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(56) Documents cited
 GB 2196161 A GB 2182791 A WO 86/06890 A1
 US 4812821 A US 4737769 A US 3925763 A
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 HNNB
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(54) Signal communication systems

(57) A signal communication system, especially for security purposes, uses the mains electrical wiring (26) for the transmission and reception of signals. A control unit (10) is connected to the wiring, as are a plurality of repeater units (28). The control unit and repeater units are each hard wired to sensors (27a, 27b; 29). The control unit (10) is also responsive to one or more remote alarms, e.g. car alarms (31), and hand-held key fobs (32) by means of coded radio communication.

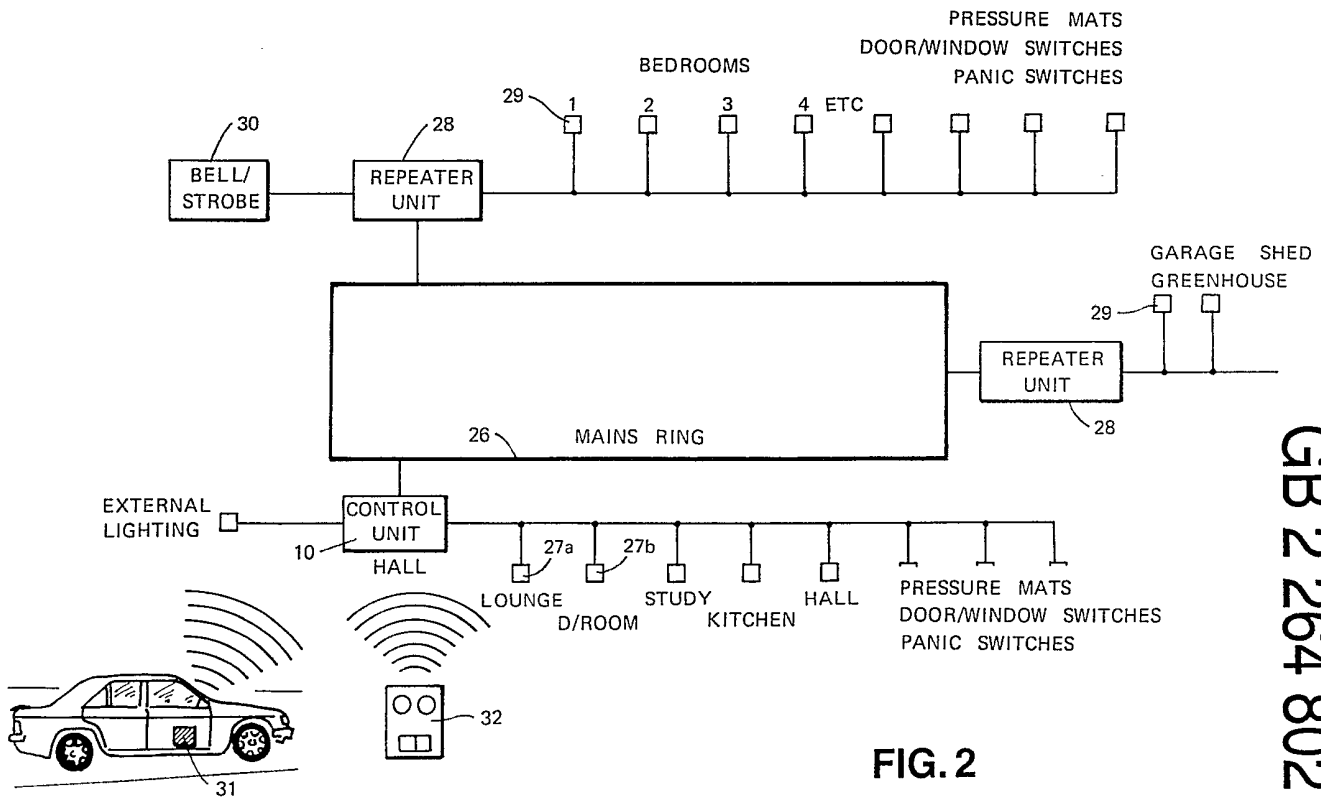


FIG. 2

GB 2 264 802 A

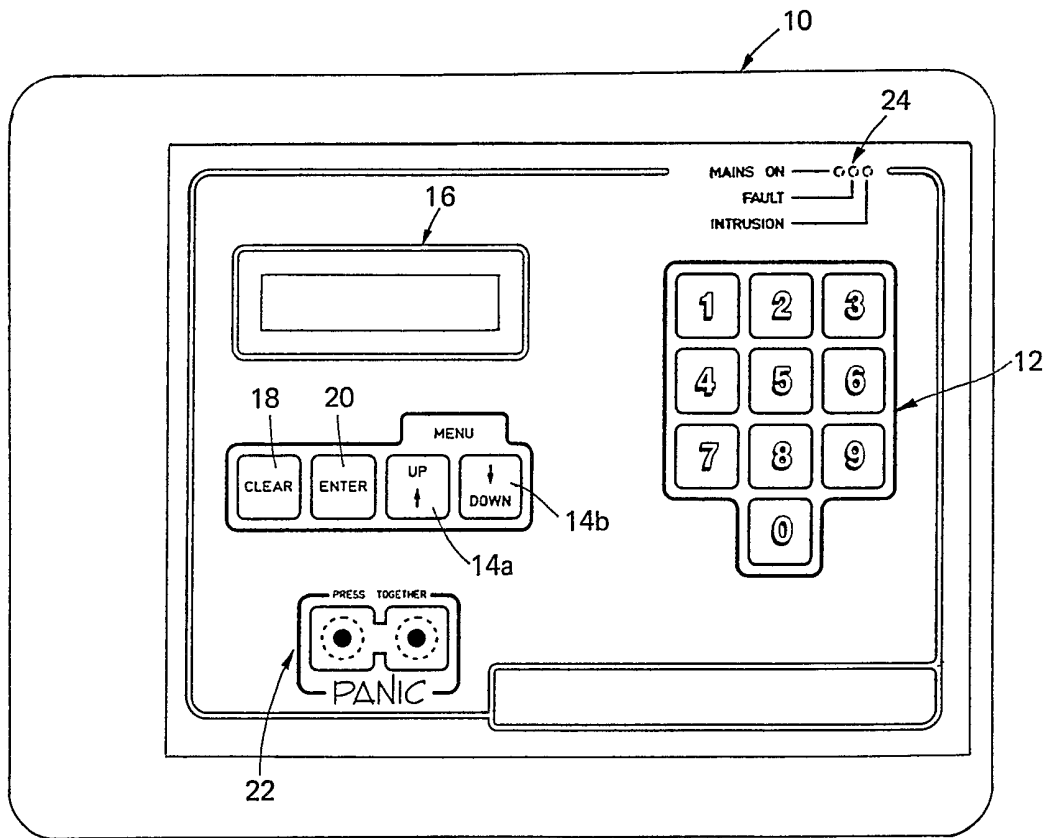
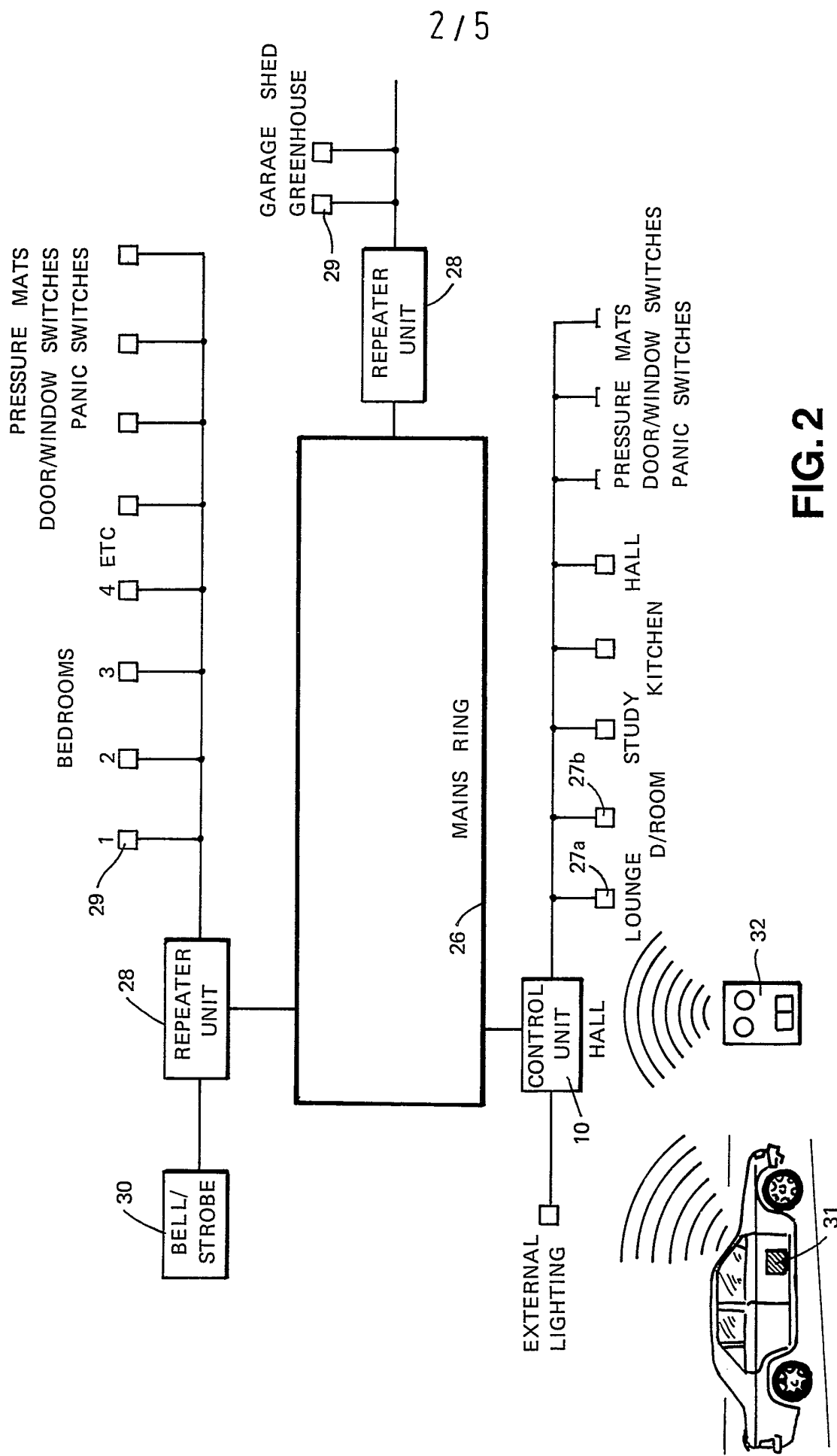


FIG. 1



* * *

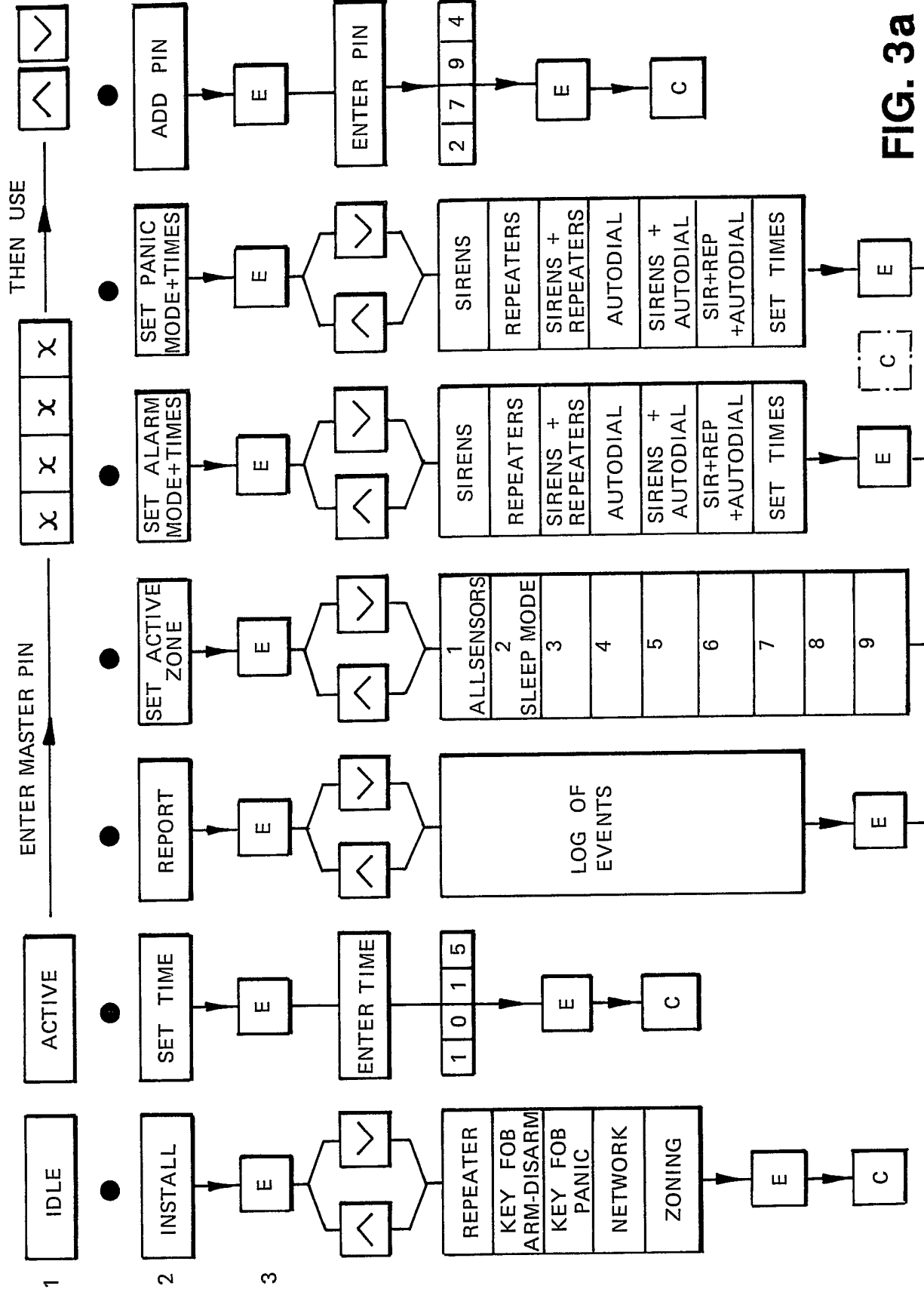
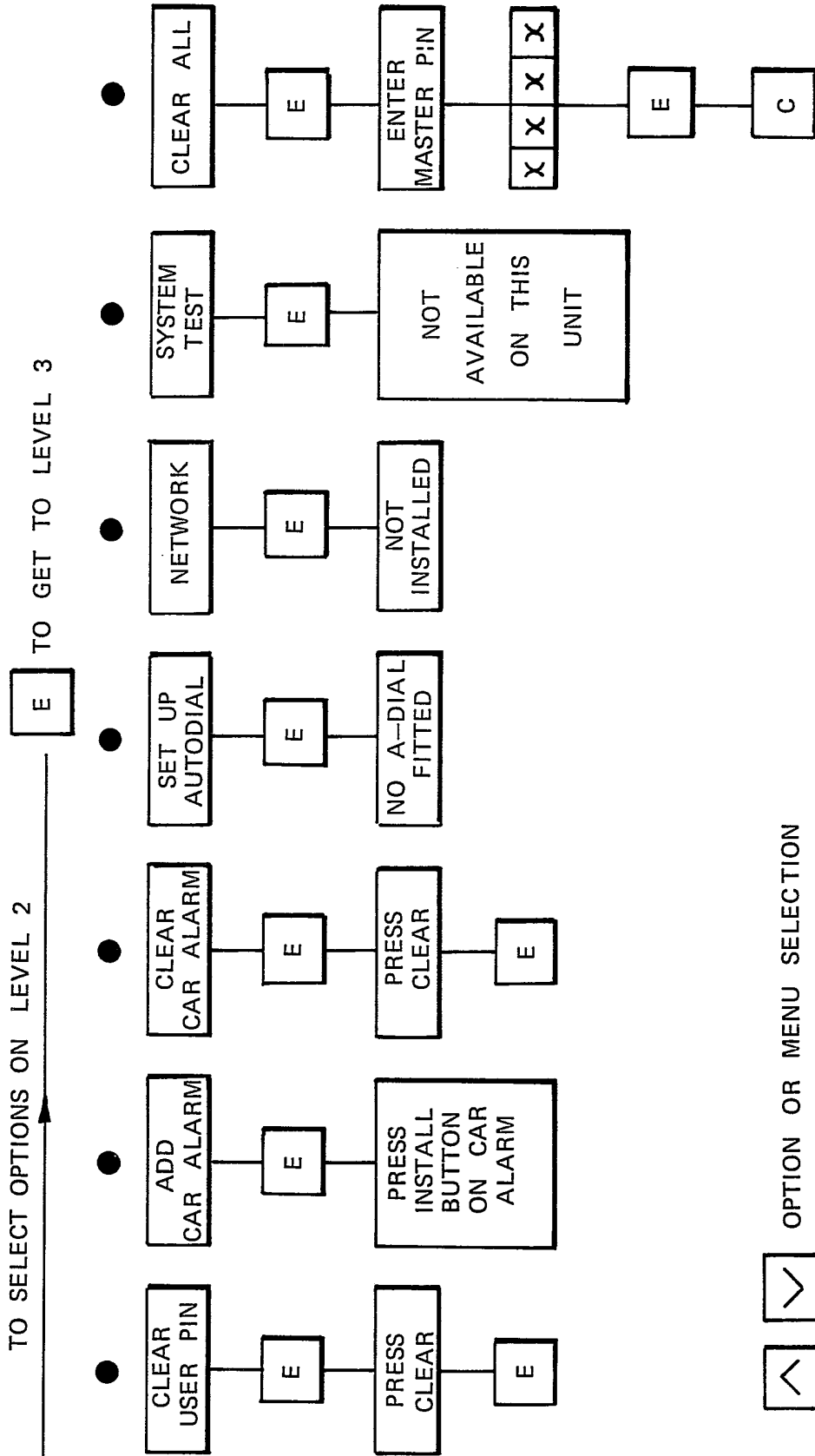


FIG. 3a



- ✓ OPTION OR MENU SELECTION
- E ENTER OR ACCEPT
- C CLEAR OR CANCEL

FIG. 3b

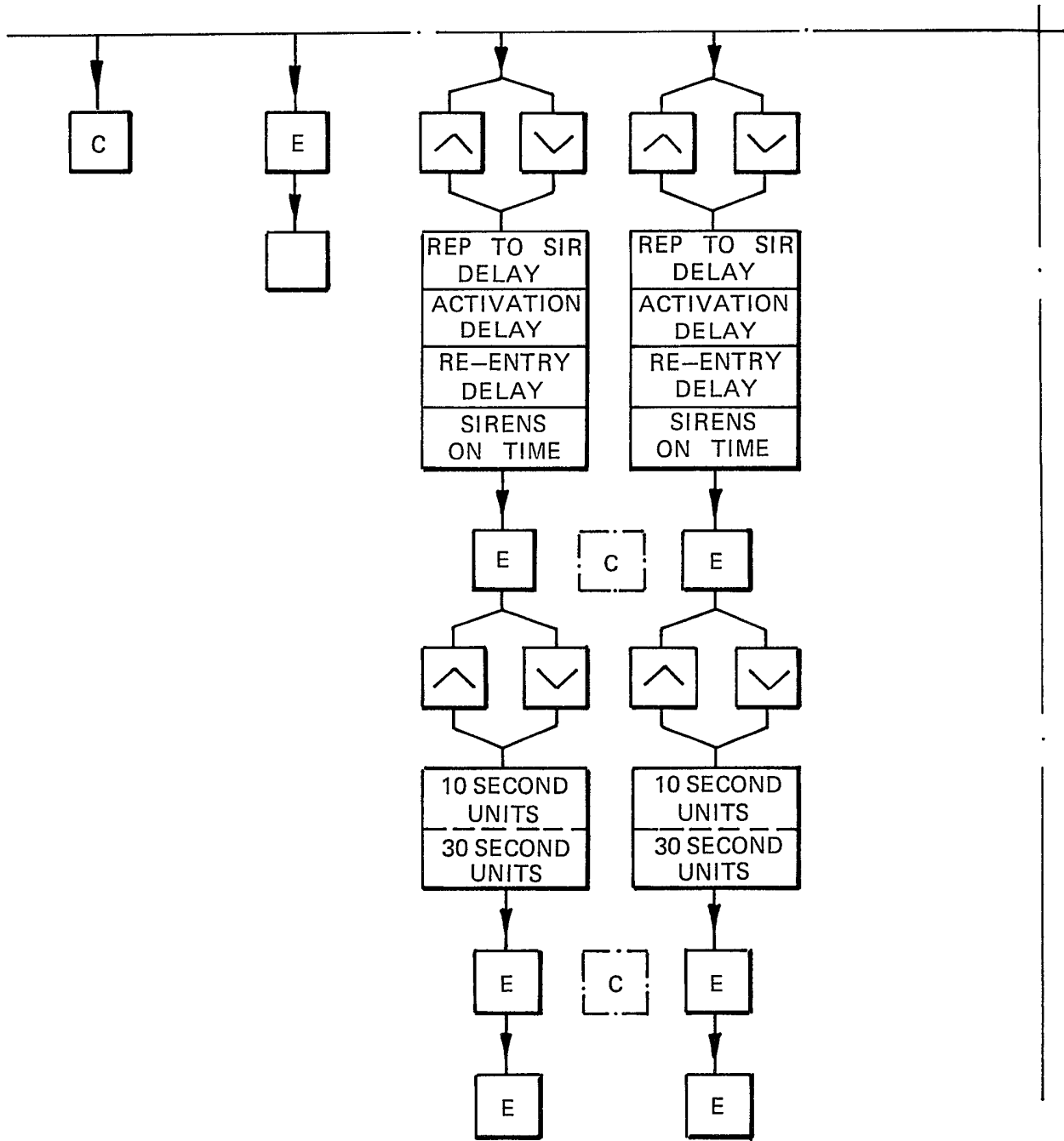


FIG. 3c

SIGNAL COMMUNICATION SYSTEMS

5 This invention relates to signal communication systems involving the transmission and reception of signals using mains electrical wiring to carry the signals. The invention is particularly, but not exclusively, concerned with security systems, for example for the detection of intruders.

10 Although the communication system of the present invention is particularly appropriate to form the basis of a security or alarm system, it can also be applied to other areas, for example to fire control systems or monitoring systems.

15 Many existing security or alarm systems are expensive to purchase and/or install, and require regular maintenance. If the installation is not carried out properly, or if the hardware is not of a sufficient standard, then the user will be faced with either breakdowns or false alarms, both of which reduce the confidence of the user in the system and, in extreme cases, may cause the user simply to disconnect the alarm. With domestic alarm systems, reliability and freedom from false alarms are two of the primary requirements, coupled if possible with ease of installation and low cost.

25 It is one object of the present invention to provide an alarm system which fulfils these requirements.

30 It is a further object of the present invention to provide a communication system which utilises mains electrical wiring and which is specially coded to provide security against disabling or jamming of the system.

35 The communication system of the present invention utilises mains electrical wiring of a

building or of an area in order to effect communication between one or more control units and repeater units.

5 Although, when embodied in a security system, the communication system of the present invention is particularly appropriate for use in domestic premises, it can be extended to cover a number of premises in sheltered accommodation for example, or to cover a neighbourhood, using the mains electrical wiring.

10 The communication system of the present invention is easy to install and operate. Being based upon a central control unit, with the option to add a plurality of repeater units, it can be built up as required to provide adequate security for a large area. The manner in which the repeater units are installed, 15 i.e. by being hard wired to the mains wiring, provides security against radio jamming, a problem from which radio-connected sensors suffer. Additionally, the use of mains signalling reduces the burden when installing the system in large premises. Mains signalling also 20 gives the possibility of multi-premises supervision, which is particularly useful for neighbourhood watch schemes and warden call schemes.

25 A security system in accordance with the present invention can also incorporate car alarms, linked by radio communication to the control unit.

30 In accordance with the invention there is provided a control unit for a signal communication system, the control unit being arranged for connection to mains electrical wiring for the transmission of output signals over the mains wiring and having inputs for wired connection to a plurality of analogue and/or digital sensors, wherein the control unit includes microprocessor means and is coded with an invariable code.

35 Preferably, the control unit is responsive

also to one or more remote alarms and/or user signalling devices by means of coded radio communication.

5 Also in accordance with the invention there is provided a signal communication system comprising a control unit connected to mains electrical wiring, and at least one repeater unit also connected to said mains electrical wiring and having one or more sensors wired thereto, wherein the control unit and the repeater unit
10 or units communicate by way of coded signals using the mains wiring.

Preferably, the control unit is also wired to a plurality of sensors.

15 In order that the invention may be more fully understood, one presently preferred embodiment of security system in accordance with the invention will now be described by way of example and with reference to the accompanying drawings, in which:

20 Fig. 1 is a schematic front view of the main control unit;

Fig. 2 is a schematic illustration of the preferred embodiment of security system in accordance with the invention; and,

25 Fig. 3 is an illustrative guide to explain the setting up and user operations relating to the keypad and liquid crystal display of the main control unit.

30 The main control unit of the alarm system illustrated in the drawings is indicated generally at 10 in Fig. 1. The control unit comprises a microprocessor (not shown) which is appropriately programmed. The control unit 10 is connected to the mains electrical wiring of the premises which are to be protected, for example by a standard 13 amp plug. The
35 main control unit 10 is the main user interface to the

security system. The control unit 10 is provided with a panel or keypad of buttons 12 for control purposes. The buttons numbered 1 to 0 are for the entry of code numbers or personal identity numbers (PINS). Two
5 "menu" or option selection buttons 14a and 14b are provided which are linked to the microprocessor. Depression of one or other of these buttons 14a, 14b will cause a series of "messages" to be displayed within a window 16. These displayed messages can be of
10 any desired format but are preferably in the form of a liquid crystal display (LCD). Depression of button 14a will cause the indications in window 16 to scroll in one direction and depression of the other button 14b will cause the indications to scroll in the other
15 direction. Also provided is a "CLEAR" button 18 and an "ENTER" button 20. The control unit 10 also includes panic buttons 22 which, if pressed together, will activate the alarm system. The control unit also has three LEDs 24 which respectively indicate "MAINS ON",
20 "FAULT" and "INTRUSION".

The control unit 10 in this embodiment has inputs for six digital and four analogue sensors. It also incorporates a loud alarm sounder (not shown) which may be of the order of 120 dB for example. It
25 also has a small sounder to communicate with the user. It can drive an external bell box and also, as will be described hereinafter, communicates with repeater units by way of mains electrical wiring. As will also be described hereinafter, it can accept commands by radio
30 signalling from hand-held key fobs or from a car alarm. It can also include an "autodial and report" facility, where one of several previously recorded messages is played to one of several previously entered telephone numbers upon actuation of the alarm. It can also
35 report to a network watch reporting unit, or can act as

a reporting unit itself if provided with suitable software.

5 Fig. 2 illustrates a typical security system for domestic use, including a car alarm. As shown in Fig. 2 the control unit 10 is connected to a mains ring 26. The control unit 10 is indicated as being located in the hall and is connected by hard wiring to a plurality of sensors 27a, 27b, ... etc. The sensors may be digital sensors or analogue sensors. In Fig. 2 10 sensors are shown located in the lounge, dining room, study, kitchen and hall. There is also a connection to external lighting. Digital sensors are those which give digital signals and whose operation almost certainly indicates an unauthorised presence. These 15 digital sensors include pressure mats, magnetic reed switches for windows and doors, and infra-red beam breaking sensors. These digital sensors are connected by way of conventional 4-wire leads to the digital sensor inputs of the control unit 10. A number of 20 sensors can be "strung out" on a single lead, but the use of different inputs provides the logging system with more accurate information as to where a sensor has been activated.

25 Analogue sensors are those whose output varies and for which some output may be given under non-alarm conditions. These are commonly available in the security industry wired as digital sensors. They use an internal means of distinguishing real from false intrusions, such as counting fringes in a passive 30 infra-red sensor, and physical adjustment of sensitivity in ultrasonic detectors and Doppler microwave sensors for example. All run the risk of generating false alarms. Preferably, sensors of this type provide both an analogue output as well as a 35 digital one, so that the control unit 10 can

continually monitor the signal and make its own decisions as to whether an alarm condition exists or not. Because the control unit uses a sophisticated microprocessor it can make much more intelligent decisions as to the presence of an intruder than can the sensor itself, thus reducing the risk of false alarms.

Also connected to the mains ring 26 are a number of repeater units 28. Two such repeater units 28 are shown in Fig.2. Each repeater unit 28 is connected to one or more digital or analogue sensors 29, in the same way as the control unit 10. The individual sensors 29 are hard wired to the repeater units 28. In practice, up to nine repeater units can be used with a single control unit, and each repeater unit can accept signals from a number of sensors, thus enabling large premises to be supervised with minimum wiring, by virtue of the use of the mains ring 26 to connect the repeater units to the control unit. Each repeater unit 28 is fixed in a given position within the overall security system.

Each repeater unit 28 has an "active" button which is used in setting up the unit upon installation. Each repeater unit 28 preferably has inputs for four digital and four analogue sensors. It also incorporates a loud sounder and an internal sounder for communication with the user. Each repeater unit can drive an external bell box 30 which can incorporate a bell and/or strobe light. Although the bell/strobe unit 30 is shown connected to one of the repeater units 28, it could alternatively be connected directly to the control unit 10.

The hard wiring of the sensors to the control unit and repeater units, in addition to simplifying the installation by reducing the wiring runs, also gives

security against radio jamming from which radio-connected sensors suffer.

5 The security system of the present invention can also incorporate one or more car alarms 31 to provide security for cars parked near the house or other premises where the security system is installed. The car alarms are coupled to the control unit 10 by a radio link.

10 The main control unit 10, although it communicates with the repeater units 28 using mains signalling techniques and protocols, accepts commands by radio signalling from hand-held key fobs 32, as well as from the car alarms. These hand-held radio key fobs are of two types. The first type has only one button, 15 which is a "panic" button which, when pressed, causes the control unit 10 to perform its preset panic actions, including for example the sounding of alarms and activating of the auto dialler if fitted. The second type of key fob has a slide switch and two 20 buttons. The slide switch chooses between car or main system functions and the two buttons choose "arm" and "disarm". In the preferred system of the present invention up to 25 key fobs of these two types may be used on any one main system, or up to 4 of the second 25 type of key fob per car alarm. The key fobs 32 are powered by internal batteries and use radio signalling, having a range of up to about 200 metres in free air.

30 In the case of the "panic" key fobs, when their signal is received the control unit can be set to activate its alarm and, if an auto-dialler is fitted, will call a preset number and replay a message or alert a network watch unit. This feature can be used by elderly or infirm people if they fall or become ill, in 35 much the same way as existing warden call systems. It can also be used to frighten off an intruder and to

call for help.

As will be described hereinafter, the system uses coding techniques. Because of the sophisticated coding techniques which are used, false operation of any radio-connected unit is very unlikely. However, any radio system can be jammed so as to make it "deaf" even to correct codes. In order to cater for such an occurrence, a back-up of manual intervention is provided. Thus, a householder can use a personal identification number (PIN) to activate and deactivate the system rather than using the radio key fob 32. This also applies if the householder has forgotten or lost his key fob. Normal arming and disarming of the system is by means of the radio key fob. When the system accepts a key message it will respond with a short "beep" from the control unit 10 to confirm that it has received the message. Because it is possible to control the security system from outside the premises it is not necessary to provide a long delay after detection of entry to the premises before the alarm is sounded. This provides an enhanced level of security. This delay is provided in non-radio systems in order to give the user time physically to disarm the system when he re-enters the premises. This time is generally of the order of 20 to 40 seconds, during which period a burglar could snatch valuables and escape without activating the alarm. This relatively long period of delay is not required with the present system because of the facility to control it from outside the premises.

All the radio and mains signalling units of the system of the present invention use a coding technique which enables good communication in noisy environments and which also gives high security against unauthorised users. This is achieved by forward error

correction, resistance to false messages by error detection, and uniqueness of numbering through the use of a very large unchangeable factory-embedded code in all units. There are various conventional coding schemes for radio devices. Currently, such radio units incorporate semiconductor chips which at best give around 12 bits of data. This corresponds only to what a locksmith would call 4096 differs, i.e. different possible keys in the system. It is now possible to make small computers which generate radio key codes one after the other and transmit them. Each code takes only around 1/20th to 1/15th of a second to transmit, so that one could send fifteen to twenty codes a second. On that basis it would take only three to four minutes to transmit all of the codes appropriate to 12 bits of data. On average, one would therefore find the correct code in about half that time. In order to avoid this problem the coding system used with the present invention uses a code which is 24 bits long, embedded in a 48 bit error detection and correction scheme. This makes it quite impractical to find the correct code even by the computerised method referred to above.

A further advantage of the system of the present invention is that the control unit 10 is able to "remember" all arming and disarming actions and intrusions (while armed) and car alarms detected, in a log which is up to 250 events long. This log is available on the LCD display 16, as will be described hereinafter. This can therefore be used both to prove to an insurance company that the system was armed when a burglary took place, and can also aid the police by establishing the exact time of an intrusion.

The range of mains signalling is sufficient to cover quite large areas. This means that the

communication system of the present invention can be extended beyond an individual dwelling or other building. The basis is here for building a network where installations which have been "introduced" to each other by means of their unique identity codes can exchange messages beyond a single premises. One can thus build up a neighbourhood watch scheme or warden call scheme using the mains electrical supply which runs between the houses or dwelling places. Hence, if a householder leaves his premises it can be arranged that his control unit will report any intrusions to a local "reporting point", which may be any other control unit in mains signalling range. This "reporting point" will then sound its own local alarms, informing the local watcher (someone who expects to be there for a period and has activated this mode) that a panic button has been pressed or an intrusion has occurred in his area, and at which house this has happened. The watcher can then either check the premises concerned or call the police as appropriate. There is also no problem in making several control units active as "reporting points". They would merely all be informed of intrusions and panic button actuations, and could all investigate the source. With the system of the present invention up to 200 control units and repeater units can be supported in this way.

All the control units and repeater units have built in switches which detect any attempted unauthorised opening of the housing. In an armed system this automatically causes an intrusion response, such as the actuation of bells and/or strobes, etc. as preset. In a system having both a control unit and repeater units the repeater units regularly exchange secure messages with the control unit. Both units have detectors for the disconnection (not just failure) of

the mains supply. If communication with an armed unit fails either through damage or the removal of its mains plug, the control unit and repeater units will act as if an intrusion had taken place. If the mains supply fails through an operation which breaks the mains connection, for example if an earth leakage sensor trips, communication within the house will continue (powered by batteries) but communication within a network will not be possible.

10 The control unit 10 and/or the repeater units 28 can incorporate miniature cameras, thereby providing a video link.

15 The method of setting up and using the control unit 10 will now be described with reference to Fig. 3. The keypad 12 and LCD display 16 are used to guide the user through all normal and setting-up operations.

20 In the following description a word enclosed in angular brackets, e.g. <CLEAR>, refers to a key depression. An LCD message is shown thus "ILLEGAL OP".

25 There are two "operating states" for the system: "IDLE" or disarmed mode, and "ACTIVE", where a zone has been armed. These constitute "level 1" of the system. States can be changed using the key fob <ARM> and <DISARM> buttons. At each change the main control unit makes a distinctive sound. These states can also be changed by means of keypad operations using a PIN (Personal Identity Number). During these states a 24-hour clock will be displayed. If in IDLE mode and an intrusion has been detected during the previous ACTIVE period, the intrusion LED 24 will be flashing, warning the user to check the log via the REPORT mode - see below. If in ACTIVE mode the particular active zone will also be displayed.

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The 14 other "level 2" states can only be accessed by means of entering a PIN. Some require the master PIN; some will work with either the master or any user PIN. These "level 2" states need normally
5 only be used when the zone to be armed is to be changed (e.g. when going to bed), reading the log of recent events, or when setting up the machine. The states which constitute "level 2" are:

- 10 INSTALL
- SET TIME
- REPORT
- SET ACTIVE ZONE
- SET ALARM MODE
- 15 SET PANIC MODE
- ADD PIN
- CLEAR PINS
- ADD CAR ALARM
- CLEAR CAR ALARM
- 20 SET UP AUTODIAL
- NETWORK
- SYSTEM TEST
- CLEAR ALL

FINDING YOUR WAY AROUND: There are several "levels" of menu, each of which has a set of options. In order to get from "level 1" which may be either IDLE or ACTIVE one must enter a PIN. Thereafter one can choose which "branch" to go along within each level by means of the <^> and <v> keys 14a, 14b. When one reaches the one
25 which is wanted, press <ENTER> and the next level of menu will be available. If one wishes to choose an option use <ENTER> again, which will return one to the previous level at which choices can be made.

For a simple branch - such as setting the
35 time - this will return one to "level 2", with all the

main options still available. In a more complex branch - such as setting all the timers for what happens in the ALARM situation - setting one time then <ENTER> will return one to where one can set the next timer.

5 To accept an entry, continue pressing <ENTER>, which will take one back step by step, accepting the setting at each stage, to "level 1", showing ACTIVE or IDLE depending on the setting. To reject a choice, use <CLEAR>, which will return one down the branch but without altering the previous settings.

10

GETTING TO "LEVEL 2" FROM "LEVEL 1":

From here, entering a valid PIN will cause the unit to go to "level 2" and present the main list of 14 options as shown above. Choosing <IDLE> or <ACTIVE> then <ENTER> will return one to "level 1" with the new state as chosen. Pressing <CLEAR> will also go to "level 1", but not change the previous state. Within "level 2" use <A>, <V> to get the option required. Some options are only permitted if the master PIN has been used - these are marked ***.

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*** INSTALL: This allows the user to add repeaters and their associated sensors to the system, and to add key fobs. Once chosen the user must activate the unit to be installed in order to "introduce" it to the system.

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SET TIME: Allows the user to set the correct time in 24 hour format.

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REPORT: Allows the user to step back through the "log" - a list of up to 250 events. An event is either an arming, disarming, or an intrusion detected during the ACTIVE (armed) state. All events are presented in terms

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of 24 hour time and number of days previous - so "today's" events will be 0 days old. Events beyond 250 are lost. Use <^>, <v> to step up and down the list, and either <ENTER> or <CLEAR> to return to "level 2".

5

SET ACTIVE ZONE: Up to 9 zones can be defined, each of which can be any mixture of repeaters and sensors. This option allows the user to select which selection will be "armed" when "level 1" ACTIVE mode is next entered. Note that ZONE 1 is always "all installed sensors" by default. Use <^>, <v> to choose the zone, then <ENTER> to accept, <CLEAR> to exit without change.

10

SET ALARM MODE: This defines what will happen when an intrusion is detected when the system is "ACTIVE".

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SET PANIC MODE: Defines what happens when either the PANIC buttons 22 on the main unit are touched or an installed PANIC key is operated. The options are as for ALARM mode above.

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*** ADD PIN: Allows the use to define new user PINS. Use <ENTER> to accept, <CLEAR> to reject the new PIN and return to "level 2".

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*** CLEAR PINS: Clears all the user PINS - useful if one believes that one has been acquired by someone who should not have access to the system. Note that all user PINS are cleared by this operation, so one has to re-enter those which one wishes to retain by means of the ADD PIN function above.

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*** ADD CAR ALARM: Allows the user to add a car alarm to the system. The "INSTALL" button on the car alarm

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(placed in its "INSTALL" mode) should be pressed several times as prompted to "introduce" it to the system.

5 *** CLEAR CAR ALARMS: De-installs all car alarms -
useful if one sells a car.

10 *** SET UP AUTODIAL: Allows the user to define numbers
to be called and their order, and record the messages
to be played.

15 *** NETWORK: With suitable software allows the user to
participate in a multi-main unit network. This part of
the menu is to activate the network reporting/listening
functions for everyday use. The introduction of main
units to each other is done via the main "INSTALL" mode
above.

20 SYSTEM TEST: Displays the present installed repeaters
and sensors activated, hence allowing the user to check
(with the aid of a helper) that each of the installed
sensors is correctly detecting activation and reporting
back to the main unit.

25 *** CLEAR ALL: Used to shut down a system and reset
all the set-ups to "default" values. This could be
used when moving house, for example, as it also turns
off the battery. It does not directly clear the log,
although removal of the mains supply after this
30 operation will cause loss of log data.

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CLAIMS:

- 5 1. A control unit for a signal communication system, the control unit being arranged for connection to mains electrical wiring for the transmission of output signals over the mains wiring and having inputs for wired connection to a plurality of analogue and/or digital sensors, wherein the control unit includes microprocessor means and is coded with an invariable code.
- 10 2. A control unit as claimed in claim 1, which is responsive also to one or more remote alarms and/or user signalling devices by means of coded radio communication.
- 15 3. A signal communication system comprising a control unit connected to mains electrical wiring, and at least one repeater unit also connected to said mains electrical wiring and having one or more sensors wired thereto, wherein the control unit and the repeater unit or units communicate by way of coded signals using the mains wiring.
- 20 4. A signal communication system as claimed in claim 3, in which the control unit is also wired to a plurality of sensors.
- 25 5. A signal communication system as claimed in claim 3 or 4, in which the control unit is responsive to one or more remote alarms and/or user signalling devices by means of coded radio communication.
- 30 6. A signal communication system as claimed in claim 5, in which the remote alarm or alarms are car alarms.
- 35 7. A signal communication system as claimed in claim 5 or 6, in which the user signalling devices are hand-held key fobs.
8. A signal communication system as claimed

in any of claims 3 to 7, in which the sensors comprise sensors which provide both an analogue and a digital output.

5 9. A signal communication system as claimed in any of claims 3 to 8, in which the control unit and said at least one repeater unit regularly exchange secure messages and have detector means for detecting disconnection of or failure of the mains electrical supply.

10 10. A signal communication system as claimed in any of claims 3 to 9, in which the control unit includes panic button means which can be actuated by a user to generate an output signal.

15 11. A signal communication system as claimed in claim 7, in which the key fob includes a panic button which when pressed causes the control unit to respond according to preset actions.

20 12. A signal communication system as claimed in claims 6 and 7, in which the key fob includes switch means to change between car and main system functions, and two buttons for arming and disarming the main system respectively.

25 13. A signal communication system as claimed in any of claims 3 to 12, in which the control unit comprises a log of events including all arming and disarming actions and intrusions while the system is armed.

30 14. A signal communication system as claimed in any of claims 3 to 13, in which the control unit includes a keypad, a display panel and means to select menus for display.

35 15. A signal communication system as claimed in any of claims 3 to 14, in which the code used for communication consists of 24 bits of data embedded in a 48-bit error detection and correction scheme.

16. A signal communication system as claimed in any of claims 3 to 15, in which the control unit includes an auto-dialler.

5

17. A network communication system comprising a plurality of systems as claimed in any of claims 1 to 16 connected by said mains electrical wiring.

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18. A system as claimed in claim 17, in which one or more of the individual systems can be activated, at will, to be reporting points to receive signals originating at another of the systems.

19. A control unit as claimed in claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

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20. A signal communication system as claimed in claim 3, substantially as hereinbefore described with reference to the accompanying drawings.

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Patents Act 1977
Examiner's report to the Comptroller under
Section 17 (The Search Report)

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- (i) UK Cl (Edition L) G4H (HNEC, HNEE, HNEM, HNHE, HNNB)
(ii) Int Cl (Edition 5) G08B

Search Examiner

M J DAVIS

Databases (see over)

- (i) UK Patent Office
(ii)

Date of Search

5.5.93

Documents considered relevant following a search in respect of claims 1, 2, 17 (PART), 18 (PART) 19

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2916161 A (WOON ET AL) whole document eg figure 3	1 at least
X	GB 2182791 A (PCG) whole document eg figures 3, 4	1 at least
X	WO 86/06890 A1 (BT) whole document	1, 2 at least
X	US 4812821 (SANTY) whole document	1 at least
X	US 4737769 (VILA-MASOT) whole document	1 at least
X	US 3925763 (WADHWANI ET AL) whole document eg figures 1, 15	1, 2 at least



Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).