

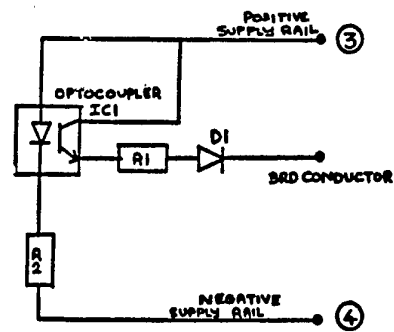


FIG 16

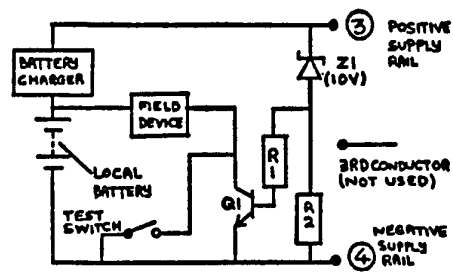


FIG 17

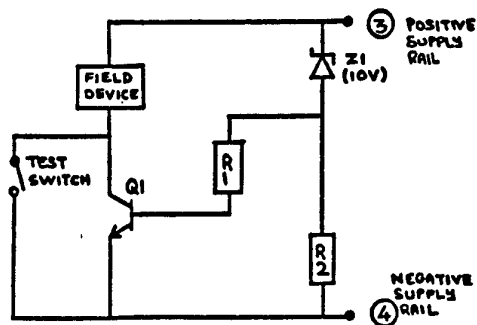


FIG 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 94/00151

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl. ⁵ G08B 25/00, 27/00, 17/00 According to International Patent Classification (IPC) or to both national classification and IPC					
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC G08B 25/00, 25/01, 25/04, 25/06, 25/08, 25/10, 25/12, 25/14, 27/00 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU: IPC as above Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)					
C. DOCUMENTS CONSIDERED TO BE RELEVANT					
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.			
Y	EP,A, 102229 (MONICELL LTD) 7 March 1984 (07.03.84) whole document	1,2,5,6			
Y	WO,A, 91/10980 (OY SAPAL SECURITY LTD) 25 July 1991 (25.07.91) whole document	1,3,5,6			
Y	GB,A, 2226901 (CLEETON) 11 July 1990 (11.07.90) whole document	1,2,5,6			
Y	GB,A, 2254174 (NITTAN COMPANY LIMITED) 30 September 1992 (30.09.92) whole document	1,3,5,6			
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.					
<table style="width: 100%; border: none;"> <tr> <td style="width: 33%; vertical-align: top;"> * Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 33%; vertical-align: top;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family </td> <td style="width: 33%;"></td> </tr> </table>			* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family				
Date of the actual completion of the international search 5 July 1994 (05.07.94)	Date of mailing of the international search report 15 July 1994 (15.07.94)				
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer  D.BARNES Telephone No. (06) 2832198				

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
Y	EP,A, 490836 (G.P.B.BEGHELLI Srl) 17 June 1992 (17.06.92)	1,2,5,6
Y	whole document	1,3,5,6
	whole document	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
EP	102229	JP	59094198		
WO	9110980	AU NO	69094/91 922766	CA	2073854
		FI	900209		
GB	2226901	GB	8900502		
GB	2254174	GB	9204085	JP	4295991
EP	490836	CA	2056961		
END OF ANNEX					