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(71) Applicant: **PITTWAY CORPORATION**
Chicago, Illinois 60606 (US)

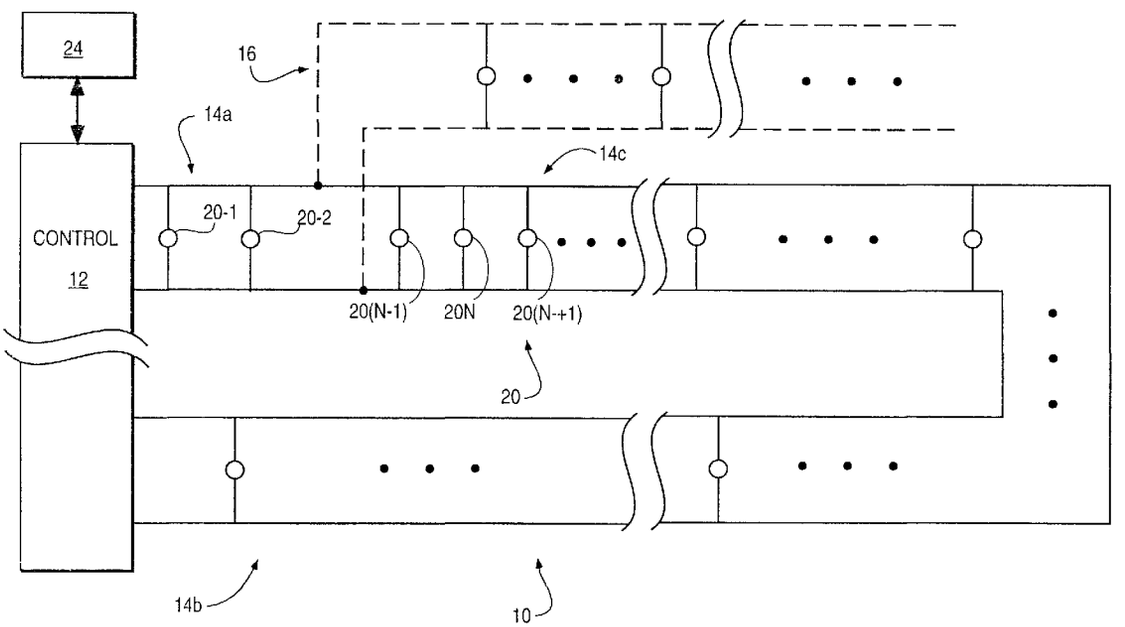
(72) Inventor: **Gonzales, Eric V.**
Aurora, Illinois 60504 (US)

(74) Representative: **Vigars, Christopher Ian et al**
Haseltine Lake & Co.,
Imperial House,
15-19 Kingsway
London WC2B 6UD (GB)

(54) Detection systems

(57) Event or ambient condition detectors which incorporate isolation circuitry will generate the address of the next detector. The detector which receives the address communicates an acknowledge signal to the address assigning detecting indicating that it has properly received the address. The address receiving detector in turn, after storing the received address, increments same and transmits it to an adjacent detector. The adjacent detector upon receipt of a valid address acknowledges same. The detectors communicate on a bidirectional communication link and utilize isolation circuitry for the purpose of transmitting an address to be received by and stored in an adjacent detector. The isolation circuitry can incorporate solid state or mechanical switches.

FIG. 1



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Description

Field of the Invention:

[0001] The invention pertains to detection systems, in particular systems which incorporate a plurality of event or ambient condition detectors.

Background of the Invention:

[0002] Systems for monitoring regions of commercial and industrial establishments have been found to be useful for security and safety purposes. One type of system includes a control unit which is coupled to a plurality of spaced apart ambient condition detectors via a communications link. The detectors can for example include intrusion, smoke, flame, temperature or gas sensors.

[0003] In such systems, detector designations, sometimes called addresses, are used to facilitate communication and to identify a particular detector. The control unit includes a data base that links detector addresses, arbitrarily assigned, to physical locations. It is often useful to be able to establish which detectors are adjacent to one another on the communication link.

[0004] Addresses can be assigned when detectors are manufactured. Alternately, they can be set at installation manually or by the control unit.

[0005] Detectors are usually removably mountable on a permanently installed base. A given detector can be removed for maintenance or repair and then replaced on the respective base.

[0006] When the detector, or detectors is, are replaced on the respective base or bases, there is not necessarily any assurance that a given detector will be replaced on the base from which it was removed. This presents a problem to the control unit which must keep track of the locations of the detectors so as to be able to map a particular detector, which may be indicating the presence of an event or an ambient condition of concern, into a physical location.

[0007] One solution to this problem has been disclosed and claimed in U.S. Patent No. 5,357,243 entitled *Electrical Unit with an Adjustable Mechanical Switch For Address Verification,* assigned to the Assignee hereof. The system of the '243 patent while effective, required that address switches installed on the detector be manually set to an appropriate address corresponding to the address of the base. Hence, a mismatch between a base and a detector kept the detector from engaging the base.

[0008] In another known approach, the detectors are coupled in series to a communication line. The detectors open circuit the communication line, and then close circuit the line sequentially.

[0009] The control unit senses the first open circuited detector and it closes the circuit therethrough. The control unit then senses the second detector and it closes the circuit therethrough. Each of the detectors, which are serially linked to at least one other detector is then located relative to the adjacent detectors. In this approach, the control element is the only recipient of communications from the respective detectors. Detector identification takes place using current signals.

[0010] In yet another known system, the control element issues a command to a selected detector directing it to send a current pulse to the control element. The control element then checks to determine which detectors sensed the current pulse. Each detector on the loop between the current transmitting detector and the control element will sense the current pulse. This information can be used to establish the relative locations of the various detectors on the communications link.

[0011] There continues to be a need for systems and methods which can be used to automatically establish detector locations relative to other detectors and/or detector addresses. Preferably such functionality could be provided without significantly increasing the complexity or cost of the associated monitoring systems.

Summary of the Invention

[0012] Various aspects of the present invention are exemplified by the attached claims

[0013] Addresses can be automatically and self-assigned to a plurality of ambient condition or event detectors which communicate with one another via a bidirectional communication link. The detectors each include control circuitry as well as non-volatile storage circuitry.

[0014] An operator or an installer can manually generate an initial address at a first detector using, for example, detector mounted push buttons. That address is stored in the detector in the non-volatile storage circuitry. An initial address can also be established by an operator using a wireless communication unit.

[0015] The control circuitry in the detector alters the address and transfers it to a selected adjacent detector on the communication link. The adjacent detector, upon receipt of a valid address, transmits an acknowledgement signal back to the address transmitting detector. In addition, the addressed detector stores the received address in its respective non-volatile storage circuitry.

[0016] In one aspect, each detector can increment or decrement a respective address. The altered address is then transferred to the next detector.

[0017] The addressed detector can in turn increment its received address and, in a similar fashion, transfer it to a selected adjacent detector. The process is then repeated until an address has been assigned to every detector in the system.

[0018] In the event that the communication link incorporates one or more branches or junctions, two or more detectors may be assigned the same address on different branches. When the initial phase has been completed, address assignments can be checked.

[0019] Where more than one detector has been assigned a common address, the first detector on one of

the branches becomes a candidate for receipt of a different address. The different address can be manually entered.

[0020] Once a new address has been entered, the above process can be repeated by just the detectors on that one branch resulting in a unique set of addresses being assigned to the detectors coupled thereto. In the event that there are multiple parallel branches, the above process is repeated.

[0021] In one aspect in addition to control circuitry and non-volatile storage, each of the detectors includes first and second independently operable switches coupled to the communication link. In yet another aspect, the detectors each can include a third switch for use in transmitting acknowledgement messages to an upstream or addressing detector. The switches can be implemented as either solid state devices or mechanical switches.

[0022] In a particular embodiment, the present apparatus provides automatic addressing of detectors without the aid of a common control unit. Auto-addressing is accomplished using individual detectors to propagate and store, incremented address values. When auto-addressing is initiated from detector N, the address will be incremented by one and passed to detector N + 1. Detector N + 1 will store this address and will provide an incremented value to the next detector, etc.

[0023] The detectors each include additional power sensing ports. These ports have two functions. One is to detect the origin of the power source. The auto-addressing process propagates away from the power source.

[0024] These ports also detect acknowledge signals from the following detector. These signals indicate that the address data sent was received properly. The following unit validates the data, for example, by evaluating a check sum. After detector N + 1 validates the address from detector N, it transmits an acknowledge signal to detector N.

[0025] A particular advantage of a system which embodies the present invention lies in the fact that the common control unit or alarm panel, which is also coupled to the communication link, need not dedicate resources to the generation and assignment of addresses. Rather, once an initial address has been established in an upstream or initial detector, all of the subsequent addresses for the system can be automatically generated therefrom. Hence, no transmissions of addresses from the common control unit are required.

[0026] Numerous other advantages and features of the present invention will become readily apparent from the following detailed description of the invention and the embodiments thereof, from the claims and from the accompanying drawings.

Brief Description of the Drawings:

[0027]

Fig. 1 is an overall block diagram of a system in accordance with the present invention;

Fig. 2 is a block diagram illustrating some of the characteristics of some of the units of Fig. 1;

Figs. 3A and 3B together are a flow diagram illustrating a method of automatic addressing implementable by the system of Fig. 1;

Fig. 4 is a more detailed schematic diagram of one implementation of the units of Fig. 2; and

Fig. 5 is a block diagram illustrating another implementation of the units of Fig. 2.

Detailed Description of the Preferred Embodiments:

[0028] While this invention is susceptible of embodiment in many different forms, there are shown in the drawing and will be described herein in detail specific embodiments thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the specific embodiments illustrated.

[0029] Fig. 1 illustrates a system 10 which incorporates a common control element 12. The element 12 can incorporate one or more programmable processors as would be understood by those of skill in the art.

[0030] Coupled to the control element 12 is at least one branch 14a of a bidirectional communications link. The branch 14a can be coupled at a first end to the control element 12 and can terminate at a second end remote from the control element 12. Alternately, the branch 14a can be coupled to a branch 14b which terminates at the control element 12. A branch 16, illustrated in phantom, can in turn, be coupled to the branch 14a and extend electrically in parallel with a segment 14c thereof.

[0031] Coupled to the branch 14a is a plurality of event detectors 20. The event detectors 20 could be implemented as motion detectors, position detectors, or ambient condition detectors. Ambient condition detectors could include smoke or gas detectors without limitation. The branches 14a, b and 16 enable the members of the plurality 20 to carry out bidirectional communication with the control element 12 as would be understood by those of skill in the art.

[0032] For purposes of issuing commands to, or, receiving information from various members of the plurality 20, the control element 12 includes circuitry for generating instructions which can specify one or more members of the plurality 20 or for analyzing feedback signals received, via the branches 14ab from one or more of the members of the plurality 20.

[0033] The members of the plurality 20 are designated by indicators or addresses. The addresses for vari-

ous of the members of the plurality 20 can be linked via a data base maintained by the control element 12 to physical locations of the respective members of the plurality 20.

[0034] The control element 12 includes circuitry in turn for receiving inputs from or generating visible or audible messages to an operator in put/output unit 24. The unit 24, as will be understood by those of skill in the art, could include an operator manipulatable keyboard as well as display devices or printers for the purpose of providing operator understandable messages or diagrams concerning the status and operation of the system 10.

[0035] Fig. 2 illustrates in more detail characteristics of three of the members of the plurality 20(N-1), 20N, and 20(N+1). Each of the units 20(N-1), 20N and 20 (N+1) is operably coupled to the bidirectional communication branch 14a. Each of the units includes a housing indicated in phantom for unit 20(N-1) as housing 30N-1. Each housing carries respective control circuitry 32N-1, 32N and 32N+1. As discussed in more detail subsequently, the circuitry 32N can include one or more programmable processors along with selected discrete circuitry. In such an implementation, the system 10 corresponds to an event detecting distributed multiprocessor communication system.

[0036] Each of the members of the plurality 20 includes first and second communication link isolation elements, SW1N-1, SW1N, SW1N+1, SW2N-1, SW2N and SW2N+1. The respective isolation elements, which function under the control of the respective local control circuitry, such as 32n, can be open circuited or closed circuited thereby enabling communication signals and electrical energy to travel unimpeded through the respective detector via branch 14a.

[0037] The system 10 in accordance with the present invention implements automatic assignment of indicators or addresses for each of the members of the plurality 20 based on little or no intervention by the control element 12. The process can be initiated at unit 20-1 via control element 12. Alternately, the process can be initiated at any member of the plurality 20.

[0038] In the event that there is a single communication branch 14a, the process will propagate away from a power source, one unit at a time from the initiating unit to the right as illustrated in Fig. 1. In the event that the communication link includes branches 14a, 14b, a decision will be made at the initiating unit in connection with the direction of propagation.

[0039] Where the respective system includes a branching link such as the branch 16, units on the branch 14a which correspond, relative to the initiating unit, to units on the branch 16 will be assigned the same address in an initial pass. Subsequently, in response to manual intervention, addresses can be re-assigned to the units on the branch 16.

[0040] Figs. 3A and 3B illustrate the steps of a method implementable by the system 10 for the purpose of assigning the subject addresses.

[0041] When the system 10 is powered up in a step 100, all of the isolation switch elements such as SW1n and SW2n are open circuited. In the step 102, N is initialized to the value one.

[0042] In a step 104, unit N, with respect to Fig 2, detects power on the communication branch 14a, in this instance from the control element 12, at port Ln. In a step 106, in response to power being detected, isolation element SW1N is closed.

[0043] In a step 108, unit N awaits an instruction or command from a prior unit. Where unit N corresponds to unit 20-1, the prior unit corresponds to the control element 12. Alternately, where N is a larger number, the unit N receives an initiating command from a prior unit, closer to a power source, corresponding in Fig. 2 to unit 20(N-1).

[0044] If a step 110, the designated unit detects an auto-addressing instruction, in a step 112 an address will be transmitted on the branch 14a from the prior unit along with a check sum. The received data will be processed in a step 114, by the receiving unit N. If the received address and check sum are acceptable, in a step 116, the received address is stored at unit N.

[0045] In a step 118, an acknowledge signal is sent to the transmitting unit, either control element 12 or unit N-1. In a step 120, unit N modifies the stored address for transmission to the next unit N + 1 illustrated to the right of unit N in Fig. 2.

[0046] Any one of a variety of processes can be used to modify the stored address for the next unit. For example, the stored address could be incremented, or decremented by predetermined amounts. Other modifications of the stored address can be carried out without departing from the spirit and scope of the present invention.

[0047] In a step 122, switch SW2N is closed. This in turn applies electrical energy to the subsequent unit.

[0048] In a step 124, the value of the designator N is incremented. The process then repeats starting at step 104.

[0049] Where the processed input has been found not to be acceptable in the step 115, a signal is sent to the transmitting unit indicating non-receipt or non-acknowledgement of a valid address and check sum. The transmitting unit will, in turn, in step 126 retry steps 112, 114 and 115 up to three times.

[0050] In the event that there are three failures in a row, in a step 128 a failure or trouble message or signal can be generated by the unit N-1 for the control element 12. In the event that the last unit on the link has been addressed, no acknowledgement or failure signals will be received. This condition will be detected in a step 130 causing the process to terminate.

[0051] The above-described process reflects a sequence of energizing the respective communication link and initiating the addressing process via the control element 12 and unit 20-1. Alternately, in the event that the control element 12 does not generate an automatic ad-

dressing mode instruction in the step 108, an operator or installer in a step 134 can specify an address at a selected unit. The specified address will in turn be stored at the specified unit and in response thereto, the corresponding isolation element SW2 will be opened in a step 136.

[0052] The selected unit can then modify the stored address in the step 120, close or short circuit its respective isolation element SW2 in the step 122 increment the value of the designator N in the step 124 and continue the process starting the step 104. In this way, the units in the branch 16, see Fig. 1, can be assigned addresses which are distinct and unique from any of the address assigned on either of the branches 14a, b.

[0053] It will be understood that an address can be manually entered at a selected unit by means of manually manipulating one or more switches located on the unit so as to specify the automatic addressing mode, and to enter a selected address for that unit. Alternately, a wireless portable programming unit which could be placed in communication with selected unit via RF, ultrasonic, or infrared links can be used to specify a mode and an address for a selected unit.

[0054] In Fig. 4, a schematic diagram illustrates one embodiment of a unit N usable in the system 10. The unit N includes terminals 50a, b which can be coupled to one side of the branch for example 14a and a terminal 50c which can be coupled to the other side of the branch.

[0055] Unit N includes isolation elements or switches SW1N, SW2N as discussed above. Each of the switches is coupled in parallel across a respective isolation diode D1, D2. The cathodes of the diodes D1, D2 are, in turn, coupled to a bidirectional communications port of an event detector 52, intended to operate as part of a communications system.

[0056] The detector 52 could include a sensing element, such as a smoke or temperature detector, a movement detector or position detector as would be known to those of skill in the art along with local control circuitry.

[0057] The unit N also includes resistors R1 and R2 which are coupled between terminals 50a, c and input port P3 to the detector 52. Input port P3 is adapted to detect the application of electrical energy on the branch 14a between terminals 50a, c. The unit N also includes resistors R3 and R4 coupled between terminals 50b, c and in turn coupled to input port P2. The detector 52 includes circuitry for detecting the presence of electrical energy applied to either of ports P2 or P3 indicating a direction of receipt of electrical energy or power.

[0058] The unit N of Fig. 4 also includes an isolation diode D3 coupled between bidirectional communications port P4 and an energy storage capacitor C1. A control switch or isolation element SWB is coupled in parallel across the diode D3. Electrical energy is applied via the cathode of diode D3 to capacitor C1 and to an energy input port P1 of the detector 52.

[0059] The detector N of Fig. 4 operates as described above in carrying out the process of Figs. 3A, 3B. An acknowledge signal can be generated for use by the address transmitting unit N-1 by removing electrical energy from the branch 14a in the vicinity of the unit N and closing or short circuiting the isolating element SWB. This in turn generates an acknowledge signal detectable by the unit N-1. The capacitor C1 also stores energy locally functioning as a local power supply for purposes of energizing the detector N. The input ports P2, P3 in addition to detecting a direction of application of electrical energy to the unit N, are also effective to detect the presence of an acknowledge signal generated by closing or short circuiting the isolation element SWB generated by the address receiving unit.

[0060] Fig. 5 illustrates an alternate form of a unit 60 usable with the system 10 to carry out an automatic addressing process. The unit 60 includes local control circuitry implemented in part by a programmable processor 62a. The processor 62a is coupled to an event or ambient condition sensor 62b. The sensor 62b could include any form of position, motion, temperature or smoke sensor without limitation.

[0061] Coupled to processor 62a is read-only memory 62c, programmable read-only memory 62d and read-write memory 62e. The memory units 62c, d and e could be used individually or combined together as would be understood by those of skill in the art for the purpose of storing in a non-volatile fashion commands, constants or other information and for storing in a volatile fashion transient information.

[0062] The processor 62a includes signal input ports 64a, b for the purpose of detecting a direction of applied electrical energy on the branch 14a as discussed previously. The ports 64a, 64b can also be used to detect transmission acknowledgment or failure signals from units to which addresses have been sent as discussed previously.

[0063] Processor 62a is in turn coupled to a local power supply 66a which can be energized from electrical energy received via the branch 14a. Interface circuitry 66b enables the processor 66a to carry on bidirectional communications via the branch 14a with a control element, such as the element 12, or other units in the system.

[0064] Diodes D1' and D2' provide isolation as discussed previously. The unit 60 includes two isolation units SW1-60 and SW2-60 which function under the control of the processor 62a so as to implement the method previously described in Figs. 3A and 3B.

[0065] The method of Figs. 3A, 3B could be modified, as would be understood by those of skill in the art, to incorporate additional detail or variations obvious in view of the above description and figures. Isolation elements SW1N, SW2N can be implemented as solid state or mechanical switches.

[0066] From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the invention. It is to be understood that no limitation with respect

to the specific apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

Claims

1. An event detector comprising:

a sensor;
at least one terminal for coupling to a communications link;
control circuitry, coupled to the sensor and the terminal;
at least one isolation element coupled to the control circuitry and the terminal;
an information storage element; and
an address receiving input port coupled to the control circuitry wherein in response to selected inputs, the control circuitry stores a unit identifier in the storage element, and establishes a unit identifier for another detector, including circuitry for placing the isolation element into a low impedance state whereupon the established address can be coupled to the terminal.

2. A detector as in claim 1 which includes a second terminal for coupling to the communications link and a second isolation element coupled to the control circuitry and the second terminal.

3. A detector as in claim 1 wherein the input port includes at least one manually operable member.

4. A detector as in claim 3 which includes a visual readout coupled to the control circuitry.

5. A detector as in claim 1 wherein the input port incudes radiant energy receiving circuitry.

6. A detector as in claim 2 which includes circuitry for establishing a direction from which power is being supplied to the detector by the link.

7. A detector as in claim 6 which includes circuitry for generating an identifier received signal.

8. A detector as in claim 6 which includes circuitry for altering a detector's identifier to establish the identifier for another detector.

9. A detector as in claim 8 wherein the altering circuit comprises circuitry for one of incrementing and decrementing the identifier.

10. A detector as in claim 1 wherein the sensor comprises a smoke sensor.

11. A method of substantially automatically assigning addresses to a plurality of linked detectors of a type as in claim 1 comprising:

establishing an address to be assigned to an initial detector;
assigning the address to the detector;
forming in the detector an address to be assigned to the next detector;
repeating the assigning and forming steps in the next detector.

12. A method as in claim 11 wherein at least some of the address assigned detectors communicate receipt of an assigned address to a respective address assigning detector.

13. A method as in claim 11 wherein in the event of multiple, connected, parallel links, detectors on different links will be assigned identical addresses.

14. A method as in claim 11 wherein the forming step includes one of incrementing and decrementing the address assigned to the detector.

15. A method as in claim 11 wherein the next detector receives electrical energy from the detector.

16. A method as in claim 15 wherein the next detector establishes a direction indicative of receipt of the electrical energy.

17. A method as in claim 11 which includes, in at least some of the detectors, sensing an ambient condition.

FIG. 1

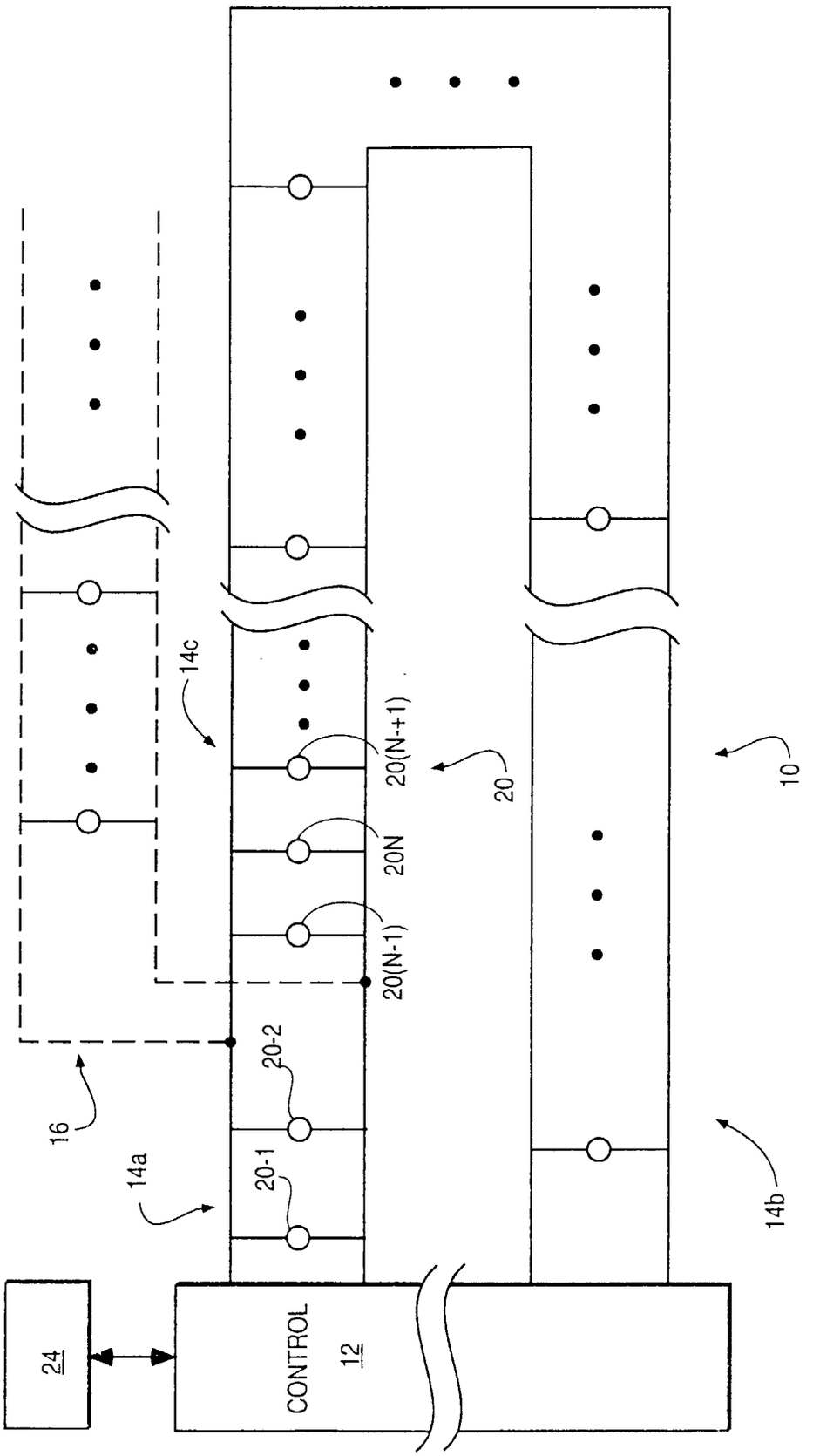


FIG. 2

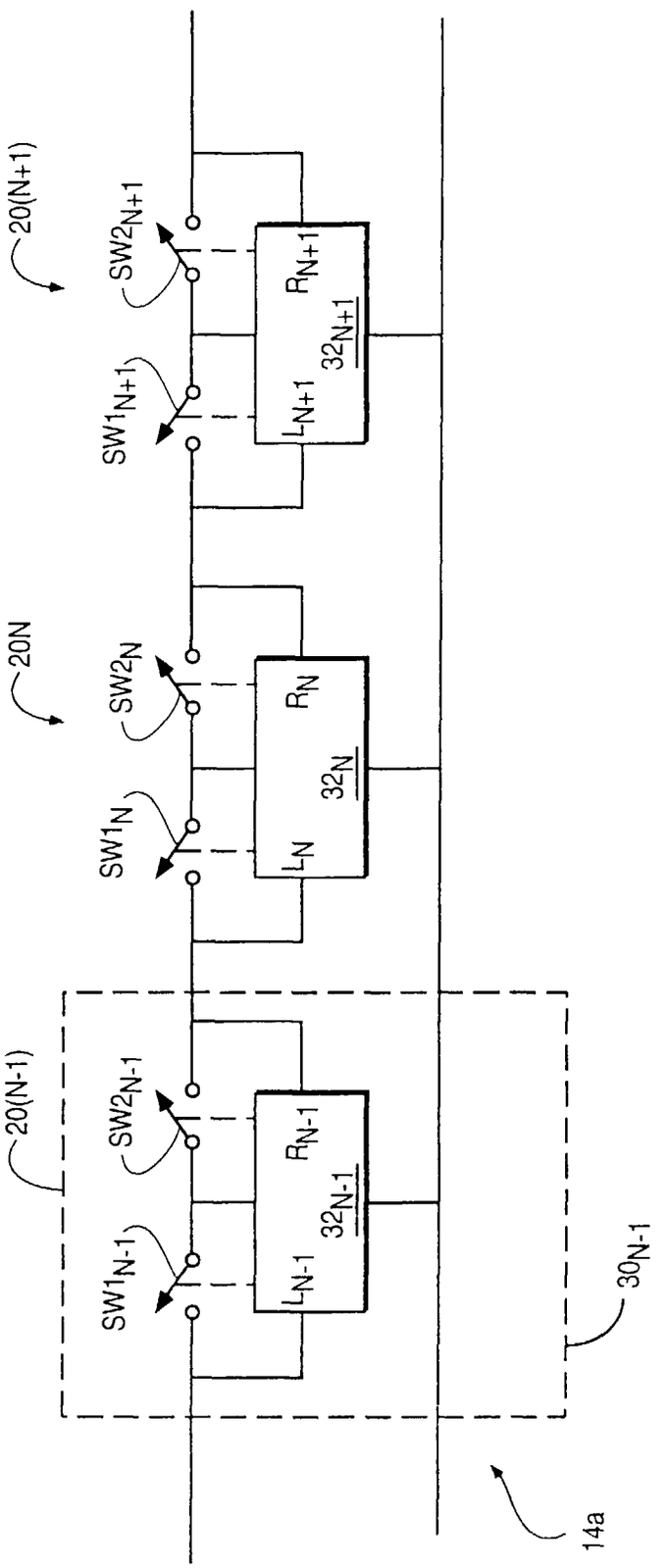

20(N+1)
SW2N+1
SW1N+1
RN+1
LN+1
32N+1
20N
SW2N
SW1N
RN
LN
32N
20(N-1)
SW2N-1
SW1N-1
RN-1
LN-1
32N-1
30N-1
14a

FIG. 3A

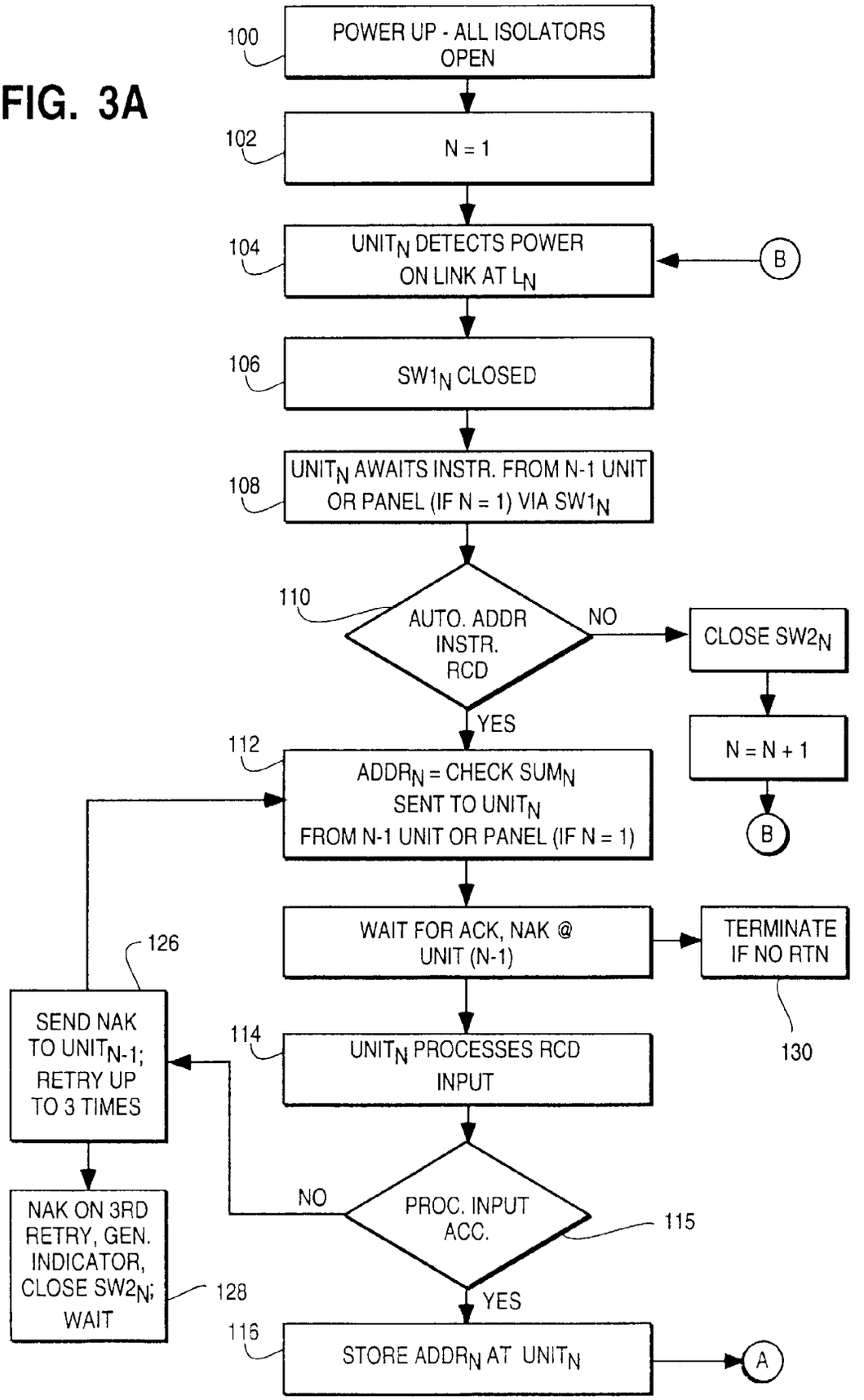

100
POWER UP - ALL ISOLATORS OPEN
102
N = 1
104
UNIT$_N$ DETECTS POWER ON LINK AT L$_N$
B
106
SW1$_N$ CLOSED
108
UNIT$_N$ AWAITS INSTR. FROM N-1 UNIT OR PANEL (IF N = 1) VIA SW1$_N$
110
AUTO. ADDR INSTR. RCD
NO
CLOSE SW2$_N$
N = N + 1
B
YES
112
ADDR$_N$ = CHECK SUM$_N$ SENT TO UNIT$_N$ FROM N-1 UNIT OR PANEL (IF N = 1)
WAIT FOR ACK, NAK @ UNIT (N-1)
TERMINATE IF NO RTN
130
126
SEND NAK TO UNIT$_{N-1}$; RETRY UP TO 3 TIMES
114
UNIT$_N$ PROCESSES RCD INPUT
NAK ON 3RD RETRY, GEN. INDICATOR, CLOSE SW2$_N$; WAIT
128
NO
PROC. INPUT ACC.
115
YES
116
STORE ADDR$_N$ AT UNIT$_N$
A

FIG. 3B

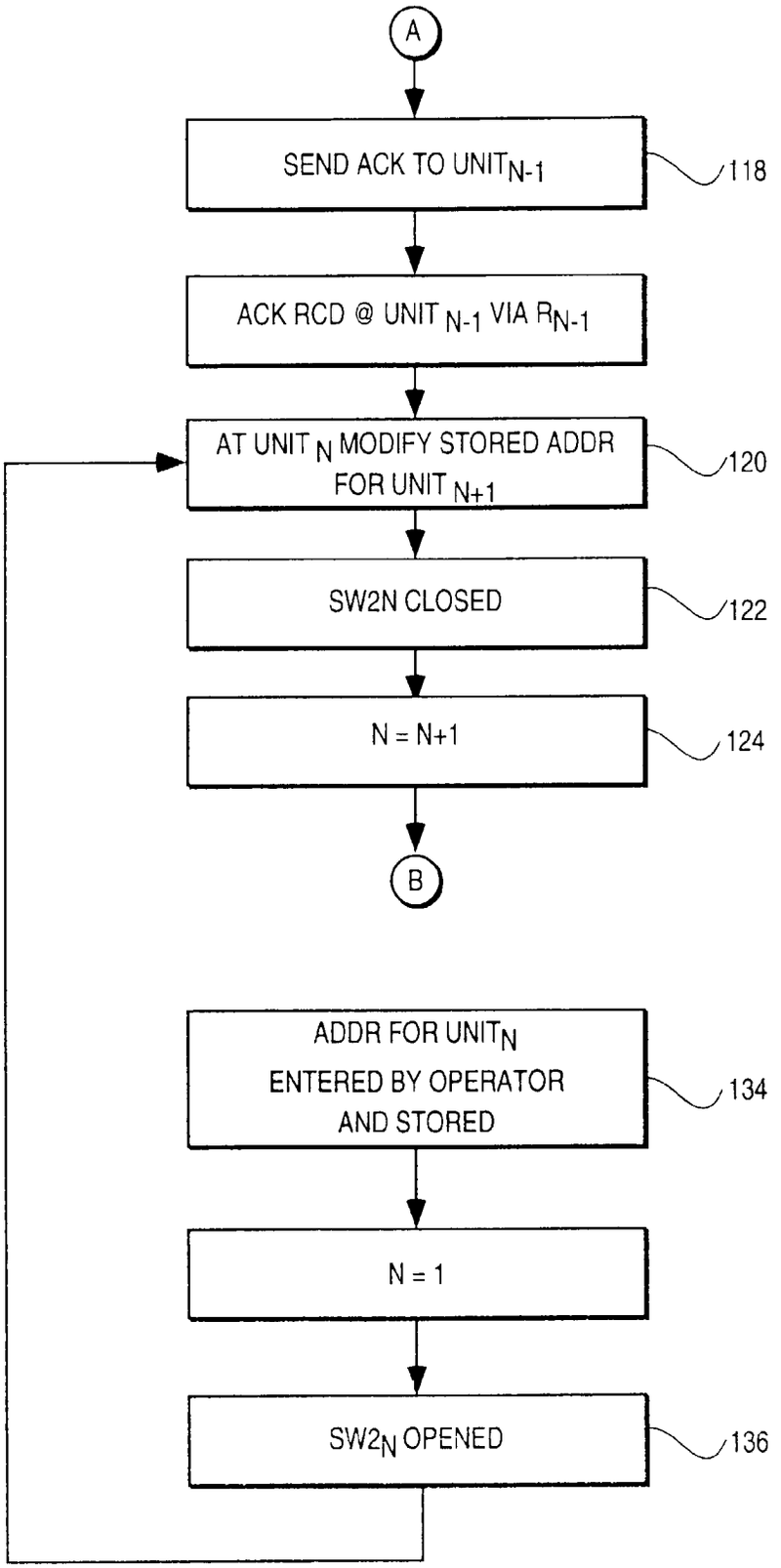

A
SEND ACK TO UNIT N-1
118
ACK RCD @ UNIT N-1 VIA RN-1
AT UNIT N MODIFY STORED ADDR FOR UNIT N+1
120
SW2N CLOSED
122
N = N+1
124
B
ADDR FOR UNIT N ENTERED BY OPERATOR AND STORED
134
N = 1
SW2N OPENED
136

FIG. 4

DETECTOR$_N$ SCHEMATIC

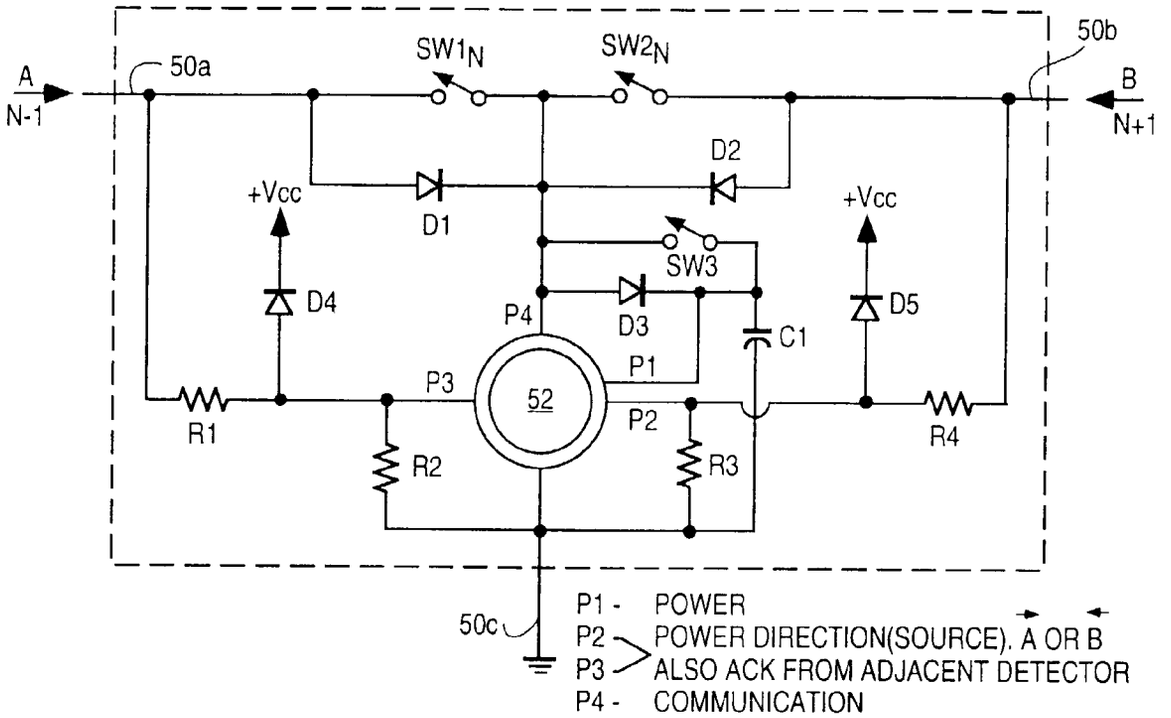
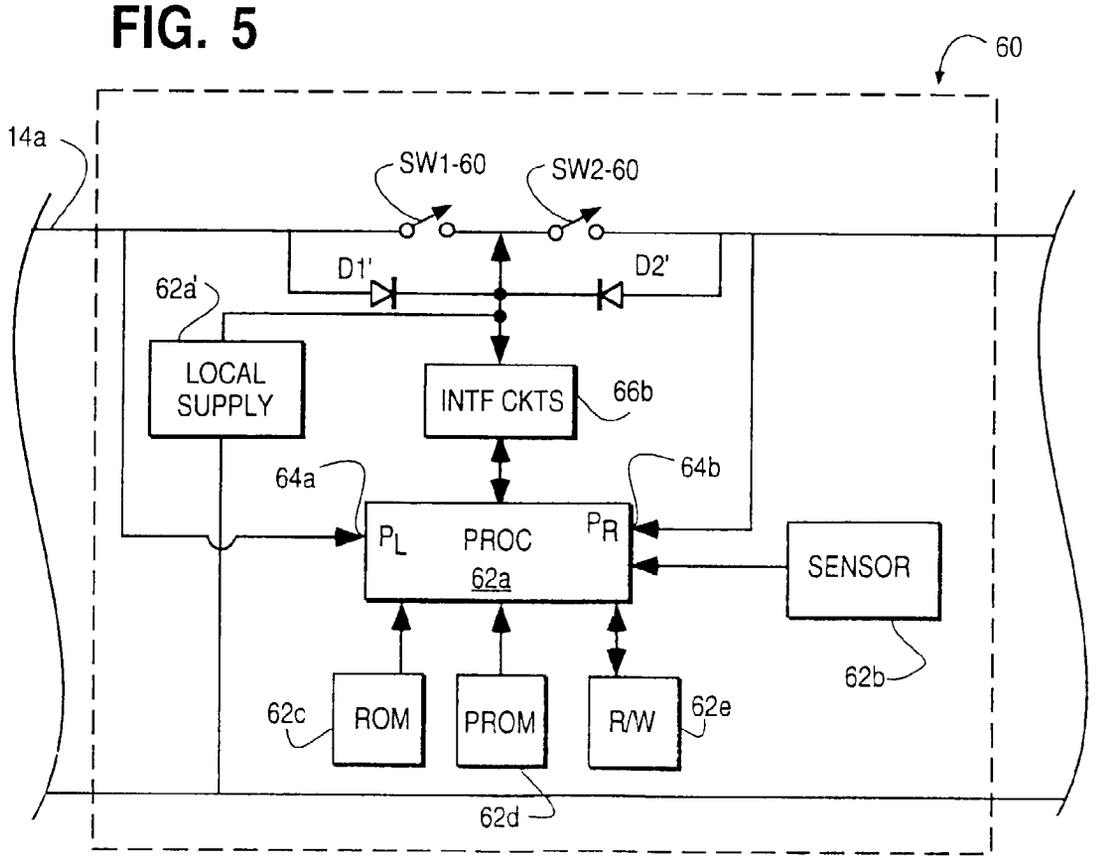


FIG. 5



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 4614

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	US 4 849 752 A (BRYANT STEWART F) 18 July 1989 (1989-07-18) * column 1, line 61 - column 2, line 35 * * column 2, line 67 - column 3, line 7 * * column 3, line 51 - line 53 * * column 4, line 54 - line 61 * * column 7, line 48 - column 8, line 17 * * column 8, line 47 - line 50 * * column 14, line 45 - line 57 * * column 15, line 45 - line 52 * * column 14, line 61 - line 63 * * figures 4,7 *	1,2,5-17	G08B26/00
Y	US 4 612 534 A (BUEEHLER RICHARD ET AL) 16 September 1986 (1986-09-16) * column 1, line 9 - line 11 * * column 6, line 33 - line 53 * * figure 3 *	1,2, 5-12, 14-17	
P,Y	EP 0 854 609 A (NITTAN CO LTD) 22 July 1998 (1998-07-22)	13	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
P,A	* column 1, line 11 - line 18 * * column 2, line 20 - line 24 * * column 3, line 8 - line 23 * * column 4, line 4 - line 10 * * column 4, line 29 - line 43 * * column 12, line 6 - line 7 * * figures 2,8,9 *	1-12, 14-17	G08B
P,A	EP 0 880 117 A (PITTWAY CORP) 25 November 1998 (1998-11-25) * column 3, line 36 - column 4, line 1 * * column 5, line 1 - line 36 * * column 8, line 33 - line 38 * * claims 3,8,11,12 *	1-17	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	9 September 1999	De la Cruz Valera, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 4614

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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09-09-1999

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