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(54) ATM SYSTEM WITH VIRTUAL DOOR

(57) An automated teller machine (ATM) system (30) comprising: a cassette bay for receiving a cash cassette (22), the cassette bay having an access space that must be accessed to remove a cassette from the cassette bay; a sensor (56) arranged to monitor the access space, and to generate an access signal when the sensor detects that the access space has been accessed; and a proc-

essor (32) configured to: receive an operating mode signal indicative of an operating mode of a cash cassette installed in the ATM system; receive the access signal from the sensor; and generate an alarm signal upon receipt of the access signal if the operating mode signal indicates that a cash cassette installed in the ATM system is in an active state.

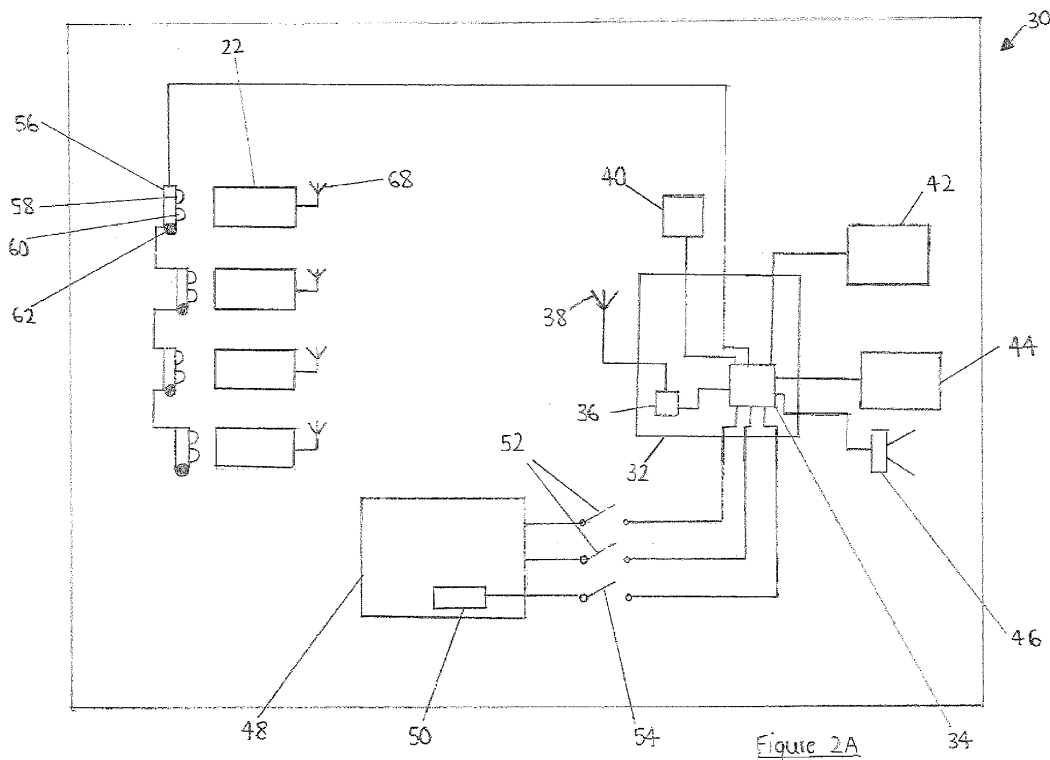


Figure 2A

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Description

Technical Field

[0001] The present application relates to an automated teller machine (ATM), to a virtual door for an ATM and to a method of operating a virtual door of an ATM.

Background to the Invention

[0002] Automated teller machines (ATMs) offer customers of financial institutions such as banks convenient access to funds in their accounts, allowing the customers to withdraw money in the form of bank notes from their accounts automatically, without having to interact with a bank teller or cashier.

[0003] A typical ATM includes a safe or vault in which bank notes to be dispensed are stored and a dispensing outlet through which bank notes are dispensed. A delivery mechanism is also housed within the safe, and is operative to deliver bank notes from the safe to the dispensing outlet on request from a customer. The dispensing outlet is normally closed by a moveable shutter, which moves into an open position when bank notes are to be dispensed.

[0004] As ATMs typically contain a large amount of cash in the form of bank notes, they are frequently targeted by criminals. To deter would-be thieves from attempting to steal from ATMs it has become commonplace for the cash within the ATM to be protected by a spoiling system which is triggered on detection of an attack on the safe (e.g. an unauthorised attempt to open the safe) and dispenses a spoiling agent onto the bank notes stored in the safe to render them unusable and thus worthless.

[0005] Typically cash is stored in the safe in one or more cassettes, to facilitate replenishment of the ATM, and to improve security of the cash in transit and in situ within the safe. In such arrangements, the spoiling system may be provided in the safe of the ATM, or may be provided in the cash cassettes to provide protection for the cash in transit as well as in situ in the ATM.

[0006] When the cash cassettes becomes empty or low on cash, they are required to be replaced by a guard. Ordinarily, when a guard comes to replace the one or more cash cassettes in an ATM, the spoiling systems associated with the cassettes are deactivated, so that removal of the cassettes from the ATM does not trigger the spoiling systems. However, there is a risk that such spoiling systems do not deactivate, meaning that an unwitting guard may remove the cash cassette and trigger the spoiling system, leading to huge economic loss as the contents of the cassette become unusable.

[0007] Previous European patent application 14838882.0 discusses a system for preventing a guard from removing a cassette before the cassettes have successfully disarmed. Such a system employs a physical door that is fitted in front of the cassettes, physically pre-

venting a guard from removing a cassette without first opening the door. The door remains locked until all cassettes have disarmed their spoiling systems, at which point the door is unlocked and can be opened. However, such a door is relatively difficult, time consuming and costly to install, especially giving regard to the variety of ATM systems available.

[0008] Accordingly, a need exists in the art for an improved system for preventing the accidental spoiling of a cassette in an ATM machine.

Summary of Invention

[0009] According to a first aspect of the present invention there is provided an automated teller machine (ATM) system comprising:

a cassette bay for receiving a cash cassette, the cassette bay having an access space that must be accessed to remove a cassette from the cassette bay; a sensor arranged to monitor the access space, and to generate an access signal when the sensor detects that the access space has been accessed; and a processor configured to:

receive an operating mode signal indicative of an operating mode of a cash cassette installed in the ATM system;

receive the access signal from the sensor; and generate an alarm signal upon receipt of the access signal if the operating mode signal indicates that a cash cassette installed in the ATM system is in an active state

[0010] Thus, the sensor and processor together define a virtual or non-physical door that can easily be applied to a range of ATM systems. The sensor is arranged to monitor the access space, this being a space in which registerable movement occurs when a person attempts to remove a cash cassette from the ATM system. The processor knows whether the cassette(s) in the ATM are armed or disarmed. If the processor receives the access signal from the sensor when a cassette is in an armed state then it triggers the alarm signal to provide a warning to the person attempting to remove the cassette. An ATM system according to embodiments of the invention can therefore reduce the likelihood of unnecessary spoilage of the contents of an ATM cassette, while also being relatively simple to apply to a range of different ATMs.

[0011] The processor can be further configured to switch the sensor between an active state, in which the sensor monitors the access space, and an inactive state, in which the sensor does not monitor the access space. Switching the sensor to the inactive state can comprise switching the sensor off.

[0012] The processor can be further configured to control the operating mode of cash cassettes installed in the ATM system. Operating mode of the cash cassette refers

equivalently to the operating mode of a spoiling system associated with the cash cassette. Operating mode may be one of "armed" (or equivalently "in an active state"), where the spoiling system will spoil the contents of the cash cassette if an attempted theft is determined, and "disarmed" (or equivalently "in an inactive state"), where the spoiling system will not spoil the contents of the cash cassette, regardless of whether an attempted theft is determined.

[0013] The processor can comprise a plurality of distinct cores and/or processors. As such, the functionality of the processor can be split among a plurality of distinct cores and/or processors.

[0014] The ATM system can further comprise a feedback system arranged to receive the alarm signal from the second processor and provide feedback to a user following receipt of the alarm signal.

[0015] The feedback can be an audible alarm or warning. An audible warning can comprise instructions to a user, instructing them not to attempt to remove a cash cassette from a cassette bay, for example. The audible alarm or warning can persist for 30 seconds or more, for example.

[0016] The ATM system can comprise a plurality of cassette bays, with a separate sensor arranged to monitor the access space of each cassette bay. Alternatively, there can be a single sensor arranged to monitor the access spaces of multiple cassette bays.

[0017] The cassette bay can comprise a magnet configured to be detected by a cash cassette installed in the cassette bay, such that upon detection of the magnet, the cash cassette is configured to determine that it is installed in the ATM system. The cash cassette may use other information in addition to the detection of the magnet to determine that it is installed in the ATM. Such other information may include the cassette's orientation and/or motion for example. Alternatively, the cassette may be able to determine that it is installed in the ATM system by being informed by an ATM controller via RF or IR, for example. Alternatively still, the cash cassette may be able to determine that it is installed in the ATM system by detecting that the money feed door is open, which is operated by a mechanism in the cassette bay.

[0018] The sensor can comprise an infrared beam transmitter and receiver, optionally configured with a beam intensity such that reflection of the beam from an object in the access space to the receiver causes the processor to generate the alarm signal but reflection of the beam from an object outside of the access space and on an opposite side of the access space with respect to the infrared transmitter does not causes the processor to generate the alarm signal.

[0019] According to a second aspect of the invention, there is provided an ATM comprising the ATM system of the first aspect.

[0020] According to a third aspect of the invention, there is provided a method of controlling an ATM system, the ATM system comprising a cassette bay and a access

space that must be accessed to release a cash cassette installed in the cassette bay, the method comprising the steps of:

- 5 monitoring the access space; and
- generating an access signal upon determination that the access space has been accessed and a cash cassette installed in the ATM system is in an active state.

[0021] Monitoring the access space can comprise transmitting an infrared beam through the access space, and the receipt of a reflected beam from an obstacle may be an indication that the access space has been accessed.

[0022] The method can further comprise the step of generating an alarm signal upon receipt of the access signal.

[0023] Optional features of the first aspect can be applied to the third aspect in an analogous manner.

Brief Description of the Drawings

[0024] Embodiments of the invention will now be described, strictly by way of example only, with reference to the accompanying drawings, of which:

Figure 1 is a schematic representation of an automated teller machine (ATM);

Figure 2A is a further schematic representation of an automated teller machine (ATM);

Figure 2B is a schematic representation of a cash cassette;

Figure 3A is a schematic illustration showing the operation of a virtual door;

Figure 3B is a schematic illustration showing the operation of a virtual door; and

Figure 4 is a schematic illustration showing an alternative arrangement of virtual door in an ATM.

Description of the Embodiments

[0025] Referring first to Figure 1, an automated teller machine (ATM) is shown generally at 10, and has a screen 12 for providing instructions or other information to a user of the ATM 10 and a slot 14 for receiving a user's ATM card. A keyboard 16 is provided to permit a user to interact with the ATM 10 to request services such as cash dispensing, balance enquiries and the like. Cash is dispensed by the ATM 10 through a dispensing outlet 18. A shutter can be provided to permit or deny access to the dispensing outlet 18, as will be described in more detail below.

[0026] The ATM 10 includes a storage area such as a safe 20 in which cash to be dispensed to customers is stored. The ATM 10 is associated with a spoiling system which is configured to dispense a spoiling agent to spoil or degrade the bank notes in the event of an attack or other unauthorised attempt to gain access to the bank notes, as will be described in more detail below.

[0027] In the example illustrated in Figure 1, the safe 20 includes a plurality of cash cassettes 22 containing the cash. It is to be appreciated that the cash cassettes 22 need not be received in the safe 20; indeed, where cash cassettes 22 are used, the safe 20 may not be necessary. The use of the cash cassettes 22 in this way facilitates replenishment of the ATM 10, as an empty (or partially empty) cash cassette 22 may simply be removed from the safe 20 of the ATM 10 and replaced with a full cash cassette 22.

[0028] Each cash cassette 22 is provided with a spoiling system 24, which is configured to be activated if an attack on the cash cassette 22 is detected, to dispense a spoiling agent such as ink, dye or an adhesive onto the contents of the cash cassette 22, thereby spoiling the bank notes stored in the cash cassette to render them unusable and therefore worthless. The cash cassettes 22 may also interface with a security system of the ATM 10 which includes one or more sensors to detect interference or tampering with the ATM 10, such that the spoiling systems 24 of the cash cassettes 22 are triggered in the event of an attack on the ATM 10. Additionally or alternatively, the safe 20 (where provided) may itself be provided with a spoiling system 24 that can be activated on detection of an attack on the ATM 10, the safe 20, or one or more of the cash cassettes 22, to dispense a spoiling agent into an interior of the safe 20.

[0029] The operation of the ATM 10 is controlled by a processor 26, which is connected to a wireless communications device 28 which operates under a suitable wireless communications protocol such as Bluetooth®, Bluetooth® Smart (also referred to as Bluetooth® low-energy) WiFi®, RFID, Near Field Communications (NFC) or the like. The wireless communications device 28 permits the processor 26 to receive communications from a wireless communications transmitter of a sensor system associated with the shutter of the ATM 10, as will be described in more detail below.

[0030] The processor 26 may be connected to the safe 20 by a physical connection (e.g. a wired connection), and the safe 20 may in turn have a physical connection with each of the cash cassettes 22 installed in the safe 20 (e.g. by an arrangement of cooperating connectors on the cash cassettes 22 and the safe 20) to facilitate communication between the processor 26 and the spoiling systems 24 of the cash cassettes 22 and/or of the safe 20, to permit actuation of the spoiling systems 24 when an attack on the ATM 10 is detected. An attack on the ATM 10 may be detected using any one of a number of sensors, such as seismic sensors, gas sensors, tilt sensors and door and lock switches. Alternatively or ad-

ditionally, the wireless device 28 may have transmit capabilities as well as receive capabilities (i.e. the wireless device 28 may be a wireless transceiver operating under a suitable wireless communications protocol such as Bluetooth®, Bluetooth® Smart (also referred to as Bluetooth® low-energy) WiFi®, RFID, Near Field Communications (NFC) or the like), and the safe 20 and/or the cash cassettes 22 may each be provided with a compatible wireless receive or transceiver device, to facilitate wireless communication between the processor 26 and the spoiling systems 24 of the cash cassettes 22 and/or the safe 20, to permit actuation of the spoiling systems 24 when unauthorised access is detected.

[0031] Turning now to Figure 2A, an ATM system including a virtual door is shown generally at 30. The ATM system 30 includes a processor 32, which can be the ATM processor 26 shown in Figure 1, or one or more distinct processors or cores. In this embodiment the processor 32 comprises a microprocessor 34. The microprocessor 34 is coupled to an RF transceiver 36, which in turn couples to an antenna 38. The microprocessor 34 is further coupled to a gas sensor 40, a seismic sensor 42 and an accelerometer 44. These security sensors 40, 42, 44 can be used to determine if an attempted robbery of the ATM is taking place, for example detection of flammable gas by the gas sensor 40 may indicate that thieves are pumping gas into the interior of the ATM 10 with a view to igniting the gas and gaining access to the cash. Seismic sensor 42 and accelerometer 44 may, independently of one another or in combination, be used to detect a force on the ATM 10 indicative of an attempted robbery. The microprocessor 34 is further coupled to a speaker system 46, which is capable of emitting an audible noise/alarm.

[0032] The processor 32 is coupled to the ATM door 48 and to its associated door lock 50. The coupling in this example is a physical, wired connection. The coupling between the processor 32 and the ATM door 48 include two door switches 52 that indicate whether the door is open or closed. Two door switches 52 provide a redundancy in the event that one switch fails. Hence, a determination of an illegal opening may be reached. Equally only a single door switch 52 may be included, or more than two door switches 52 may be included. The coupling between the processor 32 and the ATM door lock 50 includes a single lock switch 54 that indicates whether the door 48 is unlocked or locked.

[0033] The processor 32 is further coupled in series to a number of virtual doors 56. Each virtual door 56 comprises an infrared transmitter 58 and an infrared receiver 60. The virtual doors 56 are associated with the cassette bays containing the cash cassettes 22. The phrase "associated with" in this context can mean that the virtual doors 56 are arranged such that they transmit infrared light across an appropriate portion of the cash cassettes 22, as is described in greater detail below. In this embodiment, each cassette bay has its own associated virtual door 56. Each cassette bay also has an associated

magnet 62. The coupling between the processor 32 and the virtual doors 56 can for example be an RS485 serial bus.

[0034] Each cassette bay is arranged to receive a cash cassette 22. As shown in Figure 2B, a cash cassette 22 contains a processor such as a microprocessor 64. The microprocessor 64 is coupled to an RF transceiver 66 which in turn couples to an antenna 68. The microprocessor 64 also couples to the spoiling system 24, which in this embodiment is fitted into the cash cassette itself. It will be appreciated though, that such a system 24 could be fitted into the ATM 10 itself, and be configured to engage with a cash cassette 22 when the cash cassette 22 is installed. The microprocessor 64 in this example further couples to an accelerometer 70 and in turn a connector 72 that connects the cash cassette 22 to the ATM 10 when it is installed. The microprocessor 64 in this example is also coupled to first and second LEDs 74a, 74b, which may be red and green for example.

[0035] The processor 32 is in two-way communication with the cash cassettes 22 via their respective antennas 38, 68, i.e. the processor 32 is able to send signals to the cassettes 22 and the cassettes 22 are able to send signals to the processor 32. In this manner, the processor 32 can monitor the operating mode of each of the cash cassettes 22, and can optionally control the operating modes. The "operating mode" of a cash cassette 22 can refer to whether an associated spoiling system 24 is armed or not, i.e. if the spoiling system 24 is armed it will spoil the contents of the cash cassette 22 if an attempted theft is detected. If the spoiling system 24 is disarmed, it will not spoil the contents of the cash cassette 22 in the event of an attempted robbery, for example because it is not monitoring for signs of an attempted robbery, or because the spoiling system 24 is switched off. Such an operating mode may be "armed" or "disarmed". Changing the operating mode of a cash cassette 22 involves switching the associated spoiling system 24 from an armed state to a disarmed state, or switching the associated spoiling system 24 from a disarmed state to an armed state. Each cassette 22 can for example have a red LED 74a and a green LED 74b. These LEDs 74a, 74b are indicative, when the cassette 22 is installed in the ATM 10, of the operating mode of the cassette 22. For example, if the red LED 74a is lit, this may be indicative that the cassette 22 is armed, and any detected theft attempt will activate the spoiling system 24 to spoil the contents of the cash cassette 22. On the other hand, if the green LED 74b is lit, this may be indicative that the cassette 22 is disarmed.

[0036] Each cash cassette 22 installed in the ATM 10 is able to make a determination to that effect in the following manner. As mentioned, each cassette bay can comprise a magnet 62. The magnet 62 can be used during a "pair" command broadcast by the processor 32. Such a command is broadcast when the ATM door 48 is closed and locked. All cash cassettes 22 within range receive the broadcast, but only cash cassettes 22 that

are in the correct orientation (to be installed in the ATM 10), stationary and can "see" i.e. detect the flux of the magnet respond. If these criteria are fulfilled, it is indicative that the cash cassette 22 is installed in a cassette bay in the ATM 10. The responding cash cassettes 22 transmit their serial numbers to the processor 32, which is then aware of which cash cassettes 22 are installed in the ATM 10, and hence which cassettes 22 it should communicate with. These cash cassettes 22 are said to be "paired" with the processor 32. If a cash cassette 22 is disarmed it forgets its pairing, as it may not return to the same ATM 10. Hence if a "disarm" command is sent to all cassettes (explained more below), all cassettes 22 forget their pairing, and the processor 32 forgets all the serial numbers of the previously paired cassettes 22.

[0037] When issuing commands, the processor 32 can command a specific subset of cash cassettes 22 defined by a stored set of cassette serial numbers, or may broadcast globally to all cassettes 22 in range.

[0038] A processor such as the processor 32 is configured to control the operating mode of each of the cash cassettes 22 installed in the ATM 10, by issuing commands. Such a command may instruct a cash cassette 22 to change its operating mode from "armed" to "disarmed", or from "disarmed" to "armed".

[0039] The processor 32 monitors the operating mode of each of the cash cassettes 22 installed in the ATM 10. This is carried out in the following manner. The processor 32 communicates with the cash cassettes 22 installed in the ATM 10 and requests an operating mode from each one. Each cash cassette 22 then communicates their operating mode to the processor 32. As discussed previously, communication between the processor 32 and a cash cassette 22 takes place wirelessly, over the antennas 38, 68. This process can be repeated periodically; for example, every time the safe door is locked or unlocked. Alternatively, the cassettes can be configured to inform the processor 32 of any status change. For example, if the spoiling system has activated in the cassette, the cassette will inform the processor 32 that it has activated.

[0040] The virtual doors 56 will now be described in more detail.

[0041] The virtual doors 56 are intended to result in a perceivable warning being generated in order to prevent removal of a cash cassette 22 if it has not successfully disarmed. An unsuccessful disarming may arise due to a fault in the communications channel or a physical fault in the spoiling system, for example. If a guard removes the cash cassette 22 without realising that the cassette 22 has not been successfully disarmed, the spoiling system 24 will trigger, spoiling the contents of the cash cassette 22 unnecessarily. The contents can be cash, bonds or other high value items, the accidental/unintended spoiling of which would be economically detrimental.

[0042] Turning now to Figure 3A, as explained, each cash cassette 22 has an associated virtual door 56. Each virtual door 56 comprises an infrared transmitter 58 and

an infrared receiver 60. Each cassette bay can comprise or is adjacent to an access space, which must be accessed in order to remove a cassette 22 from the cassette bay. In this embodiment, the access space comprises a volume of space that must be moved through in order to access a handle 76 positioned on the front of the cassette. A user must access the handle to release and pull the cassette 22 from the cassette bay. The user must therefore also pass through the volume of space to release the cassette 22 from the cassette bay. During operation of the virtual door 56, the infrared transmitter 58 transmits an infrared beam 78 across the front of the cassette 22 through the volume of space, such that the infrared beam 78 will be disturbed if the handle is actuated. In this manner, the access space (i.e. the handle in this embodiment) is monitored. The infrared beam 78 can be transmitted substantially directionally as illustrated, or substantially isotropically, though in such cases it may be required to have a blocking member placed between the infrared transmitter 58 and infrared receiver 60.

[0043] As shown schematically in Figure 3B, in the event that a user's hand 80 interrupts the path of the infrared beam 78, for example because the user is reaching for the cassette's handle 76, thereby passing through the volume of space in front of the cassette 22, the infrared beam 78 is reflected from the hand 80 as a reflected beam 82. The reflected beam 82 is detected by the infrared receiver 60. Such detection causes the infrared receiver 60 to generate an access signal. This is described in greater detail below.

[0044] The infrared beam 78 may reflect from any obstacle in the access space. The presence of such an obstacle in the access space is likely indicative that an attempt to remove the cash cassette 22 from the cassette bay is about to be made. Detection of an obstacle in the access space is therefore indirect detection of an impending attempt to remove the cash cassette 22 from the cassette bay. Other than a user's hand, potential obstacles include the cassette's handle 76 itself. If the handle 76 is raised, the infrared transmitter 58 is configured to emit the infrared beam 78 in such a way that it will reflect from the handle 76.

[0045] To prevent the infrared beam 78 reflecting from the inside of the far wall of the ATM and being sensed by the infrared receiver 60, the infrared beam 78 is in this embodiment arranged to suitably attenuate. The infrared beam's attenuation is set so that it is able to travel the entire length of the access space (i.e. the length of the handle 76 in this case) and further travel to the infrared receiver 60. However, the attenuation is also set so that the beam 78 cannot travel to and from an obstacle whose presence is not indicative of an attempted cassette removal from the cassette bay (such as the inside of the ATM wall).

[0046] In other embodiments, the sensors can take any suitable form. In one example, the sensor can be arranged with a beam transmitter on one side of the access space and pointing at a beam received on the other side

of the access space such that the beam is broken if an object moves into the access space. In another example, the sensor can comprise a camera with a vision based object detection algorithm arranged to detect access of the access space.

[0047] Operation of the virtual doors 56 according to an embodiment will now be described. Initially, the ATM door 48 is closed and locked. The cash cassettes 22 are armed, such that any detection of a robbery attempt will cause the spoiling systems 24 to activate, spoiling the contents of the cash cassettes 22 installed in the ATM 10. A robbery attempt can be detected by a sensor 40, 42, 44 fitted into the ATM 10, in which case the processor 32 will broadcast a signal to its paired cassettes 22 (i.e. those cassettes 22 installed in the ATM, as discussed previously) commanding them to activate their spoiling systems 24. Alternatively, a robbery attempt can be detected by a sensor 70 associated with a specific cash cassette 22. When the ATM door 48 is closed and locked, the virtual doors are inactive (i.e. the infrared transmitter 58 is not transmitting an infrared beam 78).

[0048] When a user (such as a guard whose task is to replace the cash cassettes 22 in the ATM 10) unlocks the ATM door 48, the lock switch 54 is opened. Upon opening of the lock switch 54, the processor 32 broadcasts a signal commanding all paired cassettes 22 to disarm. Each cassette 22 receives the broadcast signal via their antennas 68. The processor 32 also activates all of the virtual doors 56 via a command sent down the coupling between the processor 32 and the virtual doors 56. Once activated, each virtual door's infrared transmitter 58 begins transmitting an infrared beam 78. The infrared beam 78 is transmitted across the front of the cash cassette, so as to monitor the access space of the cassette 22.

[0049] Following unlocking of the ATM door 48, the user physically opens the ATM door 48, which opens the two door switches 52. Opening of the three switches in this order (lock switch 54 followed by both door switches 52 simultaneously) indicates a "legal opening". If the lock switch 54 is not opened before the door switches 52, this is indicative of an "illegal opening", and will result in the spoiling systems 24 (which in this case have not been disarmed) being activated.

[0050] The cash cassettes 22 attempt to disarm following receipt of the broadcast signal from the processor 32. Once a cassette 22 successfully disarms, it communicates this to the processor 32. If all paired cassettes 22 communicate their successful disarming to the processor 32, the processor 32 de-activates the virtual doors 56. Once the user has replaced the cash cassettes 22 and performed a "legal close" of the ATM 10 (i.e. closing both door switches followed by the lock switch), the processor 32 pairs with the installed cassettes 22 and commands them to re-arm.

[0051] If on the other hand at least one of the cassettes 22 remains armed following the disarm command, all virtual doors 56 remain active. If the user attempts to re-

move a cassette 22 from the cassette bay, the infrared beam 78 will be reflected from his hand 80 or the cassette handle 76 as it is raised, and the reflected beam 82 will be received by the infrared receiver 60. As mentioned previously, receipt of a reflected beam 82 by the infrared receiver 60 causes the infrared receiver 60 to generate an access signal, which is transmitted to the processor 32 via the coupling between the processor 32 and the virtual doors 56.

[0052] Upon receipt of the access signal, the processor 32 generates an alarm signal. This is transmitted to the speaker 46, which, in response to receiving the alarm signal, generates an audible alarm or sound. This alarm or sound warns the user not to remove the cassette 22 from the cassette bay. Though the user should have received training to understand the meaning of this alarm/sound, an untrained user hearing the alarm/sound would immediately be deterred from removing the cash cassette 22, hence protecting the contents of cassette 22 from being unnecessarily spoiled.

[0053] Although in this embodiment, the functions of monitoring and controlling the operating mode of the cash cassettes 22, and the functions of receiving the access signal and generating an alarm signal are performed by a single processor 32, it will be appreciated that each function or each of the sets of functions may equally be performed by a separate processor or core.

[0054] The virtual doors 56 can each be coupled individually to the processor 32, rather than in series.

[0055] Additionally or alternatively to a handle, a latch or other release mechanisms on the side, front, back or any other portion of the cassette may be included, that must be accessed to release the cassette from the cassette bay. A further alternative or additional feature can be a cover that must be moved or removed to access the cash cassette. All of these features may have access spaces (i.e. volumes of space) that may be monitored. These access spaces define spaces that must be accessed in order to access a release mechanism of a cash cassette, and to release the cassette from a cassette bay.

[0056] Figure 4 illustrates an embodiment in which there is a single virtual door associated with all of the cassettes 22 installed in the ATM 10. The single virtual door 56 is able to monitor the access spaces of all of the cassettes 22 installed in the ATM 10. The infrared transmitter transmits the infrared beam 78 across the front of all cassettes 22.

[0057] Equivalently, there can be a virtual door 56 associated with a number of cassette bays, wherein the number is greater than one, but less than the total number of cassette bays in the ATM 10. For example, in an ATM 10 having four cassette bays, there may be two virtual doors 56, where each of the two virtual doors 56 is arranged to monitor the access spaces of two cassette bays.

[0058] In an alternative embodiment, a sensor embedded in the handle of a cash cassette can determine whether an attempt to remove the cash cassette from a

cassette bay is imminent. The sensor may be an accelerometer, a temperature sensor or a proximity sensor for example. In this instance, an access signal is transmitted once it has been determined that an attempt to remove the cash cassette from a cassette bay is imminent. In this embodiment, the handle of the cash cassette is the access space.

[0059] The ATM 10 can be provided with further sensors or sensor systems to detect attacks or other unauthorised interference with the ATM. These sensors or sensor systems can each be provided with a wireless communications transmitter operating in accordance with a suitable wireless communications protocol such as Bluetooth®, Bluetooth® Smart (also referred to as Bluetooth® low-energy) WiFi®, RFID, Near Field Communications (NFC) or the like. The additional sensors or sensor systems can be configured to transmit a signal to trigger the spoiling system 24 of the safe 20 and/or cash cassettes 22 in the event of that unauthorised interference such as an attack on the ATM 10 is detected.

[0060] The sensors or sensor systems may take a variety of forms. For example, one or more "anti-cut" sensors can be provided in or associated with the walls of the ATM 10, and equipped with a wireless communications transmitter, such that in the event of an attempt to breach a wall of the ATM 10, a signal can be transmitted by the wireless communications transmitter associated with the anti-cut sensor to trigger the spoiling system 24 of the safe 20 and/or cash cassettes 22. Additionally or alternatively, one or more temperature sensors can be provided, again equipped with a wireless communications transmitter such that in the event of attack on the ATM 10 based on extremes of temperature, a signal can be transmitted by the wireless communications transmitter associated with the anti-cut sensor to trigger the spoiling system 24 of the safe 20 and/or cash cassettes 22. Additionally or alternatively, one or more accelerometers can be provided, again equipped with a wireless communications transmitter, such that in the event of attack on the ATM 10 which uses shock or movement of the ATM 10, a signal can be transmitted by the wireless communications transmitter associated with the anti-cut sensor to trigger the spoiling system 24 of the safe 20 and/or cash cassettes 22.

[0061] As will be appreciated from the foregoing, an ATM having an ATM system according to embodiments of the invention can have any suitable configuration.

Claims

1. An automated teller machine (ATM) system comprising:
 - a cassette bay for receiving a cash cassette, the cassette bay having an access space that must be accessed to remove a cassette from the cassette bay;

a sensor arranged to monitor the access space,
and to generate an access signal when the sensor detects that the access space has been accessed; and
a processor configured to:

receive an operating mode signal indicative of an operating mode of a cash cassette installed in the ATM system;
receive the access signal from the sensor; and
generate an alarm signal upon receipt of the access signal if the operating mode signal indicates that a cash cassette installed in the ATM system is in an active state.

2. An ATM system according to claim 1, wherein the processor is further configured to switch the sensor between an active state, in which the sensor monitors the access space, and an inactive state, in which the sensor does not monitor the access space.
3. An ATM system according to claim 1 or claim 2, wherein the processor is further configured to control the operating mode of cash cassettes installed in the ATM system.
4. An ATM system according to any preceding claim, wherein the access space is a volume of space adjacent an opening to one or more cassette bays.
5. An ATM system according to any preceding claim, wherein the access space is a volume of space in which a handle of a cassette must move for the cassette to be removed from the ATM system.
6. An ATM system according to any preceding claim, further comprising a feedback system arranged to receive the alarm signal from the processor and provide feedback to a user following receipt of the alarm signal.
7. An ATM system according to claim 6, wherein the feedback is an audible alarm or warning.
8. An ATM system according to any preceding claim, comprising a plurality of cassette bays, wherein the ATM system comprises an exclusive sensor arranged to monitor the access space of each cassette bay.
9. An ATM system according to any of claims 1 to 7, comprising a plurality of cassette bays, wherein the sensor is arranged to monitor the access spaces of the plurality of cassette bays.
10. An ATM system according to any preceding claim, wherein the cassette bay comprises a magnet con-

figured to be detected by a cash cassette installed in the cassette bay, such that upon detection of the magnet, the cash cassette is configured to determine that it is installed in the ATM system.

11. An ATM system according to any preceding claim, wherein the sensor comprises an infrared beam transmitter and receiver, optionally configured with a beam intensity such that reflection of the beam from an object in the access space to the receiver causes the processor to generate the alarm signal but reflection of the beam from an object outside of the access space and on an opposite side of the access space with respect to the infrared transmitter does not causes the processor to generate the alarm signal.
12. An ATM comprising the ATM system of any of claims 1 to 11.
13. A method of controlling an ATM system, the ATM system comprising a cassette bay and an access space that must be accessed to release a cash cassette installed in the cassette bay, the method comprising the steps of:

monitoring the access space;
generating an access signal upon determination that the access space has been accessed and that a cash cassette installed in the ATM system is in an active state.
14. A method as claimed in claim 13, wherein monitoring the access space comprises transmitting an infrared beam through the access space, and wherein the receipt of a reflected beam from an obstacle is an indication that the access space has been accessed.
15. A method as claimed in claim 13 or 14, further comprising generating an alarm signal upon receipt of the access signal.

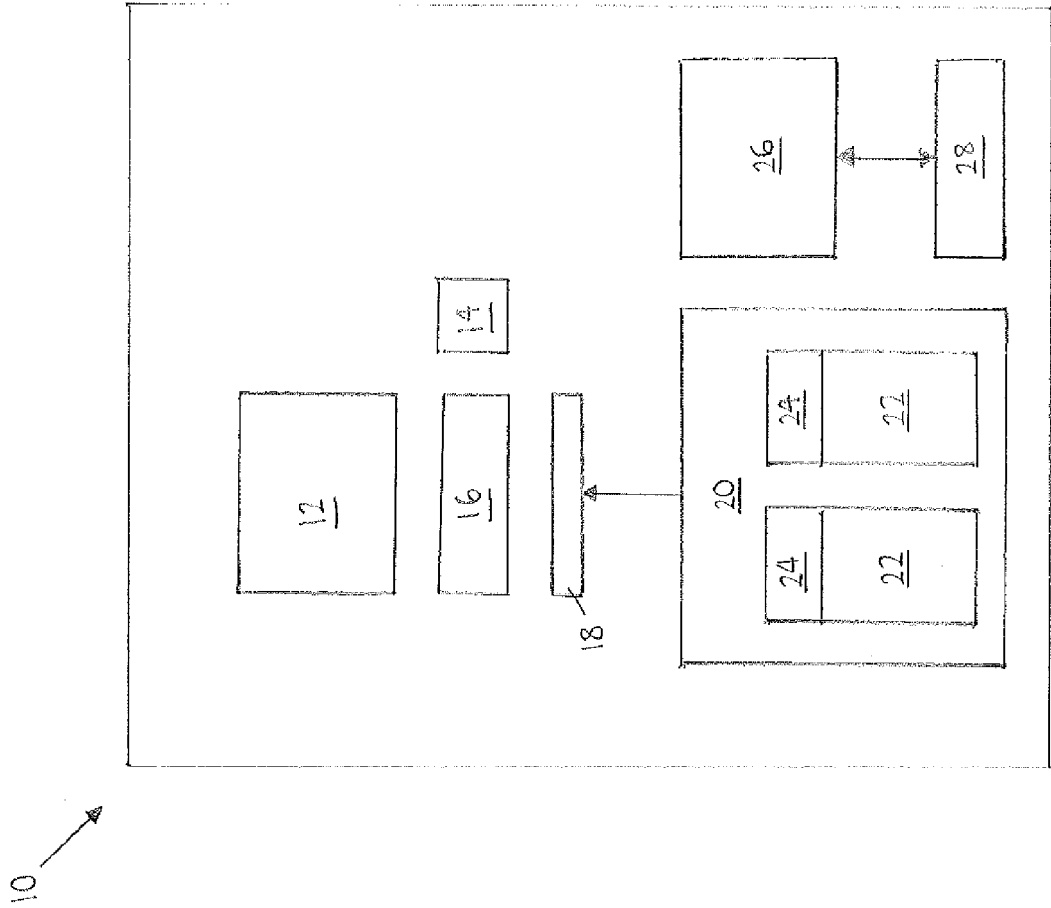


Figure 1

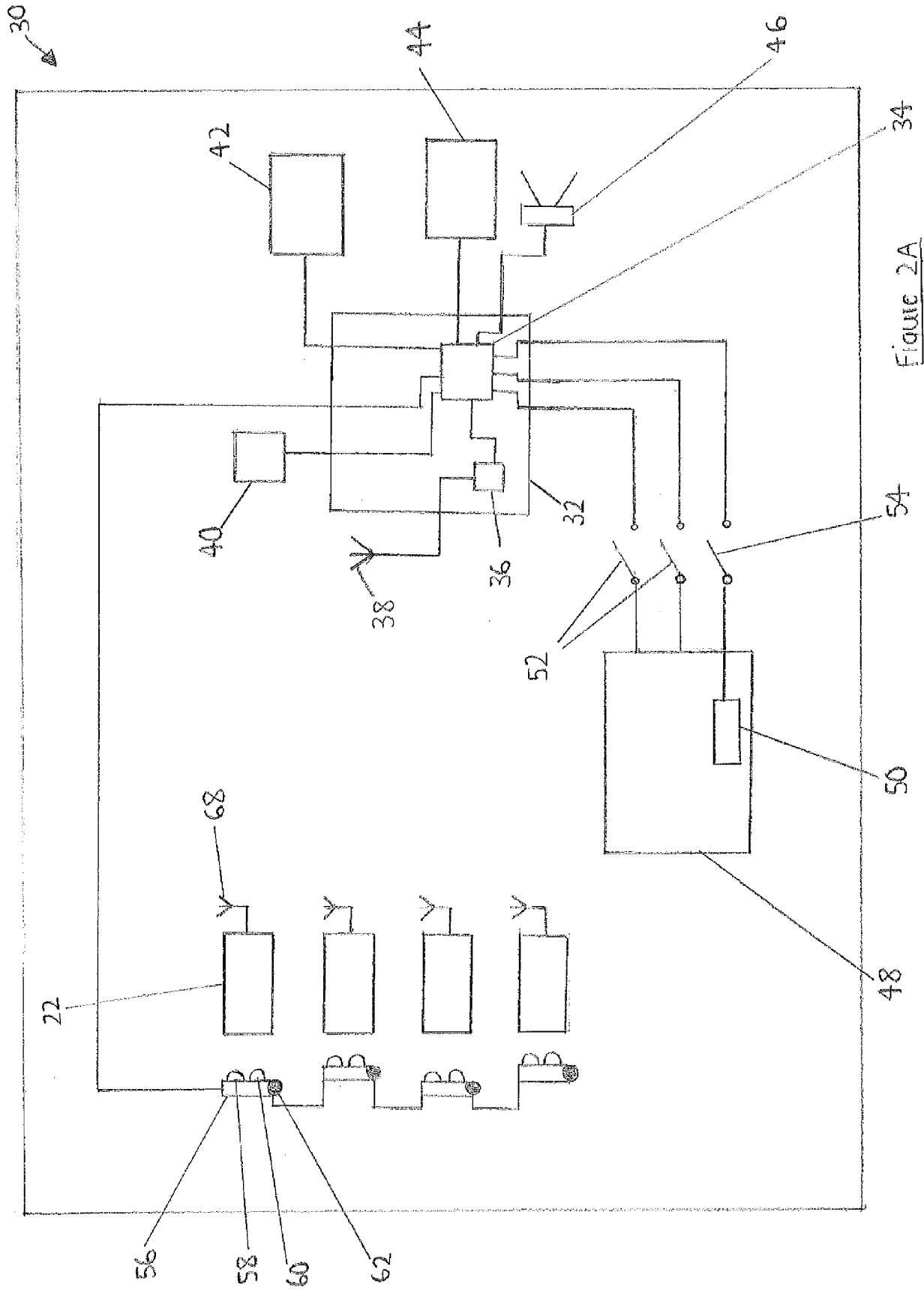


Figure 2A

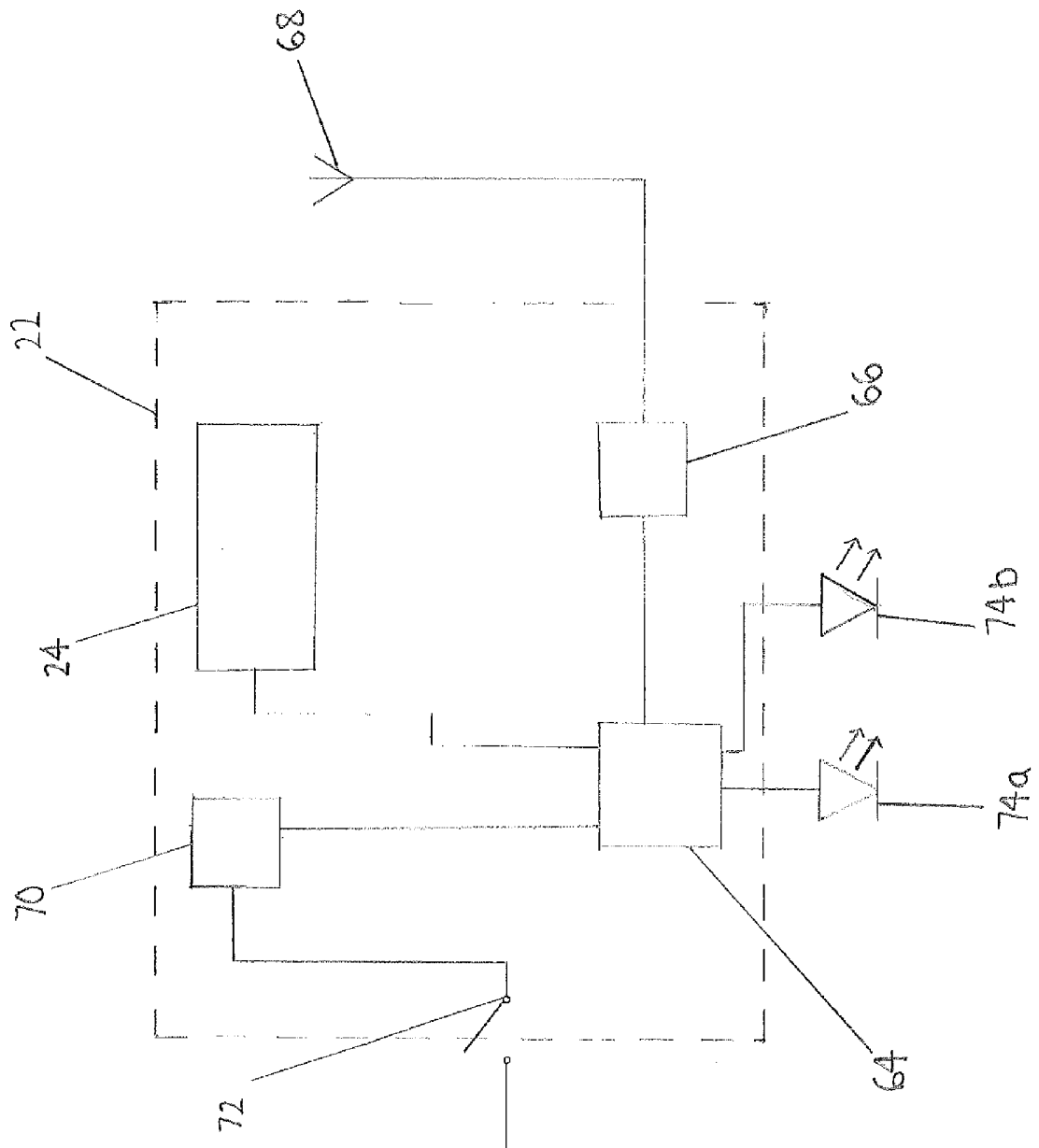


Figure 2B

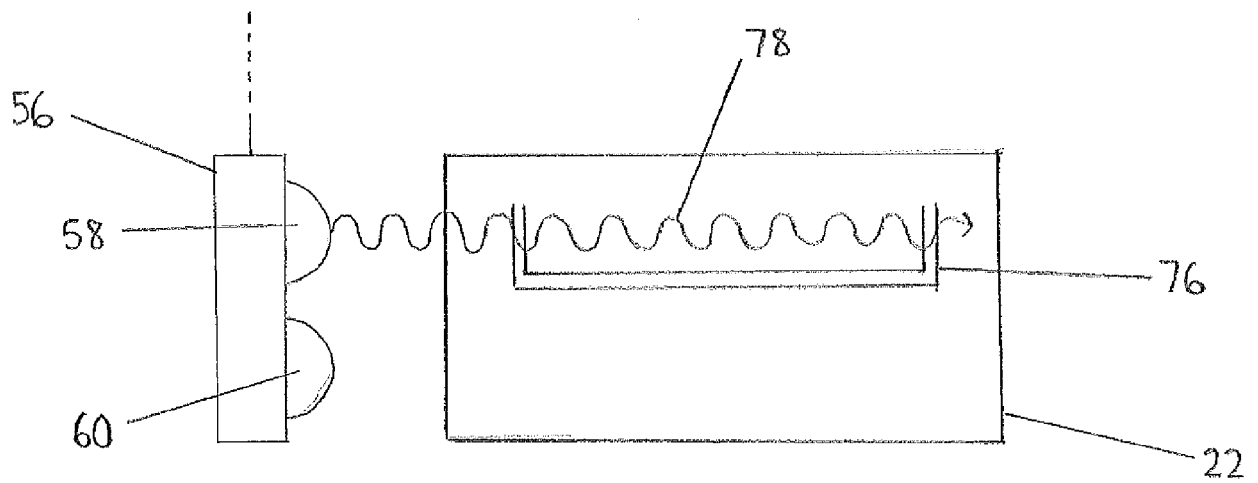


Figure 3A

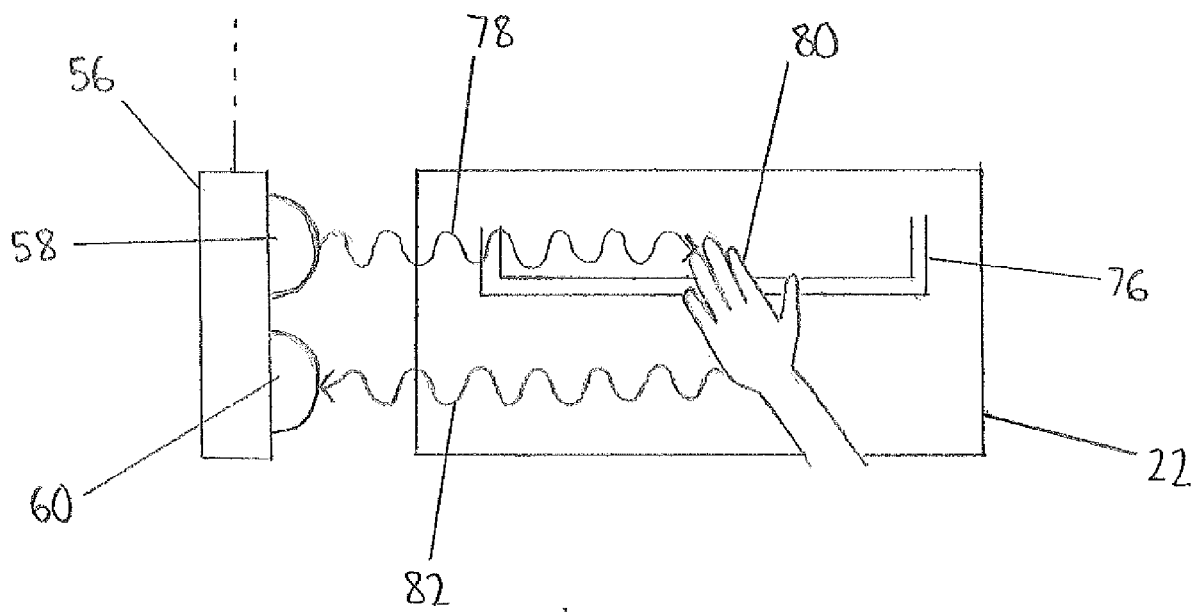


Figure 3B

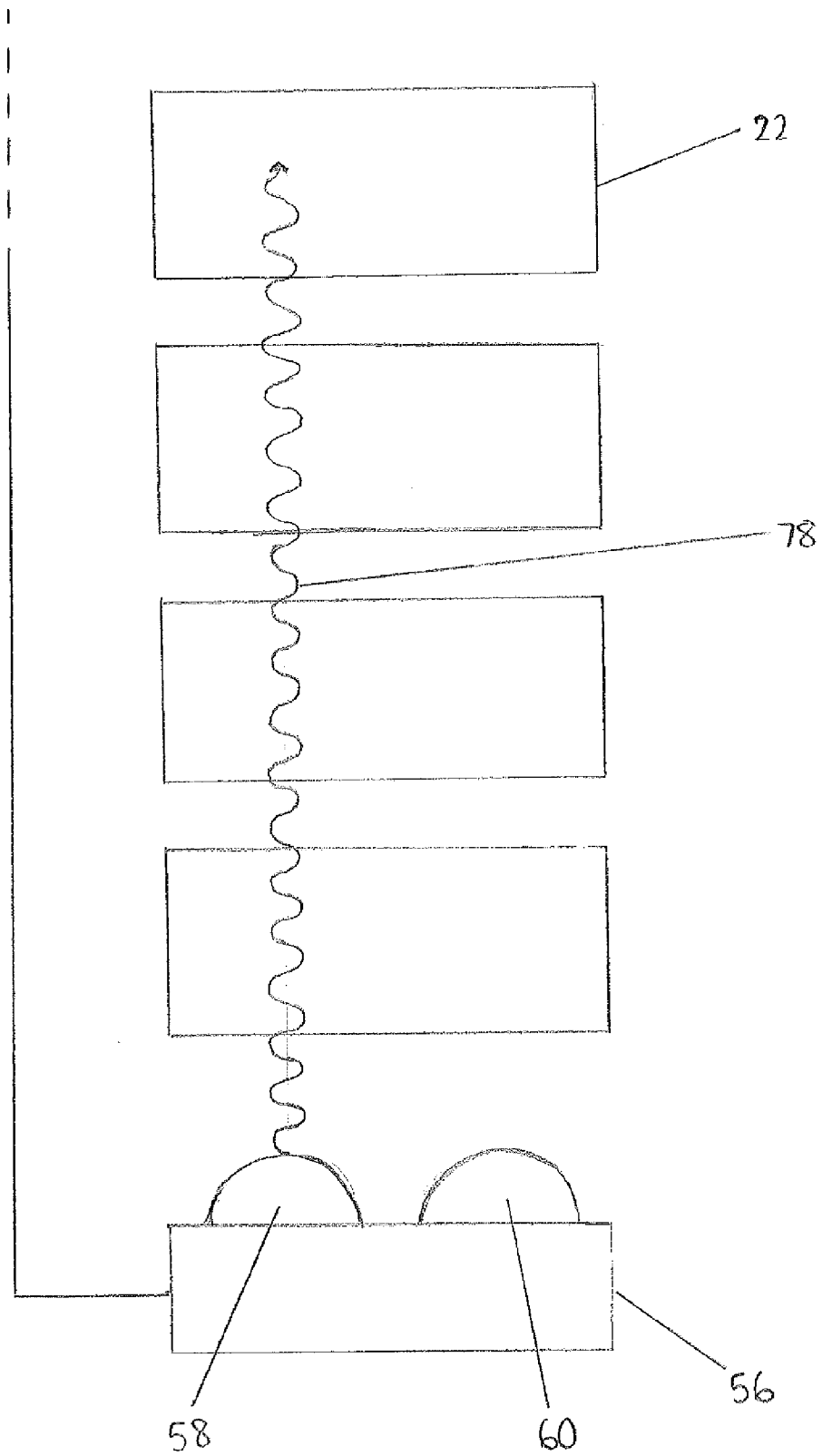


Figure 4



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			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search The Hague		Date of completion of the search 9 March 2020	Examiner Seifi, Mozhdeh
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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