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(54) **Obstruction detection system**

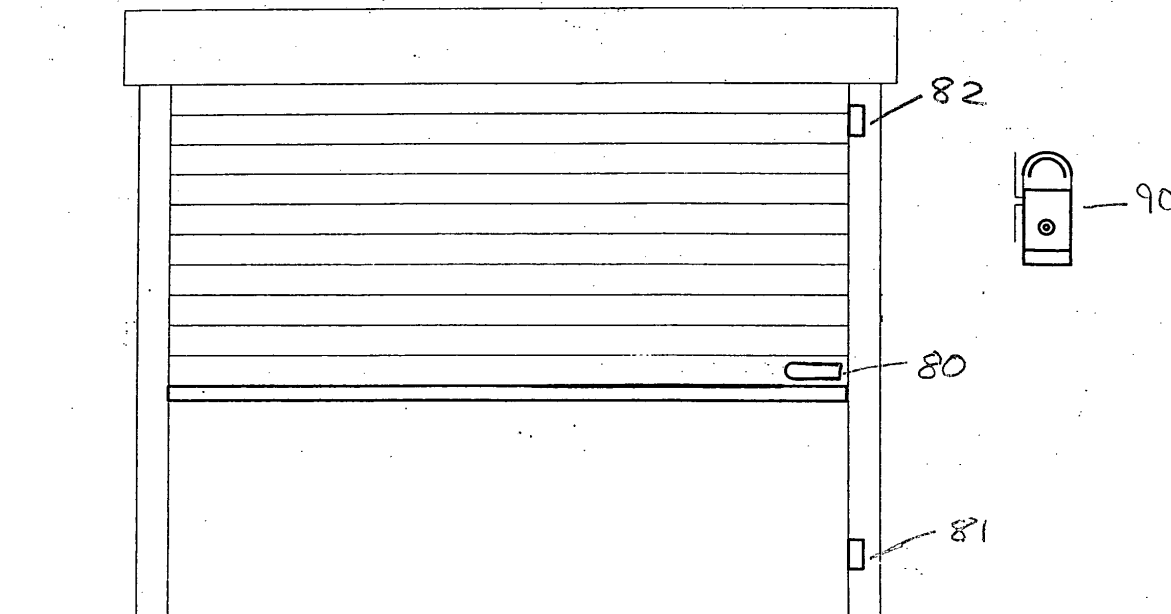
(57) A device which is arrangeable in use to detect an obstruction of a moving member, comprising:

a contact detecting means (20) for detecting contact of the moving member with an obstruction and outputting an electrical obstruction detection signal in response to the detection of said obstruction;

a control unit (10) arranged to receive the electrical obstruction detection signal output from the contact detecting means (20) and output an obstruction warning signal in response thereto;

a wireless transmission means (30) for transmitting the obstruction warning signal to a counterpart wireless device (90).

Figure 8



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Description

[0001] The present invention relates to a device, system and method for detecting an obstruction of an automated door, in particular a roller shutter door.

[0002] Roller shutter, up and over and other automated doors are often used in industrial units, commercial shop fronts, garages and the like. These doors are frequently electrically automated, by means of an electric motor, to open or close. It is a requirement that some form of safety system is employed to minimise or eliminate the risk to people or other obstacles which may be present in the path of a closing automated door, particularly to prevent a closing automated door causing harm by crushing, drawing-in or trapping.

[0003] Crushing, drawing-in and trapping of an obstruction can occur between a main closing edge of a door and an opposing edge such as the floor, and between secondary closing edges of hinged, folding, tilting and sliding doors; between closing edges and obstacles within a closing area of each leaf of the door; between leaves passing each other during movement of the door; between leaves and fixed objects in the vicinity of each leaf; between gaps and areas adjacent to each leaf which change in size during leaf movement; and parts projecting from each leaf. As such, an obstruction means any object within the vicinity of the door likely to cause harm in any of the above ways.

[0004] It is known to use an optical safety system such as an Electro-Sensitive Protective Equipment (ESPE) system comprising an optical beam, which is used to detect an obstruction and prevent the door closing further when an obstruction is detected. However, unless the ESPE system employs a plurality of optical beams at multiple levels throughout the door travel aperture, these devices only provide limited protection against a closing door trapping an obstruction. Alternatively, an optical beam may be located upon a lower edge of the door. Such door-edge optical systems employ a transmit-receive infrared beam encapsulated in a rubber profile with the transmitter fitted at one end of the door and the receiver fitted at the other.

[0005] It is also known to fit physical obstruction detection safety system to a lower edge of the door. Such systems are known as Pressure Sensitive Protective Equipment (PSPE) systems. Usually, the PSPE comprises an elongate edge switch running along the underside of the door, for example a pair of separated metallic strips located in a rubber housing may be used. In normal use, the metallic strips are arranged to rest a small distance apart and at one end of the switch a fixed end-of-line resistor connects the two separate metal contacts, providing a normally closed conduction path with a fixed resistance value. In some cases, the end-of-line resistor is replaced by a diode. Since the metallic strips are located within a flexible structure, when the leading edge of the door contacts with an object, the applied pressure causes the rubber moulding to deform

and the metallic strips to contact together, forming a closed switch, bypassing the end of line resistor or diode.

[0006] A control system, usually located integral to an electrical motor automating the door, monitors the fixed resistance path or optical beam. Upon an obstruction being detected in the path of the door, the control system detects the change in resistance of the edge switch or break in the optical beam and switches off the electrical motor automating the door. An electrical connection between the control system and the edge-switch is needed to allow monitoring of the detection device by the control system. In order to prevent the electrical connection from becoming a safety hazard in itself, the connecting cable is required to be self-coiling or mechanically controlled so as to retract any excess cable.

[0007] An aim of the present invention is to provide an obstruction detection system that eliminates the safety risk posed by the electrical cabling connecting the control system and the obstruction detection device.

[0008] According to the present invention there is provided a device, method and system as set forth in the appended claims. Preferred features of the invention will be apparent from the dependent claims and the description that follows.

[0009] According to a first aspect of the invention there is provided a device which is arrangeable in use to detect an obstruction of a moving member, comprising:

30 a contact detecting means for detecting contact of the moving member with an obstruction and outputting an electrical obstruction detection signal in response to the detection of said obstruction;

35 a control unit arranged to receive the electrical obstruction detection signal output from the contact detecting means and output an obstruction warning signal in response thereto;

40 a wireless transmission means for transmitting the obstruction warning signal to a counterpart wireless device.

45 **[0010]** Preferably the control unit is arranged to selectively operate the device in a low-power operating mode and a normal operating mode.

[0011] Preferably during the low-power operating mode, the control unit is arranged to reduce an operating voltage of the device.

[0012] Preferably the device is arranged to selectively operate in a low-power sleep mode.

[0013] Preferably, the wireless transmission means is a digital radio transmitter.

50 **[0014]** Preferably the contact detection means is a pressure sensitive switch.

[0015] The device preferably comprising:

a direction detecting means for detecting a direction of movement of the moving member and outputting an electrical direction signal to the control unit corresponding to the detected direction of movement of the moving member.

[0016] Preferably the direction detecting means comprises:

at least one reed switch operable in response to a magnetic field.

[0017] The device preferably comprising:

a movement detection means for detecting movement of the moving member and outputting an electrical movement detection signal to the control unit in response to the detected movement.

[0018] Preferably wherein the movement detection means comprises a vibration sensitive switch.

[0019] Preferably the moving member is an automated door.

[0020] According to a further aspect of the invention there is provided a safety system for moving a member comprising:

a device according to any preceding claim for wirelessly transmitting an obstruction warning signal in response to detecting an obstruction of the moving member; and

a counterpart device arranged to receive the transmitted warning obstruction signal and prevent further movement of the moving member by switching off an automation means of the moving member.

[0021] According to a further aspect of the invention there is provided a method for use in a device for detecting an obstruction of a moving member, comprising the steps of:

detecting a contact of a moving member with an obstruction;

wirelessly transmitting to a counterpart wireless device an obstruction warning signal.

[0022] The method preferably comprising the step of:

changing between a low-power operating mode and a low-power operating mode; and

changing between the normal operating mode and the low-power operating mode.

[0023] Preferably said changing steps are periodically performed.

[0024] The method preferably comprising the steps of:

changing between a sleep state and the low-power operating state; and

changing between the low-power operating state and the sleep state.

[0025] Preferably the step of detecting an obstruction comprises the step of:

interrogating a contact detecting means arranged to detect contact of the moving member with an obstruction.

[0026] The method preferably comprising the step of periodically transmitting to the counterpart wireless device a status signal.

[0027] All of the features described herein may be combined with any of the above aspects, in any combination.

[0028] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figure 1 is a schematic circuit diagram of a control unit according to a preferred embodiment of the present invention;

Figure 2 is a schematic circuit diagram of a contact detection unit according to a preferred embodiment of the present invention;

Figure 3 is a schematic circuit diagram of a wireless transmission unit according to a preferred embodiment of the present invention;

Figure 4 is a schematic circuit diagram of an operating mode control unit according to a preferred embodiment of the present invention;

Figure 5 is a schematic circuit diagram of a direction detection unit according to a preferred embodiment of the present invention;

Figure 6 is a perspective view of a magnet holder according to a preferred embodiment of the present invention;

Figure 7 is a schematic circuit diagram of a movement and tilt detection unit according to a preferred embodiment of the present invention;

Figure 8 is a perspective view of a system according to a preferred embodiment of the present invention

arranged in use to detect an obstruction of a roller shutter door.

[0029] As shown in Figures 1-3, a preferred embodiment of the present invention comprises a control unit 10, a contact detection unit 20 and a wireless transmission unit 30. Although the preferred embodiment of the present invention is described with reference to a roller shutter door, it will be realised that its usefulness is not limited to such and the present invention may be used to detect an obstruction of any automated door or other automated member.

[0030] When the present invention is arranged in use to detect an obstruction of an automated door, the contact detection unit 20 is suitably located on a lower edge of the door to detect contact of the door with an obstruction. In response to the detection of an obstruction, the contact detection unit 20 outputs an electrical obstruction detection signal A1 - A4.

[0031] The control unit 10 is arranged to receive the obstruction detection signal A1 - A4 output from the contact detection unit 20 and, if it is determined that the door has made contact with an obstruction, further output an obstruction-warning signal DAT1.

[0032] The wireless transmission unit 30 is arranged to receive the obstruction-warning signal DAT1 and transmit the obstruction-warning signal to a counterpart wireless device (not shown). The counterpart wireless device may be a control device arranged to control operation of the door and may prevent further movement of the door upon receiving the wirelessly transmitted obstruction-warning signal. In addition, the counterpart wireless device may reverse the direction of door travel so as to move the door away from the obstruction.

[0033] Advantageously, a device comprising a contact detection unit 20 for detecting contact of a moving member with an obstruction and a wireless transmission unit 30 eliminates the need to have a fixed physical connection between the device and the counterpart device or control system capable of switching off or preventing further movement of the automated door.

[0034] In the preferred embodiment, the control unit 10 is implemented by means of a digital microcontroller 11 and crystal oscillator X1.

[0035] In the preferred embodiment of the present invention, the device is battery-powered by a battery which is integral to the device, thereby providing an entirely self-contained device requiring no external physical connections.

[0036] As shown in Figure 3, in a preferred embodiment of the present invention, the wireless transmission unit 30 is a radio frequency (RF) modulator 31 capable of modulating the obstruction-warning signal DAT1 onto a radio carrier frequency signal which is transmitted through a suitable antenna 32.

[0037] The RF modulator 31 may modulate the data output from DAT1 onto a coded radio transmission signal. Advantageously, the use of a coded radio signal en-

ables multiple wireless devices to operate within range of each other without interference.

[0038] It is common for many automated doors, such as roller shutter or up-and-over doors used for access to a building, to only be opened or closed periodically. For example, in a commercial environment, a door may be opened periodically or infrequently to accept deliveries or at the start of each working day and remain closed at other times. In household environments, opening and closing may be even less frequent, for example weekly. Therefore, in a self-powered safety device, such as the preferred embodiment of present invention, battery life is an important consideration. Should the device fail to provide a signal warning of an obstruction due to battery exhaustion, a safety risk is created.

[0039] In a preferred embodiment of the present invention, the device is selectively operable in a normal operating mode and a low-power operating mode to extend battery life. The control unit 10 is arranged to selectively control the operating mode of the device, selecting between the normal operating mode and the low-power operating mode as appropriate.

[0040] Advantageously, because the preferred embodiment of the present invention additionally has a low-power operating mode within which the device is still operable, battery life is extended considerably.

[0041] In the preferred embodiment of the present invention, the device is normally operated at 6 Volts D.C. In this operating mode, the wireless transmission unit 30 is operable to transmit the obstruction-warning signal DAT1 to the counterpart wireless device upon detection of an obstruction. Many microcontrollers, such as those suitable for use in the preferred embodiment 11, have variable operating voltage requirements and will successfully operate at 2 Volts. In the preferred embodiment, the control unit 10 is able to select the low-power operating mode by selectively outputting an operating mode select signal CTRL1, thereby reducing the operating voltage of the device.

[0042] As shown in Figure 4, an operating mode selection unit 40 is arranged to receive the operating mode select signal CTRL1 output from the control unit 10. Within the operating mode selection unit 40, in the preferred embodiment, a switch device SW4 is arranged to receive the signal CTRL1. In Figure 4, SW4 is shown as a mechanical switch for clarity. However, as will be appreciated by the skilled person, any switching means may be employed such as MOSFET or other semiconductor based switching device.

[0043] In the preferred embodiment of the present invention, switching between a reduced voltage low-power operating mode and a normal operating mode is performed by selectively configuring a plurality of power sources BAT1-BAT4 in either a serial or a parallel mode.

[0044] In a preferred embodiment of the present invention a plurality of 3 Volt batteries BAT1, BAT2, BAT3, BAT4 are configured in the parallel mode when the switch SW4 is in an open position. A plurality of diodes

D1, D2, D3 and D4 are arranged to prevent the batteries BAT1 and BAT2 from becoming reverse polarised with respect to batteries BAT3 and BAT4. The configuration of a plurality of batteries in parallel provides greater current sourcing capabilities than a single battery, thereby improving the operational life of the device, whilst the control unit 10 remains operational.

[0045] When the control unit 10 output CTRL1 is operated to cause the switch SW4 to close, the operating mode selection unit 40 configures the batteries BAT1-BAT4 in the serial mode. In the serial mode, the pairs of batteries BAT1, BAT3 and BAT2, BAT4 produce 6 Volts between ground and an output 41 of the operating voltage control unit 40. The normal operating mode of the device is the serial mode in which the device has an operating voltage of 6 Volts and is capable of wirelessly transmitting an obstruction-warning signal to the counterpart wireless device.

[0046] Further, the configuration of the operating voltage control unit 40 allows a greater level of battery failure tolerance to be achieved. Should a battery from amongst the plurality of batteries BAT1-BAT4 fail, open circuit or become high impedance, the functionality of the present invention is preserved without causing device failure. In this situation, only the functional life of the present invention is reduced due to fewer batteries being operational.

[0047] In order to reduce the power consumption of the present invention further, the preferred embodiment of the present invention comprises a low-power sleep mode, wherein the power consumption of the device is less than in the low-power operating mode.

[0048] It is common for microcontrollers to have an in-built sleep mode to place the device in a low-power consumption mode, wherein the operation of the microcontroller is suspended. Use of such a sleep mode further extends the operational life of the present invention. Since operation of the control unit 10 is suspended, when in the low-power sleep mode it is necessary to provide a means of ensuring that any changes in the state of the automated door are detected for safety reasons. The low-power sleep mode of the present invention will be explained in detail later.

[0049] Referring again to Figure 2, the contact detection unit 20 in the preferred embodiment comprises a pressure sensitive switch SW3. The use of a pressure sensitive switch to detect contact of the door to which it is mounted with an obstruction advantageously allows effective monitoring of the door throughout the full range of door travel. When the present invention is arranged in use to monitor an obstruction of an automated door, the pressure sensitive switch SW3 may run the entire length of the leading or underside edge of the door, thereby detecting obstructions across the entire width of the door.

[0050] In the preferred embodiment of the present invention, the control unit 20 monitors outputs of the contact detection unit A1 and A2. In normal use, the switch

SW3 is arranged to be normally open. In the normally open configuration, resistors R1, R2 and R3 form a potential divider providing outputs A1 and A2 which have different output voltages due to the intervening resistor R2. In the preferred embodiment, R2 is located in use at a distal end of the door to the present invention in order to enable effective condition determination of the pressure sensitive switch SW3, even in a failure or a defective mode.

[0051] However, when the switch SW3 becomes closed due to contact with an obstruction, the resistor R2 is effectively removed from the potential divider then formed by resistors R1 and R3. In this state, the voltages present at A1 and A2 become equal or as nearly equal as is practicably possible given any contact resistances introduced by the switch SW3.

[0052] Advantageously, the control unit 10 monitors the outputs A1 and A2 in order to allow the present invention to detect an open and a closed state of the pressure sensitive switch SW3 and also a defective state. Should the switch SW3 become defective, for example by causing an entirely open circuit of the potential divider R1-R3, the voltage detected at output A1 would rise to approximately the voltage present at CTRL2, given any voltage drop across the diode LED1 present in the preferred embodiment. The voltage present at A2 would also fall to the ground voltage, indicating a defective state of switch SW3. The present invention could then warn of such a defective state being identified by transmitting a defective state signal to the counterpart wireless device.

[0053] Further, due to the dependence of the voltages at output A3 and A4 on the state of the switch SW3, further monitoring of the state of switch SW3 is possible, thereby providing an increased confidence.

[0054] When the present invention is arranged to detect an obstruction of an automated door, it will be common for the door to remain in a closed position in contact with the ground for long periods of time. In such a situation, if the present invention continuously monitored the position of switch SW3 or electrical current continuous flowed through any of the potential dividers R1-R3, R4-R5 or R6-R7, the battery life of the device would be reduced considerably. Therefore, in the preferred embodiment of the present invention, the control unit output CTRL2 is only periodically activated or polled. In order for the control unit 10 to detect the state of the switch SW3, the control unit must first output a signal CTRL2 to the contact detection unit 20, during which the outputs A1-A4 would be monitored.

[0055] Advantageously, the polling of the contact detection unit 20 further reduces the power supply requirements of the present invention. In addition, reduced power consumption could be achieved through use of high value resistors to form the potential dividers. However, such use of high value resistors could cause unreliable switch monitoring due to an extremely low current flow which is comparable with the level of random

electrical noise expected.

[0056] As shown in Figure 2, the preferred embodiment of the contact detection unit 20 also comprises a diode LED1 operable by the control unit output CTRL2. Due to the possible short duration of CTRL2 polling, the pulse of light output from LED1 will be barely visible. Therefore, as the skilled person will be aware, the diode LED1 may be replaced with a non light-emitting diode. Advantageously, because the voltage drop across a diode will be nearly constant at all forward current levels, the use of a diode in series with the contact detection unit SW3 allows the control unit 10 to monitor the output voltage condition of the plurality of batteries BAT1-BAT4 supplying the device by voltage measurement of A1 - A4. If a low battery output voltage is detected, a battery condition warning signal may be transmitted to the wireless counterpart device.

[0057] The preferred embodiment of the present invention comprises a low-power sleep mode, wherein operation of the present invention is suspended to further conserve battery power. In order to resume operation of the present invention and return to an operational mode of the device, the preferred embodiment comprises a direction detection unit 50 shown in Figure 5. The direction detection unit 50 is arranged to detect a direction of movement of the automated door and, in the preferred embodiment, wake the control unit 10 should the device be in the low-power sleep mode.

[0058] When the door has been opened, for example to its full extent, a period of time may pass, during which, the present invention may transfer into its sleep mode to conserve power. Whilst residing in the sleep mode, an operator may activate a door close function and lower the automated door toward an obstruction. If the present invention remained in the sleep mode, a safety risk may arise from not detecting contact of the door. However, the preferred embodiment of the present invention is arranged to wake upon the direction detecting unit 50 detecting a direction of movement of the door. The direction detection unit can be configured to cause an interrupt of the microcontroller 11 used in the preferred embodiment, as will be appreciated by those skilled in the art.

[0059] In the preferred embodiment of the present invention, the direction detection unit 50 comprises at least one reed switch SW1, SW2, which is operable in response to a magnetic field.

[0060] Preferably, as shown in Figure 5, there will be two reed switches located a vertical distance apart at a side of the door. At a side of the door aperture, first and second magnets may each be arranged toward an upper and lower extent of the door aperture respectively. The first and second magnets are provided to close the reed switches SW1 and SW2 when a portion of the roller shutter door upon which either of the reed switches are located passes either the first or second magnets.

[0061] The first and second magnets may each be mounted within a magnet holder 60 as shown in Figure

6. The magnet holder 60 comprises first A and second B magnet holding positions 61, although only one magnet will be mounted in each holder. The use of first A and second B magnet holding positions will be explained later.

[0062] When movement of the door commences, in either an upward or downward direction, eventually the direction detection unit 50 will pass either the first or the second magnet located at the upper or the lower region of the door travel respectively. The preferred embodiment of the present invention is arranged to wake from the sleep mode and transfer into an operational mode upon detection of a movement direction. By detecting which of the reed switches SW1 or SW2 becomes activated first, the present invention can determine the direction of door travel.

[0063] A preferred embodiment of the present invention further comprises a movement detection unit 70, as shown in Figure 7. The movement detection unit 70 is arranged to detect any movement of the roller shutter door and wake the device from the sleep mode so that an obstruction may be detected.

[0064] Advantageously, the movement detection unit 70 allows the present invention to be woken from a sleep mode to detect an obstruction of a door in the event that the door is only partially opened or closed. For example, the movement detection unit 70 may become activated before the direction detection unit 50 detects the door approaching either an upper or lower extent of door travel.

[0065] In the preferred embodiment of the present invention, the movement detection unit 70 is a ball tremble detector 75. The ball tremble detector comprises a metallic ball 76, which is free to roll inside a metallic tube 77. When stationary, the metallic ball 76 is oriented so as to form a contact between an output of the control unit CTRL3 or CTRL4 and an input of the control unit IN3, thereby providing a continuous voltage at IN3. Movement of the roller shutter door can be detected by the ball movement creating an interrupted voltage signal at IN3. Detection of such an interrupted voltage signal indicates movement of the automated door. The preferred embodiment of the present invention is arranged to wake from the sleep mode upon movement being detected, then to monitor for an obstruction.

[0066] In the preferred embodiment of the present invention, the movement detection unit 70 is also a tilt switch. The tilt switch 70 has first and second inputs CTRL3 and CTRL4 and an output IN3. In use, the tilt switch forms a contact between either, depending on an initial orientation, CTRL3 or CTRL4, which are outputs of the control unit 10, and IN3, which is an input to the control unit 10. The control unit 10 can then determine a direction of tilt of the tilt switch 70. In normal use, it is not expected that an orientation of the tilt switch will change once the device is installed. However, should the door be a roller shutter door and reach an upper end of travel door travel yet continue winding upwards, the

lower edge of the door would eventually roll over a drum onto which the roller shutter door is wound. In this situation, the tilt switch 70 would change orientation, an event detectable by the control unit 10 by a change in position of the tilt switch. Once detected, the present invention can transmit a rollover notification signal to the counterpart wireless device.

[0067] A method of operating the preferred embodiment of the present invention will now be described with reference to Figures 1 through 7.

[0068] When the present invention detects an obstruction of an automated door, the present invention is arranged to wirelessly transmit an obstruction-warning signal to a counterpart wireless device as previously described. However, as discussed, in order to conserve battery life during possibly long periods of inactivity between door movements, the preferred embodiment of the control unit 10 is arranged to selectively operate the device in a low-power operating mode, wherein the device remains operable whilst consuming a reduced power.

[0069] A preferred embodiment of the present invention has a further sleep mode wherein device operation is suspended and power consumption is further reduced compared with the low-power and normal operating states.

[0070] When the preferred embodiment is operating in the low-power operating mode, the control unit 10 periodically selects the normal operating mode so as to enable polling of the contact detection unit 20 to detect contact of the door with an obstruction.

[0071] When the preferred embodiment is operating in the sleep mode, operation of the direction detection unit 50 is arranged to return the present invention to an operating mode. Further, a preferred embodiment of the present invention may be changed from the sleep mode to an operating mode by operation of the movement detection unit 70.

[0072] Since it is expected that the present invention will be used in safety situations to detect an obstruction of a periodically moving door, it is desirable that a counterpart control system arranged to receive the transmitted obstruction-warning signal broadcast by the present invention, has confidence in the present invention remaining operational. Therefore, a preferred embodiment of the present invention is arranged to periodically transmit an integrity signal. By the control system receiving the periodically broadcast integrity signal, confidence in the confirmed operation of the present invention can be established.

[0073] Periodic transmission of an integrity signal can be achieved in the following manner. A timer such as a crystal-controlled oscillator X1, as shown in Figure 1, can be arranged to signal the control unit 10 periodically. For example, a two second notification period may be used. The oscillator X1 may be arranged to wake the microcontroller 11, even when in the sleep mode. Upon periodically being signalled by the oscillator X1, the mi-

crocontroller 11 increments a count value, which may for example, be held in a register of the microcontroller 11. When the incremented count value reaches a predetermined value, the control unit 10 will then transmit the integrity signal through the wireless transmission means 30 to the counterpart wireless device. The present invention may be arranged to transmit the integrity signal hourly. In an event that the integrity signal is not received by the counterpart wireless device after an extended period of time, for example two hours, then the counterpart device may only allow movement of the door in an override or manual mode until an integrity signal is received from the present invention.

[0074] A preferred embodiment of the present invention may also transmit a periodic running integrity signal to the counterpart wireless device when the door is detected to be in motion. The running integrity signal provides the counterpart wireless device with an increased level of confidence in the operation of the present invention during periods of door movement. It is realised that the obstruction-warning signal is always transmitted by the present invention upon an obstruction being detected. The counterpart wireless device may be arranged to suspend movement of the door in the event that a predetermined number of running integrity signals are missed during a period of door movement. The running integrity signal will be arranged to be more frequent than the hourly general integrity signal, for example, periodically every 500 mS.

[0075] Transmission of a signal by the wireless transmission unit 30 may be of a relatively long duration, for example 100 mS, with reception of, in the example of the running integrity signal, two or three signals being used to indicate complete integrity. Should the running integrity signal occupy a long period of transmission, there would be a reduced chance of the control unit 10 receiving other radio signals, such as a control signal from a radio key fob used to start or stop movement of the door. Therefore, the preferred embodiment may be arranged to broadcast a short duration, 15 - 20 mS running integrity signal. The running integrity signal transmissions are synchronised with the counterpart device or control system and each transmission is serialised. The signal strength is also referenced by the counterpart device or control system. The serialisation counter starts from a defined offset position by using one of the rolling code 8 bit registers; this allows other systems to function in close proximity to other.

[0076] A preferred embodiment of the present invention also features a learn mode of operation. Within the learn mode, the present invention may determine a movement period of the door which corresponds to the period of time taken by the door to descend or ascend the door aperture. For example, by monitoring the period of time between the activation of switches SW1 or SW2 at the start of travel and again near the end of travel, and also the obstruction detection unit detecting a contact of the lower edge of the door with the ground, a

descent period may be calculated by the present invention for both of these situations. These timing values have two distinct uses. First it allows the remote edge-sensing unit to "give up" on the closing process if the door has not reached its expected travel destination within expected time (plus a small excess allowance). This will allow the present invention to sleep and conserve power and simultaneously enable the tremble sensor, (movement detection unit 70) to be enabled as the "mid-travel" wake-up device. Secondly, before it goes to sleep, the unit will inform in a data message to the counterpart wireless device that an incomplete travel status exists.

[0077] When woken by the movement detection unit 20, the device assumes a potentially hazardous movement downwards and transmits an appropriate message to the counterpart wireless device followed by the normal running integrity signal sequence.

[0078] If the movement detection unit 20 is repeatedly woken in the mid position condition, the edge system assumes door movement as the likely cause of the activity, transmits a warning shut-down message to the counterpart wireless device, and then awaits a reed switch detection event to re-awaken. The counterpart wireless device will then inhibit automated travel in the hazardous downward direction, until the present invention resumes normal operation.

[0079] Additional magnets can be added at regular spacing, increasing the resolution of the system.

[0080] Within the learn mode, the present invention may also be arranged to determine when the door is a predetermined distance from the floor. For example, European Product Standard BSEN13241-1 calling supporting standards BSEN12453:2000, BSEN12445:2000, BSEN12604:2001 and BSEN12605:2001 specify a 50 mm dead-zone of the door from the ground. By mounting a magnet located in the lower position A of the magnet holder, shown in Figure 7, the present invention can measure a period of time between the magnetic field of the lower magnet activating a reed switch SW1, SW2 of the preferred embodiment and the contact detection unit 20 detecting contact with the ground. By an operator then transferring the magnet from position A to position B within the magnet holder 60, wherein A and B are separated by a distance X of 50mm, the present invention can determine when the lower door edge is 50mm from contacting the ground. Advantageously, if the magnet used for distance measurement is the lower of the first and second magnets, increased accuracy of measurement can be achieved.

[0081] Figure 8 shows the preferred embodiment of the present invention arranged in use with first 81 and second 82 magnets and the counterpart wireless device 90 arranged to receive wireless signals from the present invention.

[0082] Although a few preferred embodiments have been shown and described, it will be appreciated by those skilled in the art that various changes and modi-

fications might be made without departing from the scope of the invention, as defined in the appended claims.

[0083] Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0084] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0085] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0086] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A device which is arrangeable in use to detect an obstruction of a moving member, comprising:

a contact detecting means for detecting contact of the moving member with an obstruction and outputting an electrical obstruction detection signal in response to the detection of said obstruction;

a control unit arranged to receive the electrical obstruction detection signal output from the contact detecting means and output an obstruction warning signal in response thereto;

a wireless transmission means for transmitting the obstruction warning signal to a counterpart wireless device.

2. The device according to claim 1, wherein:

the control unit is arranged to selectively operate the device in a low-power operating mode and a normal operating mode.

3. The device according to claim 2, wherein:

during the low-power operating mode, the control unit is arranged to reduce an operating voltage of the device.

4. The device according to any of claims 1 to 3, wherein the device is arranged to selectively operate in a low-power sleep mode.

5. The device according to any of claims 1, 2, 3 or 4, wherein the wireless transmission means is a digital radio transmitter.

6. The device according to any of claims 1 to 5, wherein the contact detection means is a pressure sensitive switch.

7. The device of any preceding claim, comprising:

a direction detecting means for detecting a direction of movement of the moving member and outputting an electrical direction signal to the control unit corresponding to the detected direction of movement of the moving member.

8. The device of claim 7, wherein the direction detecting means comprises:

at least one reed switch operable in response to a magnetic field.

9. The device of any preceding claim, comprising:

a movement detection means for detecting movement of the moving member and outputting an electrical movement detection signal to the control unit in response to the detected movement.

10. The device of claim 9, wherein the movement detection means comprises a vibration sensitive switch.

11. The device of any preceding claim, wherein the moving member is an automated door.

12. A safety system for moving member comprising:

a device according to any preceding claim for wirelessly transmitting an obstruction warning signal in response to detecting an obstruction of the moving member; and

a counterpart device arranged to receive the transmitted warning obstruction signal and prevent further movement of the moving member by switching off an automation means of the moving member.

13. A method for use in a device for detecting an obstruction of a moving member, comprising the steps of:

detecting a contact of a moving member with an obstruction;

wirelessly transmitting to a counterpart wireless device an obstruction warning signal.

14. The method of claim 14, comprising the step of:

changing between a low-power operating mode and a low-power operating mode; and

changing between the normal operating mode and the low-power operating mode.

15. The method of claim 14, wherein said changing steps are periodically performed.

16. The method of claim 14 to 15, comprising the steps of:

changing between a sleep state and the low-power operating state; and

changing between the low-power operating state and the sleep state.

17. The method of any of claims 13 to 16, wherein the step of detecting an obstruction comprises the step of:

interrogating a contact detecting means arranged to detect contact of the moving member with an obstruction.

18. The method of any preceding claim, comprising the step of periodically transmitting to the counterpart wireless device a status signal.

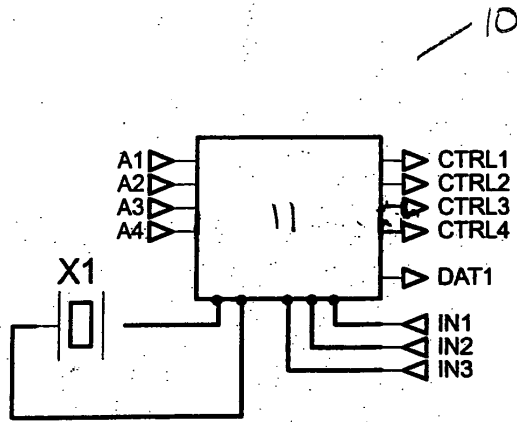


Figure 1

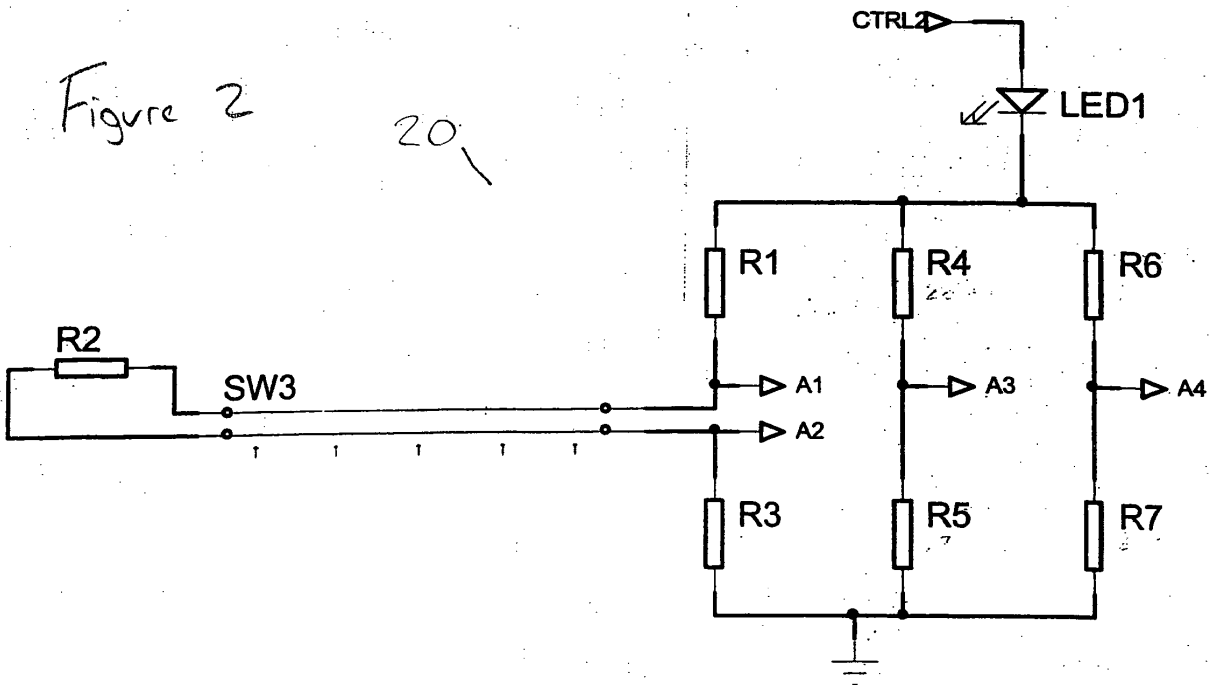


Figure 2

Figure 3

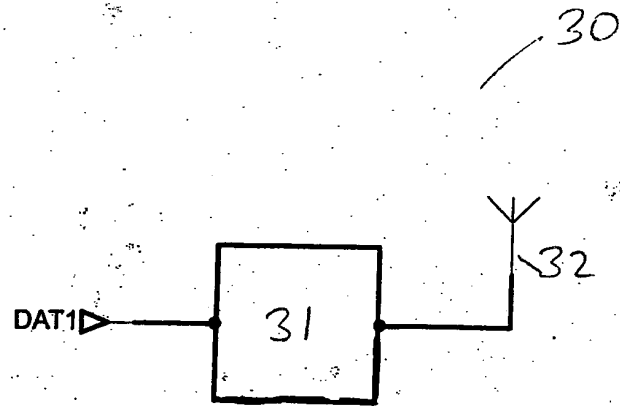


Figure 4

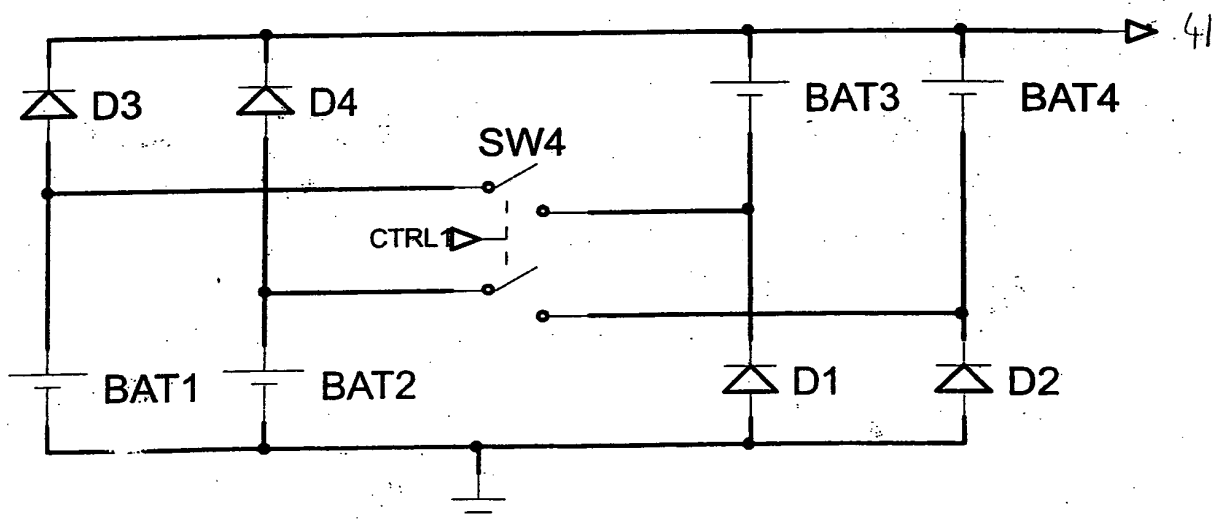


Figure 5

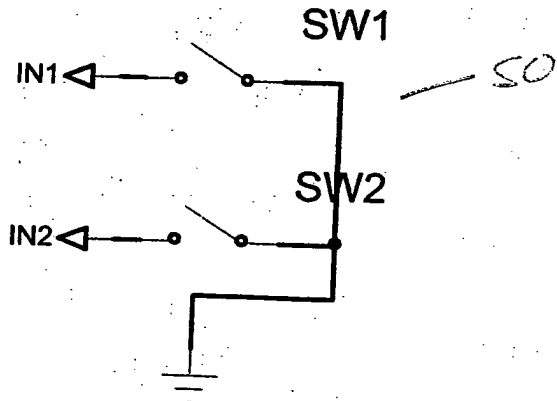


Figure 6

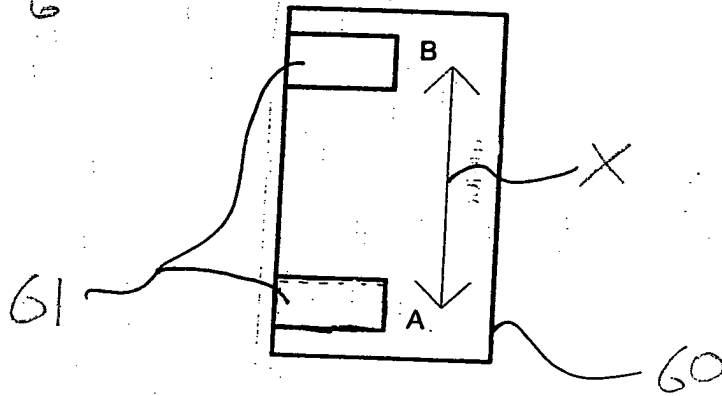


Figure 7

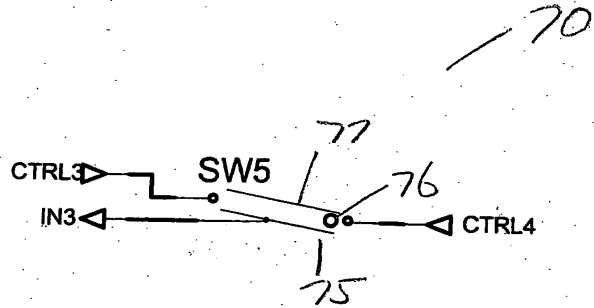
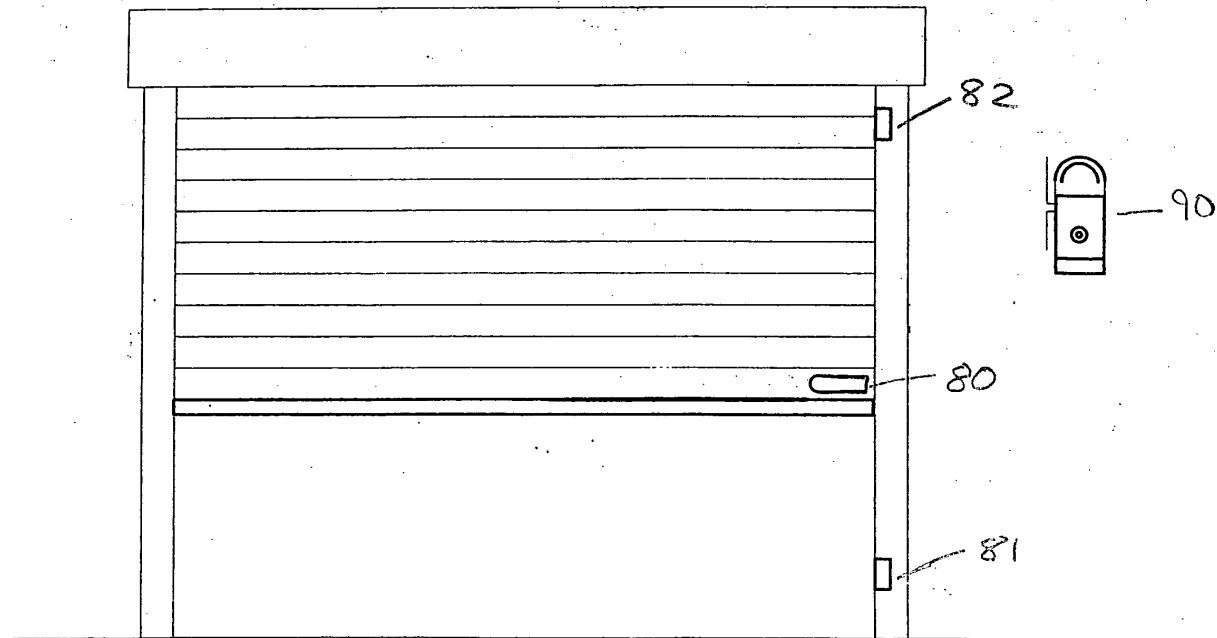


Figure 8





European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 25 2951

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Place of search Munich		Date of completion of the search 13 October 2004	Examiner Kofoed, P
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