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# (54) Alarm and signalling systems

(57) An intruder and/or fire alarm system uses mains-borne signalling between a central control unit (40) and slave sensor units (32). The sensor units are mounted on or adjacent a socket outlet (20) or lighting point (22) and signalling is *via* the neutral and earth of the mains supply. The control unit cyclically polls the sensor units which respond in turn, and prolonged absence of either a request or a response causes an alarm condition. When transmitting each unit monitors the mains cable to detect interference thereon and in the presence or anticipated presence of interference inhibits transmission. The control unit can be integral with a standard (e.g. 13 amp) plug (Fig. 7) so as to be movable around the installation. To avoid problems on disconnection a double-pole electronic switch is included between the supply and the units which is controlled by a common control unit such as a microswitch on the back of the plug. In the event of failure of the mains supply integrity is maintained by back-up batteries at the units, and battery consumption is minimised at the sensor units by only switching the sensors on when they are polled by the control unit. In normal conditions they are on continuously. A door entry keypad is provided, the keys of which are unidentified until a predetermined portion of the keypad is depressed, whereupon the keys are illuminated to permit entry of an identification code (PIN).

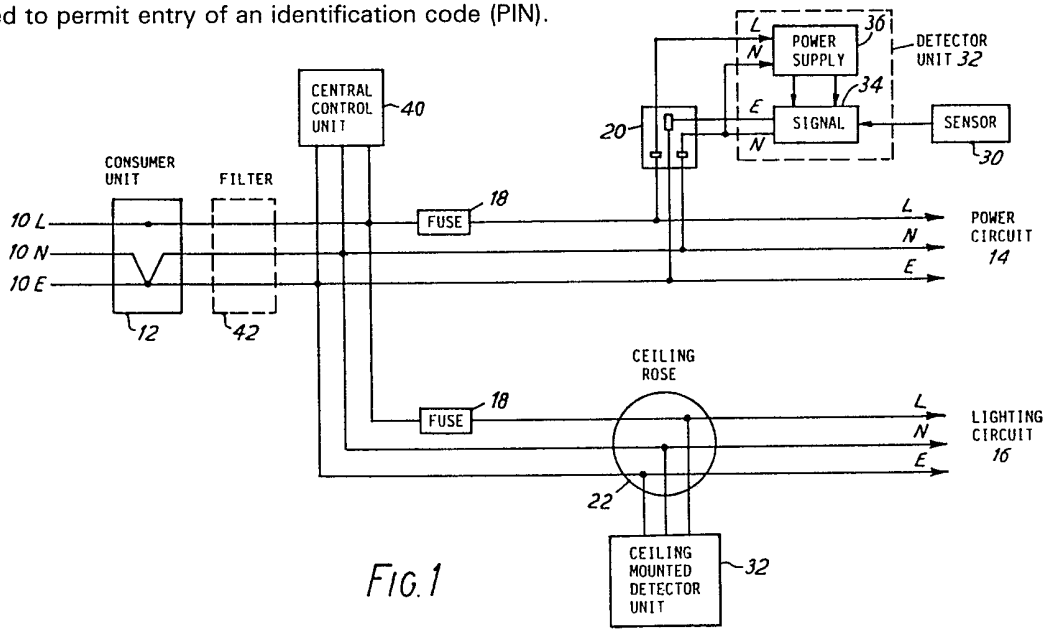


FIG. 1

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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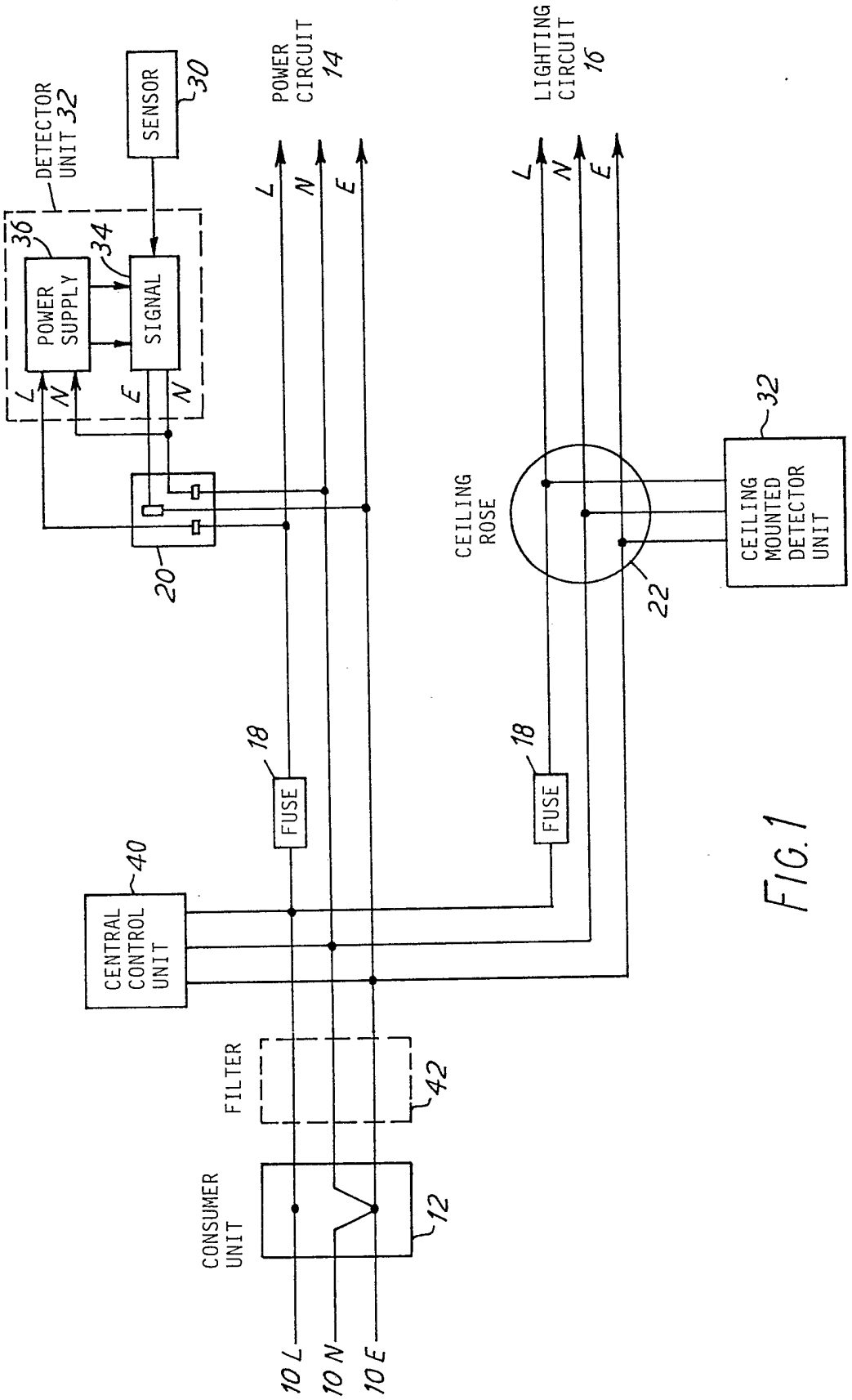


FIG. 1

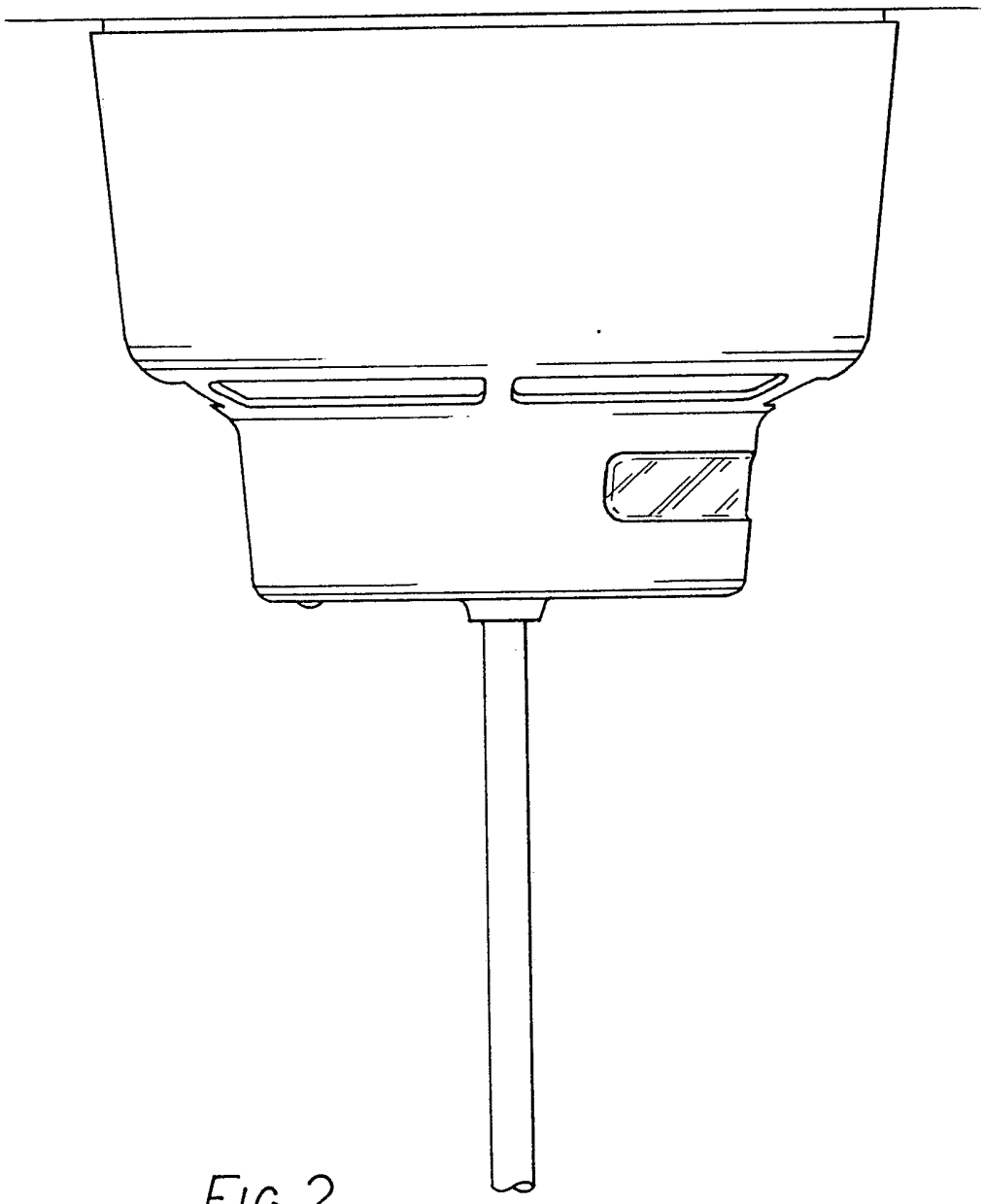

FIG 2

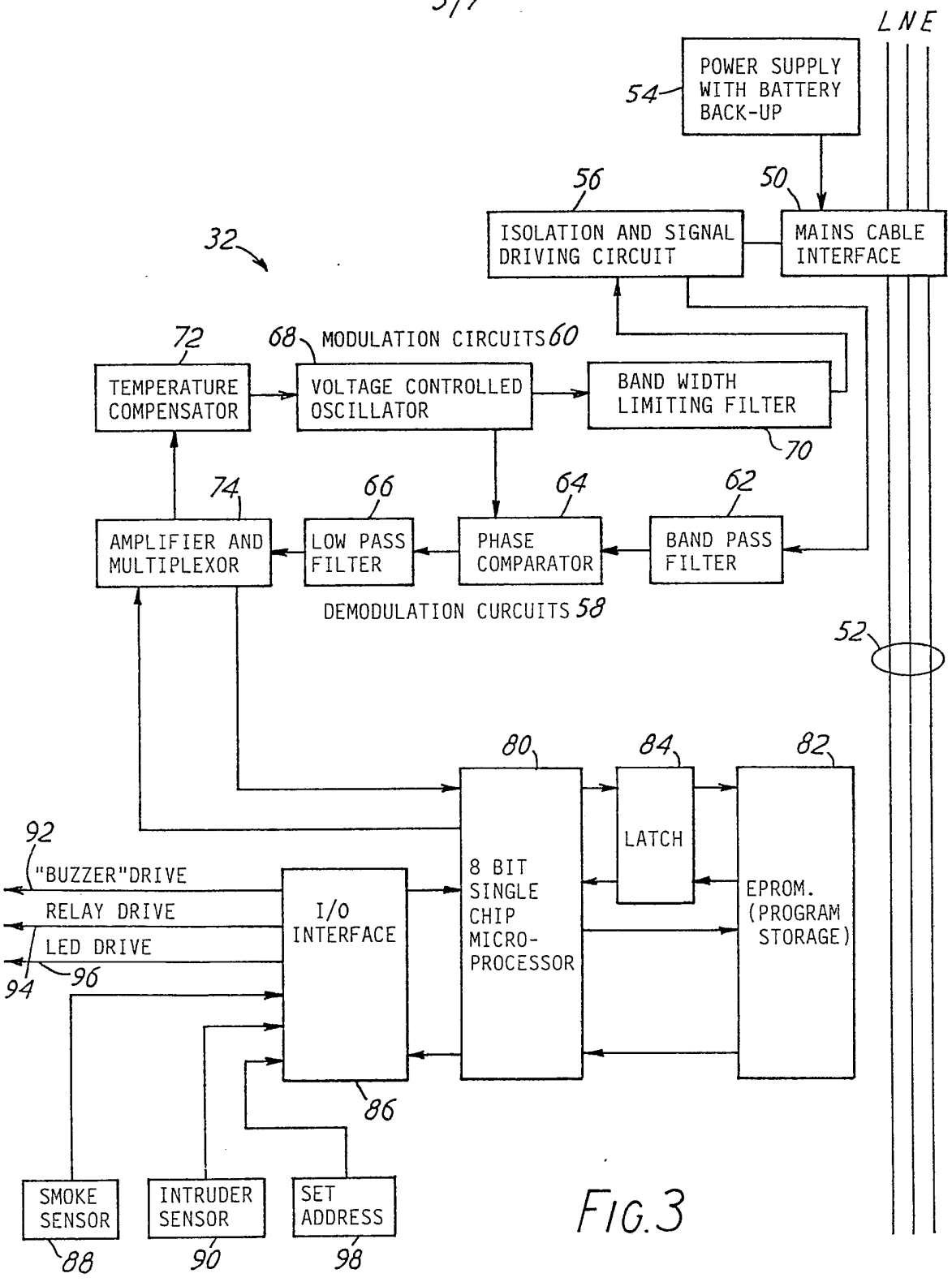
LINE
POWER SUPPLY WITH BATTERY BACK-UP
54
56
50
ISOLATION AND SIGNAL DRIVING CIRCUIT
MAINS CABLE INTERFACE
32
72
68
MODULATION CIRCUITS 60
TEMPERATURE COMPENSATOR
VOLTAGE CONTROLLED OSCILLATOR
BAND WIDTH LIMITING FILTER
70
74
66
64
62
AMPLIFIER AND MULTIPLEXOR
LOW PASS FILTER
PHASE COMPARATOR
BAND PASS FILTER
DEMODULATION CURCUITS 58
52
80
84
82
92
"BUZZER" DRIVE
RELAY DRIVE
LED DRIVE
94
96
I/O INTERFACE
8 BIT SINGLE CHIP MICRO-PROCESSOR
LATCH
EPROM. (PROGRAM STORAGE)
86
SMOKE SENSOR
INTRUDER SENSOR
SET ADDRESS
88
90
98

FIG.3

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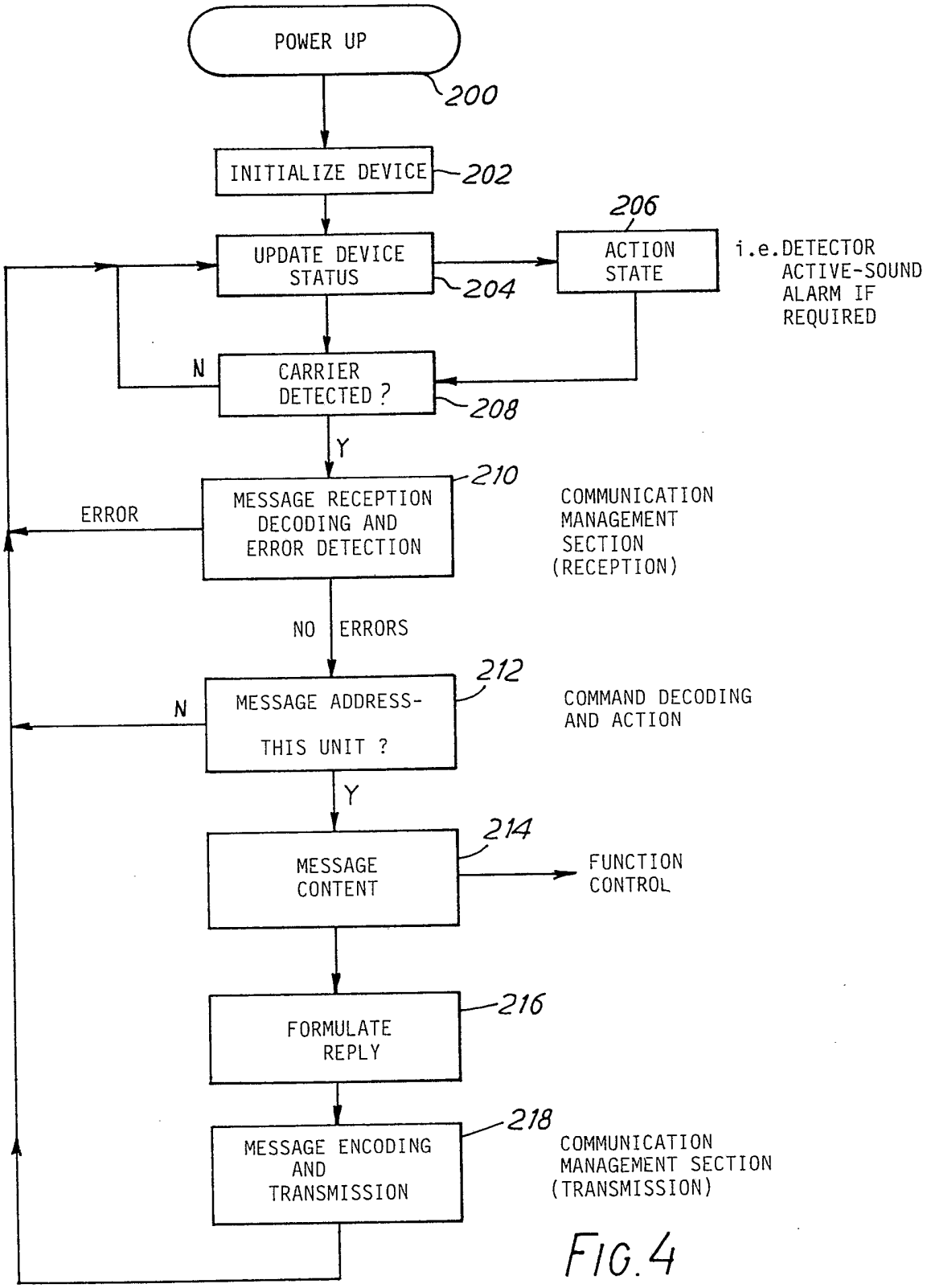


FIG. 4

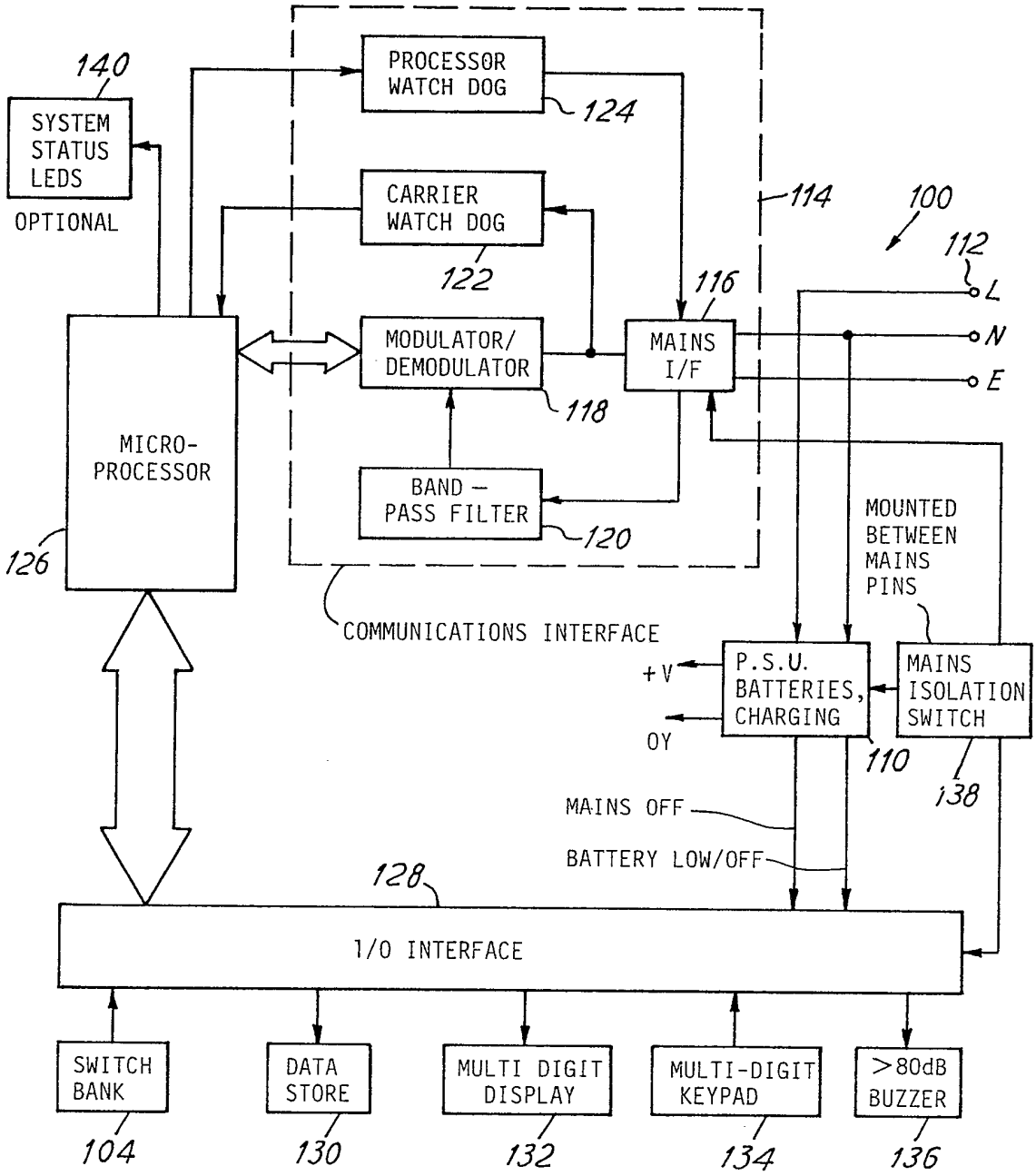
140
SYSTEM STATUS LEDS
OPTIONAL
PROCESSOR WATCH DOG
124
CARRIER WATCH DOG
122
114
100
112
L
116
MODULATOR/ DEMODULATOR
118
MAINS I/F
N
E
MICRO-PROCESSOR
126
BAND – PASS FILTER
120
COMMUNICATIONS INTERFACE
MOUNTED BETWEEN MAINS PINS
+V
0Y
P.S.U. BATTERIES, CHARGING
110
MAINS ISOLATION SWITCH
138
MAINS OFF
BATTERY LOW/OFF
128
I/O INTERFACE
SWITCH BANK
104
DATA STORE
130
MULTI DIGIT DISPLAY
132
MULTI-DIGIT KEYPAD
134
>80dB BUZZER
136

FIG.5

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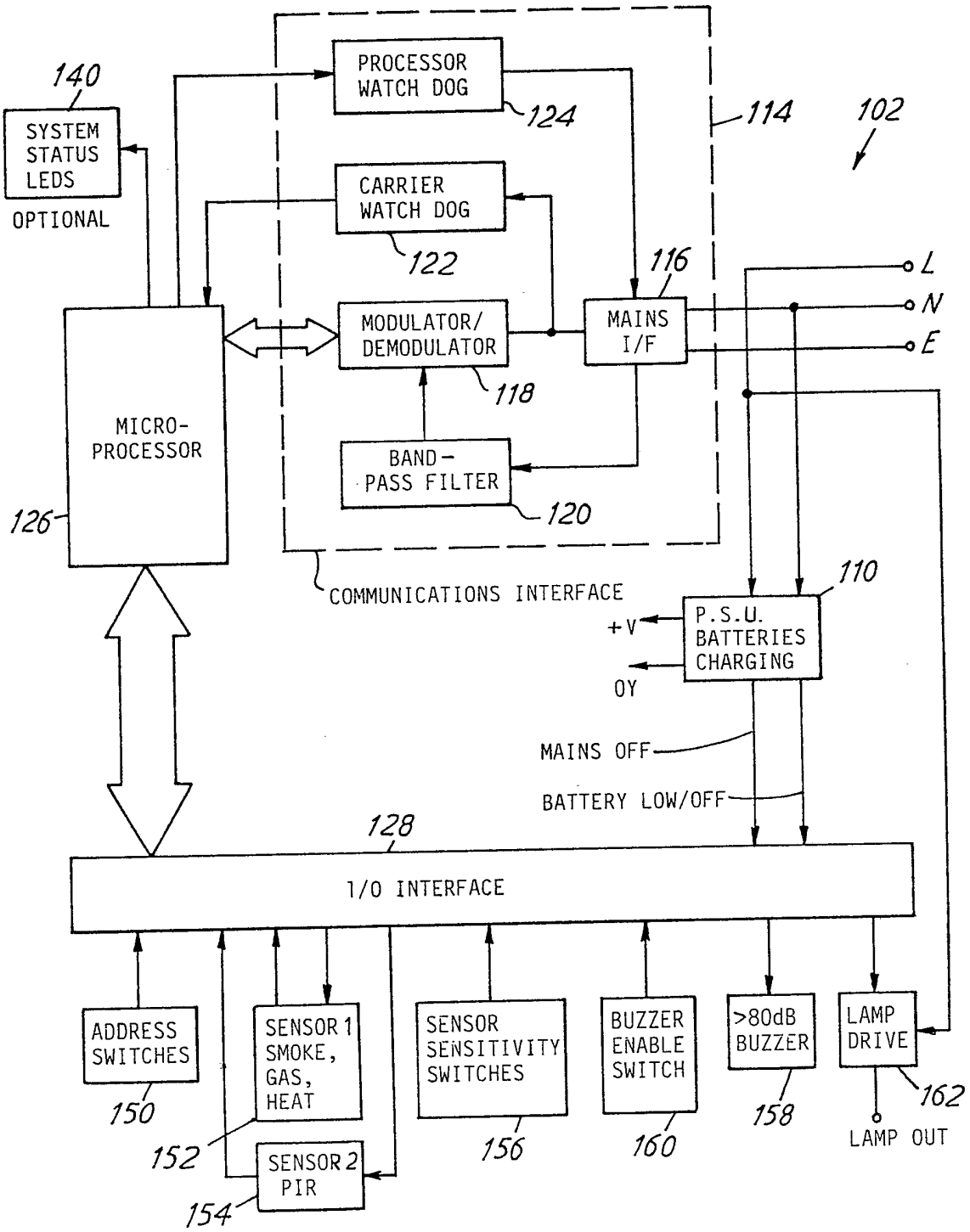


FIG.6

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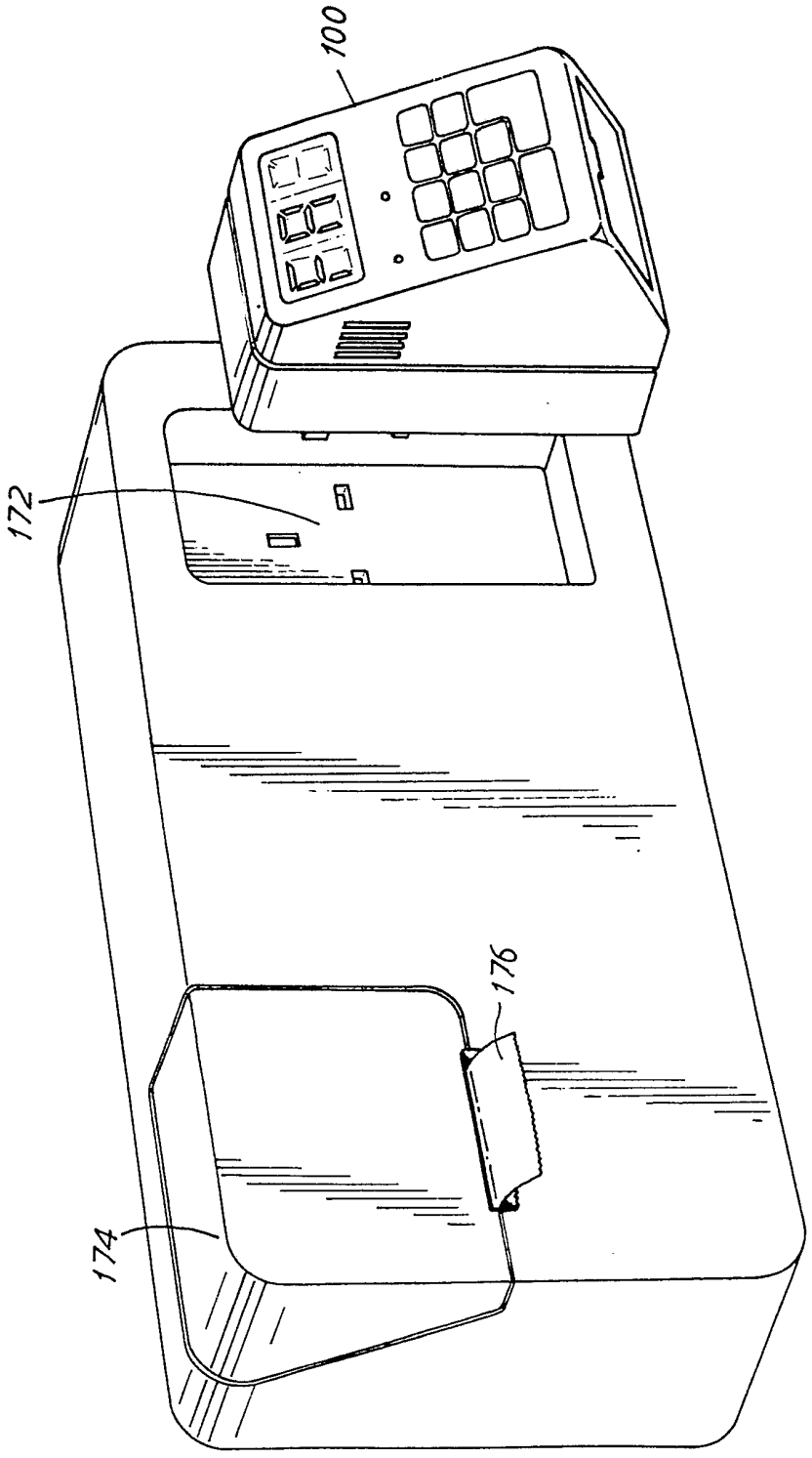


FIG. 7

SPECIFICATION

**Alarm and signalling systems**

This invention is concerned with alarm or signalling systems, for example fire or intruder alarms in buildings.

There is an increasing demand for alarm systems in buildings to connect smoke or fire sensors or intruder sensors to a central control unit or units. Installation of such systems is expensive and causes considerable damage to plaster and paint work. Once installed, the system is essentially fixed and lacks flexibility.

We have appreciated that these problems could be overcome by mounting the sensors on or in an existing mains distribution connection unit, such as a power socket outlet or the ceiling rose of a pendant light unit, and using the existing mains wiring to provide the communications link between the sensor and the central control unit.

Problems arise with such a communications system because of spikes or other noise on the mains supply which can interrupt the signal. This problem also arises with other uses of mains-borne signalling systems. With a view to overcoming such problems, we also propose interconnecting the sensors or slave units with the control unit via the neutral and earth conductors of the mains distribution system, and cyclically polling the slave units from the control unit. If the control unit receives no response from a slave unit after a predetermined number of requests, the control unit indicates an error condition. Equally, if a slave unit fails to receive a request from the control unit after a predetermined period the slave unit indicates an error condition.

The invention in its various aspects is defined in the appended claims.

An example of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:–

*Figure 1* is a schematic circuit diagram of part of the mains wiring in a house showing the incorporation of a system embodying the invention;

*Figure 2* is a side view of the exterior of a ceiling rose of a pendant light fitting embodying the invention;

*Figure 3* is a block schematic diagram of the signalling unit in the ceiling rose;

*Figure 4* is a flow chart illustrating the operation of the circuitry of Fig. 3;

*Figure 5* is a schematic block diagram of the control unit of a second system embodying the invention;

*Figure 6* is a schematic block diagram of a slave transceiver unit for use with the control unit of Fig. 5; and

*Figure 7* is a perspective view of the central control unit.

Fig. 1 shows a domestic mains wiring circuit in basic principles. The mains power from the supply utility is received on input lines 10L, 10N and 10E carrying the live (L) and neutral (N) of the single-phase mains supply and providing the earth or ground termination (E) respectively. These conductors are connected to a consumer unit 12 of known construction which is not, therefore, described in detail. In the consumer unit the neutral and earth conductors may be interconnected at what is known as the protective multiple earth or PME point.

Mains power is then distributed over a power circuit 14 and power for the lighting in the building over a lighting circuit 16. Each circuit has a fuse 18 in the live conductor. The power circuit 14 supplies power to a plurality of socket outlet units 20, only one of which is shown. The power circuit may comprise one or more rings with spurs to certain sockets and/or one or more radial circuits. The precise form of the layout of the wiring is not relevant, provided that the whole circuit is fed from the consumer unit 12.

The lighting circuit 16 is usually divided into different circuits for different floors or areas of the building and supplies the lighting units successively. The light switches can be looped in to the ceiling roses 22 or to separate junction boxes in any convenient and well known manner.

In accordance with one aspect of this invention, at least some of the mains distribution connection units, such as the socket outlets 20 and ceiling roses 22, contain or mount an appropriate alarm sensor. Conveniently a smoke detector of known type together with a movement detector of known type can be mounted in a ceiling rose, as illustrated in Fig. 2, to provide a combined fire and intruder alarm sensor unit. In other installations the sensors may, for example, be housed in a fluorescent light unit.

As indicated in Fig. 1, each such sensor 30 is connected to the associated mains component by a detector unit 32, comprising a signalling circuit 34 and a power circuit 36. The power supply circuit 36 is connected to the live and neutral terminals in the mains component, here the socket outlet 20, and comprises a transformer and rectification circuit to generate a suitable low d.c. voltage. This is applied through a mains failure detection circuit to the signalling circuit 34. If the mains supply fails, the mains failure detection circuit maintains the d.c. power from a back-up battery in the unit. This battery, preferably comprising one or more rechargeable nickel-

cadmium cells, is kept charged up by a trickle charger.

The signalling circuit 34 is connected only to the neutral and earth conductors, not it is to be noted to the live conductor. When the sensor is activated, an alarm condition is signalled by the signalling circuit 34 over the neutral and earth conductors in the manner described in more detail below. This alarm signal is detected by a central control unit 40 and used to activate appropriate audible alarms such as bells.

The system has the advantage of minimal installation costs, as all that is necessary to instal a sensor is to fit or replace an existing ceiling rose or socket outlet with a sensor and detector unit. The special unit shown in Fig. 2 provides the function of a ceiling rose as well as incorporating smoke and movement detectors along with the detector unit circuitry and can be used to replace a conventional ceiling rose. Installation of the unit is thus very easy and can be carried out by non-technical users, and causes no damage to the decoration. No special wiring is required to each sensor as the mains supply is used for that purpose.

Consequently every room in the building can be protected from fire and/or intruders, including the attic, the garage and the garden shed, providing only that there is a mains socket or light in the area to be covered. The system is very flexible and units can be moved around or new units added very simply.

The central control unit can be fitted anywhere in the building. It could even be fitted with a mains plug and plugged into any convenient socket, this making the control unit portable.

A filter 42 is preferably included to provide a high impedance to the signalling frequency at the output of the consumer unit. This assists in stopping the signalling signals travelling back up the mains wiring to interfere with signalling in other buildings. The existence of the PME point also assists in this. However, we have found that there is in practice still sufficient impedance between the neutral and earth lines at the signalling frequencies, despite the existence of the PME point, for the signal not to be 'shorted out'.

The detector unit 32 such as in a ceiling rose or socket outlet is shown in more detail in Fig. 3. A mains cable interface 50 connects with the live, neutral and earth conductors 52 of the lighting circuit. The power supply circuit 54 is also coupled to this interface and is as described above with battery back-up. The detector unit 32 is designed to receive and transmit digitally-coded messages to the central control unit 40 (Fig. 1) via the mains wiring 52. The coding and decoding circuits are isolated from the mains supply by an isolation and signal driving circuit 56 connected to the mains cable interface 50.

There are two signal paths in the detector unit 32, namely a receiving path comprising demodulation circuits 58 and a transmitting path comprising modulation circuits 60. The demodulation circuits include a bandpass filter 62 connected to the isolation and signal driving circuit 56 to separate the received messages from the a.c. mains oscillation, a phase comparator 64, and a low-pass filter 66. The modulation circuits 60 include a voltage controlled oscillator 68 and a bandwidth limiting filter 70. The oscillator 68 provides an output to phase comparator 64 to form a phase-locked loop. It is also found desirable to include a temperature compensation circuit 72 in advance of the modulation circuit to maintain the carrier frequency produced by oscillator 68 to the desired accuracy.

The output of the demodulation circuits 58 and the input of the modulation circuits 60 both share a common amplifier and multiplexer 74. Demodulated signals pass through circuit 74 to a microprocessor 80 which also supplies the output to the circuit 74 for modulation.

The operation of the microprocessor 80 is described in more detail below with reference to Fig. 4. It is shown as an 8-bit single chip microprocessor and has an associated EPROM (erasable programmable read-only memory) 82 which stores the program for the microprocessor. A separate latch circuit 84 is also provided. An input/output interface 86 couples the microprocessor to the local transducers, these including a smoke sensor 88 and an intruder sensor 90. In addition there are three outputs, output 92 to initiate operation of a buzzer in the event of an alarm, output 94 to control a relay for use by the user as desired, and output 96 to an LED (light emitting diode) to provide a visual indication. Finally a manually selectable input 98 enables a particular address code to be entered to distinguish that individual detector unit to the central control unit.

The elements 80 to 86 could be implemented by a single special-purpose integrated circuit.

Referring to Fig. 4, the microprocessor starts when switched on with the usual power up and initialisation steps 200 and 202. It then proceeds to "update device status" 204 which is in effect a self-diagnostic test routine to check the internal operation of the detector unit in so far as this is possible. If this detects either that a sensor is active or that the device is not functioning an action state 206 is implemented which sounds an alarm or provides such other indication as is appropriate.

From step 204 or 206 the device moves to step 208 "carrier detected?". If a carrier signal is detected by the demodulation circuits 58 this indicates an incoming message is present. Otherwise the system returns to step 204.

Assuming that carrier is detected, the incoming message is stored and checked for errors in

step 210. In the event of errors the system returns to step 204. If no error is found, the message is then examined in step 212 to determine the message address. It will be recalled that the unit can be individually identified by the address setting of input device 98 on Fig. 3. If the message is for this unit, the message content is then examined in step 214. It will normally simply be a status enquiry, but it may contain an instruction such as to turn the unit off or on for example. A reply is formulated in step 216, and encoded and transmitted in step 218.

The message format comprises a synchronising word, followed by an address word, and a message word containing the necessary command or information. There is then finally a cyclic redundancy check word to enable transmission errors to be detected. A data rate of the order of 10 kilobits per second can be used. There will typically be 24 bits per message, and the control unit may typically be able to handle up to 128 slave units. In one example each detector or slave unit would be polled every $1\frac{1}{2}$ to 4 seconds. The signal is modulated on a carrier of 100 to 150 KHz preferably using frequency-shift keying (FSK) with a frequency separation of about 5 KHz. The signal power output can be 2 to 5 milliwatts from each of the slave units. Data rates of 15 kilobaud and above are possible. Other modulation systems such as phase shift keying or amplitude modulation could be used.

In the system described the central control unit polls all the detector units cyclically so as to check operation and receive any alarm messages. The receipt of a message indicating an alarm condition immediately causes the control unit to take the appropriate pre-programmed action. The absence of a reply also indicates that something is wrong. A great deal of noise can arise on the mains circuit, due to appliances being switched on and off for example, and if the transmission were to coincide with a noise spike it would be lost. Thus the control unit waits until it has tried to obtain a response from the slave unit for several times and failed and then diagnoses a failure or alarm condition. Preferably the control unit will complete several polling cycles (e.g. five) rather than try the same slave unit several times in succession, to allow time for any transient noise condition to disappear. Equally, if a slave unit fails to receive a message from the central unit for the time taken for several polling cycles, the slave unit assumes the worst and sounds its alarm. These two features give protection against breaks in the cable and against attempts to disable the alarms without the alarm going off every time a message is corrupted by noise.

The control unit knows which detector unit is indicating an alarm condition and can be programmed to provide a different type of alarm for different areas of the building. Equally different types of alarm can be given to distinguish a fire from an intruder. Large installations could be provided to a video display unit to give a visual indication of the status of all the detectors or of groups of detectors.

The control functions comprised in the control unit can be quite sophisticated. The control unit can set off different alarms dependent on the position and type of alarm condition sensed. It can also disable certain alarms at certain times of the day, for example.

The system is safe and reliable in operation. A self-diagnostic test routine is included for checking the status of all the detector units, and to see if any unit has become detached or has failed. Even if a sensor becomes completely detached from the system, it will still provide a local warning from its built-in buzzer. Furthermore, the central control unit will know that all is not well because of the lack of a reply from that unit and can activate other bells or the buzzers in other units.

The battery back-up ensures that the building is still protected in the event of a power failure.

Care has to be taken when disconnecting a unit from the system. Because the signalling circuits use the neutral-earth path rather than the live-neutral path, they can provide a current path which will set off an earth leakage circuit breaker in the consumer unit. This problem is most acute on disconnection, and is particular so because of the inevitable slight difference in timing between disconnection from the neutral line and disconnection from the earth line, even when a plug is pulled straight out of a socket. We overcome this problem by including a double-pole electronic switch in the earth and neutral lines to the units which are operated by a single control signal. When an ordinary plug is concerned, this control signal might be derived from a microswitch mounted on the face of the plug which bears against the socket, and which is actuated by pressure against the socket. Thus as the plug is retracted, the microswitch is opened thus making the electronic switches non-conductive simultaneously, before the plug pins disconnect from the socket. Such an arrangement may have other uses.

In addition to providing the alarm functions described, the system can provide other intruder-deterrent functions. These may include switching on and off lights, or televisions, at different times, to simulate occupancy of the building. An additional slave unit will be required at each location which makes use of the relay output 94 of the unit. Indeed the signalling system can be used for other purposes and in other ways to the alarm system described and illustrated, and in particular can be suited to marine applications.

The coding of the transmitted messages, needs a high level of integrity in order to:–

a) cope with the electrical noise that can exist on the mains net-work itself, possible causing

the corruption of data,

b) avoid the possibility of circumvention of the system, due to its application as a security system, and

c) ensure that the co-existence of another mains-borne signalling system can be tolerated both within the location and externally.

As discussed above, the existence of a PME point in the consumer unit and the use of a filter 42, particularly a neutral-to-earth filter on the user side of the PME point, have the effect of greatly attenuating any signal that falls into the prescribed frequency band. The transmitted messages can also include a PIN or personal identity number which is specific to the system. This PIN is compared with the stored number in the control unit and in all the slave transceivers to see whether or not the message can be accepted. Secure coding and error detection systems can also assist.

Preferably the mains cable is itself monitored by the system such that any noise can be detected and the data sent between any packets of noise or periodic noise pulses. Transmission is delayed or aborted in the presence or anticipated presence of interference.

An improved and modified system will now be described with reference to Figs. 5 and 6 which show block diagrams of a master control unit 100 and a slave unit 102 respectively. The two units are designed to be relatively similar to facilitate their construction.

The Central Control Unit (CCU) 100 is capable of being able to communicate with up to 99 Sensor Units (SU) 102 in a domestic application, and 100 and upwards for larger commercial premises and offshore installations, for example with a maximum limit of 2048.

The CCU 100 (Figs. 5 and 7) can be in the form of a portable, calculator sized unit, which can be loated anywhere within the required environment. Its case is moulded in an impact and heat resistant plastic, embodying the British standard 13 Amp domestic mains connection pins on its back face. Also fitted within the region of these pins, is a mains isolation switch which is activated when the unit is pulled out of a socket as described above. It has two functions, one is to ensure that the live connection is broken before the earth and neutral connectors so as to stop the possible activation of any Earth Leakage Breakers, and secondly to discharge the internal mains coupling capacitor to avoid any possible discharge of this device through the user. This face houses as well, the Number of Transceivers Connected (NTC) switches 104. These are set by the user to the number of installed transceivers such that the CCU can look for the correct number of units within the required system. The front face contains a suitable visual display, for indicating the status of the system e.g. Safe, Fire or Intruder condition, Error mode and a 24 hour clock. A multi-function membrane switch panel is used for the input of all required data, including the use of a panic button, which requires two finger operation to become active. The case itself, contains all the appropriate communication, mains inter-face and battery charging circuitry along with a self contained buzzer. The lower section of the case houses the re-chargeable batteries, required to give a 48 hour back up in the case of a mains power cut, which, due to the system being Neutral-Earth MBS (mains-borne signalling) based, does not effect the operation of the system.

The mains unit circuitry includes a power supply unit 110 attached to the live neutral and earth conductors of the mains cable through the contact pins 112. Connected to the neutral and earth pins 112 is a communications interface 114, including a mains interface circuit 116, a modulator/demodulator 118, a bandpass filter 120 supplying the modulator/demodulator 118, a carrier 'watchdog' circuit 122 looking for the presence of a signalling carrier, and a processor 'watchdog' circuit 124 monitoring operation of a microprocessor 126. The microprocessor 126 communicates through an I/O (input/output) interface 128 with the switches 104 mentioned above, and also with an optional data store 130 for recording unit operations, a multidigit display 132, and the keypad 134 and buzzer 136 mentioned above. The microprocessor also receives signals from the power supply unit 110 indicating if the mains supply is switched off or the back-up battery is low or missing, and from the mains isolation switch control 138, and can supply outputs to indicator L.E.D.s 140 if required.

Much of the slave unit 102 of Fig. 6 is similar. In particular, the power supply unit 110, communications interface 114 and microprocessor 126 hardware are similar and carry the same reference numerals. In this caser however the interface 128 communicates with address switches 150 which identify the numeric address of that particular slave unit, a smoke, gas and/or heat sensor unit 152 (this has a 'sensor test' input from the interface), a movement or intruder sensor unit 154, and sensor sensitivity switches 156 to optimise the operation of the sensors. To provide appropriate indications at the slave unit a buzzer 158 is provided with a manually-operable 'enable' or on/off switch 160, and a lamp drive circuit 162 for switching on an associated amp in an alarm condition.

In this embodiment the sensor units (SUs) are designed to fit either over existing ceiling roses, using a special adaptor ring to locate the unit onto the prefitted rose base unit, or over a purpose built base unit. The SU's contain the appropriate sensors for their location, generally being a Passive Infra-Red (PIR) movement detector (154) and a Smoke Detection unit (152). The

casing material is of a moulded flame resistant plastic, which is also stable to Ultra Violet (UV) radiation. Where possible, any existing ceiling lamp flex passes through the centre of the SU and is connected to a socket built into the SU casing, which allows the control system to activate the lamp in an alarm condition via the lamp drive circuit 162. This circuitry is wired in parallel to the existing light switch to allow for normal operation. The outer casing is located on both the adaptor ring and the special base, with a simple "up and twist" action, which makes all the necessary mains electrical connections. The casing again contains all the appropriate communication, mains interface and battery charging circuitry along with the self contained power supply, 80 db buzzer and re-chargeable batteries. In the event of a complete system failure or where a silent intruder alarm is required, the switch 160 is incorporated into the SU to silence the internal buzzer.

The SU's are each given a unique number via two rotary switches (which are Binary Coded Decimal) which can sub-divide all 99 sensors into 4 main zones. For example:–

ZONE 1 units are given a number from 1 to 24.
ZONE 2 units are given a number from 25 to 49.
ZONE 3 units are given a number from 50 to 74.
ZONE 4 units are given a number from 75 to 99.

This enables single zones, containing a number of sensors, to be disarmed, allowing access to garages or to allow movement along one floor for example. The SU's can be sited anywhere within the required locality provided that there is either a 13 Amp socket or a mains lamp in that area. Each SU has the ability of having a different level of sensitivity setting for each individual sensor. This allows for a sensor to be more tolerant to smoke or movement depending upon the location. For example, one could expect a higher level of "background" smoke in a kitchen compared to that found in a child's bedroom. The microprocessor 126 controls all its functions, including a smoke detector check function and a remote power down function for the other sensor. In the event of a complete system failure, the SU becomes a "stand alone" smoke detector, providing the smoke detector can still function on its own.

For medium to large installations, a number of Door Entry Units (DEU), can be fitted to the nearest available power access point, such as a hallway light switch. This unit contains the same communication circuitry as the SU's and is battery backed up in a similar fashion. For the CCU to distinguish between these and the SU's, they are given their own address number via two dual-in-line switches, located on the back face. The front panel, contains a membrane switch panel on which the coding of the keys is "hidden until lit", in order to discourage tampering of the buttons. The keys are illuminated as required by the user by pressing a particular corner of the panel whereupon the microprocessor illuminates the keys in the required sequence. A panic button is located in the opposite corner to the panel activation Key, and is used when the users themselves feel threatened. It has the same result as setting off the main alarm.

The purpose of the door entry unit is to allow the user to arm or disarm the security side of the system, by entering a required pre-programmed PIN. It is also possible to silence the alarm sounders from this point, but it does not have the capability of being able to re-programme the PIN. They can be located either internally or externally where access to a garage might be required.

General Communication Boxes (GCB), control all external alarms and interfacing to any other standard equipment such as auto dialling out systems. These GCB's, are activated by the CCU when required and use the same communications format as the SU's. They are addressed in the same manner as before and also contain battery back up.

In a typical installation, the required SUJ's, GCB's and DEU's, are wired into the nearest existing lighting or power ring main using where possible the ceiling roses and the 13 amp sockets as the most convenient connection points. Where no ring main is available, a simple 3 core mains cable, can be run from the required unit to a suitable source. Each unit a given a unique address number and is "zoned" if required. At this stage, the sensitivity of the units is selected to suit the required location.

If power has yet to be applied to the system, it is done so at this point. This causes all the connected transceivers to go into an initial start mode as this is the first time that power has been applied (they should never perform this task again unless a unit is removed to have its batteries replaced or a new unit is added to the system). In this state they perform a routine power up of all electronic control hardware and the microprocessor carries out a series of functional ability tests on its communication circuitry and any attached sensors. This includes a stabilisation period for the sensors. They then sit "listening" for an initial command from the CCU.

The CCU is instructed as to the number of transceivers to "look" for by setting the NTC switches 104 to the required number. This is to ensure that all units are spoken to in the first instance and to stop any future circumvention of the system. The CCU is powered up by either installing charged batteries, or by plugging the unit into a live 13 amp socket. The CCU performs its own power up routine and functional test and set up. The user is then prompted to enter

their own multi-digit PIN. In order for the system to remain secure such that unlawful disarming of the system or changing of the PIN can not happen, and to ensure that activated sensors can not be unknowingly disconnected, the CCU constantly communicates with all the transceivers in a cyclic manner. The first time this is performed the CCU tries to talk to all 99 units in turn, looking for the required number of responses and remembering the addresses of all the active units. This information, as is the PIN, is stored in non-volatile RAM. If the number of active units is less than the required number after 5 complete cycles, the CCU indicates the fact by displaying a suitable error code. Normally a lack of communication with a unit, after the initialization period, would result in the CCU displaying that units address code, but in this case, the CCU has yet to "find" the unit. After "listening" for a period of time and having received no communication, a transceiver will set of its own buzzer once every two minutes for a period of 2 seconds, until communication is achieved. This helps the user to track down the faulty unit or units and indicates that they are functioning correctly and that a ring main fault must be the problem.

The first time that the CCU talks to an individual transceiver, it sends a message in the form:–
Preamble and synchronising word
Destination address
User PIN
Command message
Cyclic redundancy check word

Providing that the transceiver has monitored a reset, it will read in the PIN and store it for later message communications. This means that after the first instance or power up, i.e. all units now contain the PIN, if the master unit is re-set, the old PIN must be sent before any modification to the system status can take place. If the PIN sent from the CCU does not match the stored PIN then the transceivers will assume that the system is being circumvented and hence ignore the command message. In a fault or "lock up" situation, which would be very rare, the user would have to reset each transceiver in turn in order to enable them to read in the new PIN. When the user wishes to change the PIN, the above message is sent, but the command message includes the new PIN and instructs the transceiver to store the new number in its memory for all further communications.

The transceivers reply to the CCU with the format:–
Preamble and synchronising word
Source address
Stored PIN
Cyclic redundancy check word

The CCU, then checks that:
a) the unit has accepted the correct PIN number,
b) it has spoken to the correct unit,
c) that the command message is correct,
d) that the message is correct.

If the PIN is correct the CCU replies with the new PIN again. If the message is correct, the CCU replies with a command message to instruct the transceiver to store the PIN. The transceiver then acknowledges the receipt of this command. From the moment of power-up, the CCU constantly "talks" to all the transceivers, (SU's, DEU's and GCB's) in a cyclic manner, reminding them of their present status. This is to provide 24 hour fire protection by linking the "free standing" units containing smoke detection equipment. All the sensors are active all the time, except that in a mains power failure situation, where the PIR's are only activated when required in order to prolong the life of the charge contained within the batteries. For this purpose the PIR 154 in Fig. 6 is provided with a power enable input from the interface 128. When the PIR's are required they are powered up and allowed to stabalize before becoming active. Whenever the CCU or a transceiver transmits, they monitor the mains cabling for any noise, either periodic or random, and transmit in between such noise to reduce the possibility of errors occuring even further.

The command message instructions, send from the CCU to any listening device, can instruct the appropriate unit to perform any of several tasks:–

1) to store the new PIN
2) to transmit the stored PIN
3) to transmit the PIN being entered
4) to check on battery level status and report
5) to check all fitted sensors and report
6) in a mains power down mode, to arm PIR and power PIR up
7) to disarm PIR
8) to set off internal alarm sounder and switch on lamp unit, if connected
9) to switch off alarm
10) to switch off lamp

11) to switch on any attached lamp unit only
12) to report on general operational capability and status
13) total shut down of unit

The last instruction, tells the required unit to only "listen" to received messages, and not to transmit any message until told to do so again. This is used when ever a faulty sensor is detected, such that individual tranceivers can be completely isolated without effecting the operation of the system. In this mode a SU acts like a free standing smoke detector, provided that the detection circuitry is still functional.

When the intruder section of the system is required, the user enters the household PIN into either a) a DEU which instructs the CCU, or b) into the CCU itself. In both cases, the CCU compares the inputed number with the stored number in its memory. If the number is correct, the CCU will allow the user to press an "armed" button which in turn activates the system by causing the arming command to be sent to all active transceivers. The same procedure is adopted to disarm the system. If a false number is entered, the CCU will allow only 10 entries in every other 10 minute interval. No alarm state exists for the entry of false numbers.

Once armed, the SU's will send an alarm active message, if the duration of the "alarm condition" is greater than that set by the sensitivity switches. This means that the SU's decide for themselves as to whether a true alarm condition exists. Once in this state they can only be de-activated by the CCU. Removing the unit and silencing the internal buzzer does not inhibit the transmission of the alarm message. In this condition, the presence of smoke overrides the buzzer disable switch. Upon decoding an alarm condition, the CCU waits for a period of 30 seconds before sending out the alarm command message. This is to allow time for deactivation of the system in the case where a mistake has been made, where access to the building is required to disarm the system and where the panic button have been pressed by mistake. The panic button acts the same as an alarm condition set up by the SU's.

Whenever the system status needs to be changed or if the user wishes to unplug the CCU, the household PIN must first be entered and no action taken until a 'system safe' indicator is lit. This will happen after the CCU has spoken to all the active transceivers and instructed them to remain silent. With the CCU out of the wall socket, various programming functions can be more easily performed such as changing of the PIN, setting the real time clock, setting the time of activation (automatic) of the system. This allows the user to set the alarm to become active at various times of the day and night, whilst leaving 24 hour fire protection. These functions can only be performed if power is available in the form of either mains or charged batteries.

The CCU can disarm separate group zoned sensors or individual units to allow limited access to a building such as along one floor or into a garage. A DEU can be fitted to the external wall of a garage to enable an armed garage to be entered.

As shown in Fig. 7, the CCU 100 is normally received in a special base unit 170. This has a 13 amp socket 172 to receive the CCU 100 and houses a printer section 174 which can provide a print-out 176 of the system history when required. However, the control unit 100 can be moved to any other 13 amp socket on the ring main and will function properly from that socket.

The system functions as initiated by the microprocessors 126 are indicated in the Appendix below. It is important that the system responds appropriately in the event that various elements of the system fail to operate correctly as indicated.

*APPENDIX*
*Summary of alarm conditions*

| SYSTEM STATUS | SYSTEM CONDITION | RESULT |
|---|---|---|
| 1. Instruder alarm disarmed. No smoke is present. | (a) CCU, Sensor Units and all GCB's functional. | CCU displays present time and indicates that the system is safe. All buzzers are silent. |
| | (b) CCU is pulled out of the wall to programme set functions. The PIN has been entered. | After 20 second of last key being pressed, (if any) the CCU will beep for two second every minute and SU's every two minutes, until communication is restored. This acts as a nuisance alarm, to encourage the user to leave the CCU plugged into the wall. External alarms are silent. SU's act like free standing smoke detectors. |
| | (c) As above but with no PIN entered, or the system is being jammed internally. | CCU will keep for two seconds every ten seconds, and will indicate lack of communication. All SU's beep for two seconds every two minutes. |
| | (d) Failure/ circumvention of an SU or GCB. The CCU is active. | CCU displays lack of communication with appropriate unit and beeps for two seconds every minute until told to disregard "down" unit. SU/GCB in question, will if still possible, beep for two seconds, in every ten. Watch-dog circuitry stops the transmission of any "noise". A SU acts like a free standing smoke detector, if still possible. |
| | (e) Failure of CCU. | No CCU display, buzzer silent. All SU's will beep for two seconds in every ten. CCU watch-dog circuitry prevents the transmission of noise. |
| 2. Intruder alarm disarmed. Smoke present. | (a) CCU and all SU's/GCB fully functional. | After alarm "delay" time, set by sensitivity switches, has been exceeded, |

*APPENDIX*
*Summary of alarm conditions—contd.*

| | | |
|---|---|---|
| 2. contd. | | local SU sends out alarm message and sets off internal buzzer continuously and switches on any lamp unit. CCU indicates fire alarm and location. CCU beeps for two seconds in every 5. All SU's are instructed to go into an alarm state. They sound their buzzers continuously and activate attached lamps, until CCU resets the system and the cause has been removed. GCB's are activated to set off external alarms and auto dialling equipment. Reset is either manual or after 20 minutes. |
| | (b) CCU is pulled out of the wall to programme set functions. The PIN has been entered. | CCU will beep as before. Local SU will set off its own sounder continuously and activate attach lamps. All other SU's beep for two seconds in every two minutes. SU will remain in alarm state until smoke is removed. |
| | (c) As above but with no PIN entered, or the system is being jammed internally. | CCU will beep for two seconds every ten seconds, and will indicate lack of communication. Local SU will act as above. All other SU's beep for two seconds every two minutes. |
| | (d) Failure of CCU | CCU watchdog circuit stops the transmission of any noise. Local SU will go into alarm condition as above. All other SU's beep for two seconds in every 10. Local SU resets once source of alarm is removed. |
| 3. Intruder alarm armed. No intruder present. | (a) CCU and all SU's/ GCB fully functional. | CCU displays armed condition as do all DEU's. All buzzers are silent. |
| | (b) CCU is pulled out of the wall to programme set | Result as before |

*APPENDIX*

*Summary of alarm conditions—contd.*

| | | | |
|---|---|---|---|
| 3. contd. | | functions. The PIN has been entered. | |
| | | (c) As above but with no PIN entered, or the system is being jammed internally. | CCU will beep for two seconds every 5 seconds. All SU's sound constantly. GCB's are activated by the lack of communication. The SU's switch off/reset after 20 mins. Manual reset is achieved by restoring communications. |
| | | (d) Failure of a single SU or lack or communication with any unit. | CCU assumes SU has been removed and beeps for two seconds in every 5, after first waiting for a time out period of 10 seconds to pass. This is to ensure that the failure does exist. It then indicates an alarm condition to all transceivers, which sound continuously. The watchdog circuit in the failed SU prevents the transmission of any noise. Reset is as before. |
| 4. Intruder alarm armed. Intruders present. | | CCU and all SU/GCB's active. | After an alarm "delay" period set by the sensitivity switches has been exceeded, the local SU transmits an alarm message to the CCU. CCU delays total activation of the system for a period of time, to allow the user to disarm the system. If no disarming signal is given, all transceivers go off (i.e. all sounders come on GCB's are activated). Alarm sounds for a maximum of 20 minutes during which the system can be reset manually using the user's PIN. After 20 mins. the system automatically resets. The CCU displays activated sensors. |

CLAIMS

1. An alarm system comprising a control unit and a plurality of slave units communicating over a mains supply distribution system by mains-borne signalling, in which the control unit is

connected to the mains distribution system by a standard plug-and-socket connection whereby it can be connected to any standard socket on the system.

2. A connection device in a mains-borne signalling system using the neutral and earth lines of mains distribution system, comprising a double pole electronic switch the two poles of which are connected respectively to the neutral and earth lines, the switch having a common control input.

3. An alarm system comprising a control unit and a plurality of slave units communicating over a mains supply distribution by mains-borne signalling, each unit being powered from the supply but having a back-up battery to maintain the supply in the event of mains failure, and each slave unit having at least one detector unit for detecting an alarm condition, in which the detector units are normally continuously operable but in the event of failure of the mains supply at least some of the detector units remain normally off, the control unit then transmitting a succession of 'on' and 'off' commands to the detector units in turn to poll them cyclically while minimising battery current.

4. An alarm system for protecting a building comprising a control unit, sensor units and a door entry unit, in which the door entry unit is mounted externally of the secure part of the building and comprises a keypad, the keys of the keypad being unidentified until predetermined manual actuation of the door entry unit whereupon the keys are illuminated to permit entry of an identification code to which the control unit responds.

5. A signalling system employing mains-borne signalling between a plurality of stations, in which a transmitting station includes means connected to the mains supply for detecting interference thereon and inhibiting transmission in the presence or anticipated presence of interference.

6. A signalling system comprising a control unit and a plurality of slave units inter-connected by means of the neutral and earth conductors of a mains supply distribution system, in which the control unit polls the slave units cyclically, and if a slave unit fails to receive a request from the control unit after a predetermined period the slave unit indicates an error condition.

7. A system according to claim 6, in which the control unit is connected to the mains supply distribution system by a plug-and-socket connection.

8. A system according to claim 7, including means responsive to manual entry of a predetermined instruction on the control unit to instruct all the slave units not to respond to the absence of a request from the control unit, and then to indicate on the control unit that the control unit can be unplugged from the supply.

9. A system according to claim 6, 7 or 8, in which the control unit is integral with a standard plug whereby it can be mounted in any standard socket on the system.

10. A signalling system comprising a control unit and a plurality of slave units inter-connected by means of the neutral and earth conductors of a mains supply distribution system, in which the control unit polls the slave units cyclically to instruct transmission of status messages from the slave units, and if the control unit receives no response from a slave unit after a predetermined number of requests, the control unit indicates an error condition.

11. A detector unit for an alarm system, comprising one or more alarm condition sensors, the detector unit being mounted on or in a mains supply distribution connection unit (for example a power socket outlet or the ceiling rose of a pendant light unit), and having signalling means for communicating over the mains supply distribution system with another unit connected to the mains supply distribution system.

12. A detector unit according to claim 11, mounted in a light connection unit, in which in an alarm condition the detector unit switches the associated light on.

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