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(71) Applicant: **SwipBox Development ApS**
6400 Sønderborg (DK)

(72) Inventor: **Kaczmarek, Allan**
6400 Sønderborg (DK)

(74) Representative: **Patrade A/S**
Ceresbyen 75
8000 Aarhus C (DK)

(54) METHOD FOR SYNCHRONISED AND WIRELESS COMMUNICATION, A LOCK UNIT AND A COMMAND UNIT

(57) A computer-implemented method (1000) for at least one lock unit (10) of a plurality of lock units (10P) receiving commands via synchronised and wireless communication, said plurality of lock units (10P) controlling access to respective plurality of compartments (1a,1b,...), wherein each lock unit (10) of the plurality of lock units (10P) has a periodic communication cycle (20) and a unique lock unit ID (12),
wherein each of the periodic communication cycles (20) comprising
- a receiver interval (42) for receiving commands from a command unit (90),
- a response interval (44) for responding to the command unit (90), and
- a communication pause interval (46) between the receiver interval (42) and response interval (44),

wherein each lock unit has a unique response interval (24A, 24B, 24C),
wherein each lock unit (10) of the plurality of lock units (10P) perform a step of
- observing (1100) using an antenna during the receiver interval (22); and upon receiving a command (82) including a matching unique lock unit ID (12) perform steps of
- executing (1200) an action based on the received command (82); and
- transmitting (1300) wirelessly a response (84) during the unique response interval (44) based of the received command (82).

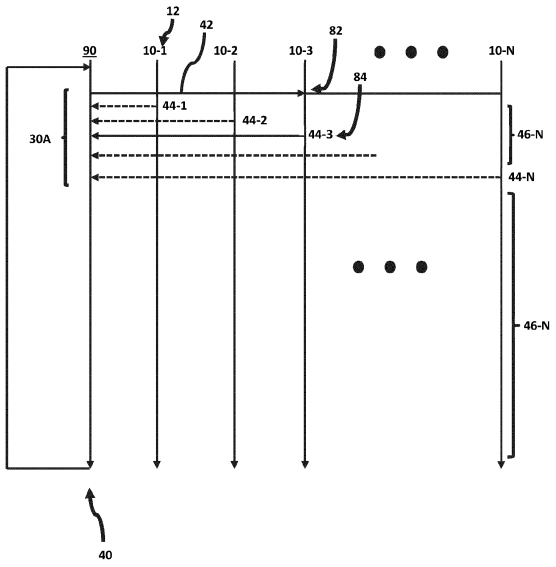

Fig. 2

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Description

Field of the Invention

[0001] The present invention relates to a lock unit, and a method for at least one lock unit of a plurality of lock units for receiving commands via synchronised and wireless communication, wherein the plurality of lock units control access to a compartment.

[0002] The present invention relates to command unit, and a method for broadcasting commands to one, two or more lock units using synchronised and wireless communication.

Background of the Invention

[0003] The total cost of sending a parcel or package can be reduced by utilizing parcel lockers, as the last mile is an expensive part of sending a parcel or package. The costs can be reduced using parcel lockers (also known as automated parcel machines - APM), which may be indoor or outdoor parcel lockers.

[0004] The number of parcel lockers have been increasing with a rapid rate. Furthermore, the number of compartments forming part of the parcel lockers have increased. Presently, some lean lockers are being sold with 32 compartments. Each compartment has a latch controlled by a controller via a wired communication protocol and the latch is typically powered via a power cord irrespective of the entire parcel locker being powered by batteries or an external power source such as the electric grid.

[0005] The wired communication protocol may be can-bus or other wired protocols. The wired communication is reliable and easy to implement. However, as parcel lockers require more and more compartments within the same volume then it becomes more and more troublesome to ensure space for the various cables. This increases costs of production and cost of maintenance. Furthermore, the complexity prevents the parcel locker from being more modular as the central controller must be in wired communication with all latches.

[0006] Thus, there is a need for a new solution for controlling a latch controlling access to a storage space of a compartment.

Object of the Invention

[0007] It is an object to provide a method, a lock unit and a command unit enabling controlling the lock unit via synchronised and wireless communication ensuring low power consumption enabling off grid operation or just low power operation for a parcel locker being powered by an electric grid.

Description of the Invention

[0008] An object of the invention is achieved by a computer-implemented method for at least one lock unit of a plurality of lock units receiving commands via synchronised and wireless communication, said plurality of lock units controlling access to respective plurality of compartments, wherein each lock unit of the plurality of lock units has a periodic communication cycle and a unique lock unit ID, wherein each of the periodic communication cycles comprising

- a receiver interval for receiving commands from a command unit,
- a response interval for responding to the command unit, and
- a communication pause interval between the receiver interval and response interval,

wherein each lock unit has a unique response interval,
wherein each lock unit of the plurality of lock units perform a step of

- observing using an antenna during the receiver interval; and upon receiving a command including a matching unique lock unit ID perform steps of
    - executing an action based on the received command; and
    - transmitting wirelessly a response during the unique response interval based of the received command.

[0009] Thereby, the method enables one to many communications while enabling the many (lock units) to transmit a wireless respond. Generally, wireless communication is less energy efficient compared to wired communication; however the method ensures a low energy consumption by synchronised communication as the commands to and responses from each lock unit can be received and transmitted within a small time period. As a result, the communication pause interval

constitutes the longest interval of the periodic communication cycle.

[0010] The communication pause interval is preferably as large as possible and the receiver interval and the response interval are preferably as short as possible. The ratio of the communication pause interval to the periodic communication cycle may be greater than 0.99 such as 0.999 or greater. The total length of the receiver interval and the response interval may be equal to or less than 1 ms.

[0011] Assuming that the periodic communication cycle is 1 second, wherein the sum of the receiver interval and the response interval are equal to 1 ms, then a lock unit will be powered for communication for 3.65 days over a period of 10 years; this is an acceptable period allowing the method to be performed on battery-powered lock units for at least 10 years. The total time for communication is inversely proportional to the sum of the receiver interval and the response interval, hence a 50 % reduction will result in the total time being 1,825 days. In the example, it is assumed that the lock unit will always use the response interval to communicate, however, this will rarely be the case depending on the specific use of the plurality of lock units.

[0012] If the lock units and the compartments form part of a parcel locker and assuming that a courier stores a parcel in each compartment and assuming recipient collects the parcel the same day, then each lock unit will receive two commands each day and send two responses each day. If the periodic communication cycle is 1 second, then there will only be sent responses during two response intervals out of the 86400 response intervals that day. There may be additional commands and responses to check state of the lock units, but that would not change the seldom use of the response interval.

[0013] The communication pause interval may be single interval or intervals before and after the receiver interval and the response interval. In some cases, the receiver interval and the response interval will come one after the other, however since each lock unit has a unique response interval then in most cases there will be a communication pause interval between the end of the receiver interval and the start of the response interval and between the end of the response interval and the start of the receiver interval.

[0014] The periodic communication cycles may be preprogrammed and stored on each lock unit and optionally the periodic communication cycle of the plurality of lock units may be stored on an external server such that any command unit is able to receive information related to the periodic communication cycle of the one or more lock units such that any command unit is able to communicate with said one or more lock units.

[0015] The command unit may be permanently installed at the plurality of lock units - in some embodiments the command unit may be part of or forms part of a controller of a parcel locker. The permanently installed command unit may be configured to assign individual periodic communication cycles to each of the plurality of lock units; thereby the command unit is in control of the synchronised communication.

[0016] The antenna of each lock unit may be designed for WLAN communication such as Bluetooth or similar solutions.

[0017] The command may include one or more instructions linked to one or more unique lock unit IDs, wherein the lock units with matching lock unit IDs will perform an action based on the instructions linked to said lock unit IDs and the other lock units will do nothing. The command may thus contain one or more commands to one or more lock units. The command may have a structure such as [instructions; ID 1];[instructions, ID 5];[instructions, ID X]; .. .;[instructions, ID N].

[0018] The action may be to check the status of a latch or check the status of an actuator or check a temperature if the lock unit is further equipped with a temperature sensor or check a sensor quantity if the lock unit is further equipped with a sensor measuring a sensor quantity. The listed actions are non-exhaustive.

[0019] The unique response interval means that there are no overlapping response intervals thereby only a single lock unit responds which improves the quality of the communication with the plurality of lock units. The communication may utilise one or more communication bands of the wireless protocol.

[0020] In some embodiments, the unique response intervals are unique by use of different communication bands such that two response intervals can overlap in time but be in different bands such that the communication does not overlap.

[0021] The communication may be encrypted using standard communication encryption.

[0022] In an aspect, the command may include instructions causing at least one lock unit to perform an unlock action, thereby allowing access to a compartment.

[0023] The instruction will cause the lock unit to activate an actuator causing the lock unit to unlock, such that the compartment is accessible. The lock unit may after performing the action transmit a response confirming the action has been performed.

[0024] In some cases, the next response interval may be used for confirming that said instructions have been received.

[0025] In an aspect, the receiver interval may be less than 1ms, or 50 to 950 μs, or 100 to 750 μs, or 150 to 500 μs, or 200 to 400 μs, or 300 μs and/or wherein the unique response interval may be less than 500 μs such as 50 to 500 μs, or 75 to 400 μs, or 100 to 300 μs, or 125 to 250 μs, or 150 to 200 μs.

[0026] The current bandwidth of wireless protocols enables that a sufficient amount of data i.e. the command and response can be sent during said receiver interval and said response interval listed above.

[0027] In an aspect, at least two lock units may have a common receiver interval. Thereby, the command unit can broadcast to the at least two lock units within the time slot thereby the power required is less compared to each lock unit having a unique receiver interval. The command may include a series of instructions wherein each instruction is linked to a

unique lock unit ID, wherein each lock unit is programmed to ignore instructions not linked to the unique lock unit ID of said lock unit.

[0028] The at least two lock units may be 8 lock units, or 16 lock units, or 32 lock units, or 64 lock units or 128 lock units or 128 lock units or more lock units having a common receiver interval.

[0029] The plurality of lock units may be divided into two or more groups of lock units, wherein the lock units of each group of lock units have a common receiver interval.

[0030] The common receiver intervals of each group of lock units are unique and do not overlap.

[0031] In an aspect, the step of transmitting may be performed during a subsequent periodic communication cycle. An action such as unlocking a lock unit typically involves activating an actuator, which will generally use more than one second to perform the action. Depending on the details of the periodic communication cycle, then it may not be possible to send a response which confirms that the action has been performed with the first coming response interval.

[0032] In an aspect, periodic communication cycle may be equal to or less than 20 s, or equal to or less than 10 s, or between 0.5 s to 5 s, or between 0.75 s to 2.5 s or between 1 s to 2 s or between 1.25 to 1.75 s.

[0033] The plurality of lock units will consume less energy as the periodic communication cycle increases in time as long as the receiver interval and the response interval remain unchanged.

[0034] However, the plurality of lock units will feel more unresponsive as the periodic communication cycle increases, thus there is a trade-off between total energy and responsiveness. In some embodiments, the periodic communication cycle changes as a function of the time of day and/or day of the week. In most cases, there will be a low collection rate during the night and certain hours during the day; during these periods the periodic communication cycle can be increased such that energy consumption is lowered.

[0035] Using the logic, the periodic communication cycle can be decreased during rush hours and/or during the period of courier delivery, thereby enabling the courier to fill up the compartments faster as the responsiveness has been increased.

[0036] An object of the invention is achieved by a lock unit for controlling access to a storage space of a compartment. The lock unit comprises

- a latch for engaging a complementary striker;
- an actuator configured to displace the latch;
- a clock unit for tracking time;
- a local energy storage and/or a connector for receiving external electric power;
- a lock communication unit with an antenna for wireless communication;
- a lock controller including a processor and a computer-readable medium having stored thereon

    - a periodic communication cycle comprising a receiver interval for receiving commands, and a response interval for responding, a communication pause interval between the receiver interval and response interval, and
    - instructions causing the lock controller to change state of the lock unit based of the periodic communication cycle between the

        - a receiver state during the receiver interval, wherein the lock communication unit is activated for wirelessly receiving a command;
        - a response state during the response interval, wherein the lock communication unit is activated for wirelessly transmitting a response;
        - a communication pause state, wherein the lock communication unit is inactive;

    wherein the processor is configured to cause the lock unit to execute an action based on the received command.

[0037] The resulting lock unit is capable of performing synchronised and wireless communication with a command unit. The lock unit enables that a group of compartments such as indoor parcel lockers or outdoor parcel lockers or lean lockers or automated parcel machines can be designed with greater flexibility and more compact as there is no need for pulling a cable for wired communication. In the embodiments, wherein the lock unit is powered by a local energy storage such as a battery, then the flexibility increases even more as there is no need for pulling a power cord to the lock unit.

[0038] In some embodiments, the lock communication unit with an antenna for wireless communication, the clock unit and the lock controller are powered by the local energy storage while the actuator is powered via a connector. The total power needed for the wireless communication and control is rather small thus even a button battery will be able to power these components for several years and other battery types such as a Li-SoCl2 battery can power the components for more than 10 years.

[0039] The lock unit may have stored on the computer-readable medium a unique lock unit ID.

[0040] In an aspect, the lock unit may comprise means for carrying out the method according to any of claims 1-6.

[0041] An object of the invention is achieved by a compartment, which compartment may comprise a storage space, a

door through which the storage space is accessible, a lock unit according to the invention configured to releasable retaining the door. The compartment may include a sticker which the lock units interact with to lock the door in place.

[0042] The compartment can be a completely self-autonomous unit in the embodiments wherein the lock unit is powered by a local energy storage such as a battery.

[0043] An object of the invention is achieved by a compartment system comprising a plurality of compartments, wherein at least one of the compartments being according to any of the previously described embodiments.

[0044] The compartment system may be an indoor parcel locker or an outdoor parcel locker or a lean locker or an automated parcel machine or a number of compartments wherein the compartments separate units or compartments of a parcel shop.

[0045] An object of the invention is achieved by a method for broadcasting commands to one, two or more lock units of a plurality of lock units, wherein each lock unit the plurality of lock units has a periodic communication cycle and a unique lock unit ID, wherein each of the periodic communication cycles comprising

- a receiver interval for receiving commands from a command unit,
- a response interval for responding to the command unit, and
- a communication pause interval between the receiver interval and response interval,

wherein each lock unit has a unique response interval and optionally at least two lock units have a common receiver interval. The method comprises steps of

- broadcasting commands to the one, two or more lock units during the receiver interval, wherein the command includes the unique lock unit IDs of the one, two or more lock units;
- receiving a response from the one, two or more lock units during the unique response interval of each of the one, two or more lock units.

[0046] The periodic communication cycles may be preprogramed and stored on each lock unit and optionally the periodic communication cycle of the plurality of lock units may be stored on an external server such that any command unit is able to receive information related to the periodic communication cycle of the one or more lock units such that any command unit is able to communicate with said one or more lock units. The command unit may be permanently installed at the plurality of lock units - in some embodiments the command unit may be or form part of a controller of a parcel locker. The permanently installed command unit may be configured to assign individual periodic communication cycles to each of the plurality of lock units; thereby the command unit is in control of the synchronised communication.

[0047] A command unit can by performing the method communicate with any number of the plurality of lock units and hence the command unit can control all the lock units by utilising the information of the periodic communication cycles.

[0048] In the embodiments, wherein the command unit is a permanently installed unit at the plurality of lock units, then the command unit has means such as a pin pad and/or display capable of receiving inputs and/or barcode reader and/or an NFC module and/or a Bluetooth unit and/or similar adapted for communication with a device of a recipient of a parcel and/or with a device of a courier. The device may be a smart phone.

[0049] In an aspect, the step of receiving may be performed during a subsequent transmission cycle.

[0050] An object of the invention is achieved by a command unit for broadcasting commands to one, two or more of the lock units of a plurality of lock units; wherein the command unit comprises

- a command clock unit for tracking time;
- a local energy storage and/or a connector for receiving external electric power;
- a command communication unit with an antenna for wireless communication;
- a command controller including a command processor and a command computer-readable medium having stored thereon permanently or temporarily

    - one, two or more periodic communication cycles of the one, two or more of the lock units of a plurality of lock units, each periodic communication cycle comprising a receiver interval for receiving commands, and a response interval for responding, a communication pause interval between the receiver interval and response interval,

  wherein command communication unit is configured to broadcast one, two or more commands to the one, two or more of the lock units in sync with the one, two or more periodic communication cycles.

[0051] The stored one, two or more periodic communication cycles of the one, two or more of the lock units of the plurality of lock units can be permanently stored in the cases wherein the command unit has assigned said periodic communication cycles to the lock units or temporarily in the cases wherein the stored data has been received from a distribution server for

the collection of one, two or more parcels stored in the one, two or more compartments being accessible by controlling the one, two or more lock units of the plurality of lock units. In this case the data can be deleted afterwards and furthermore, the stored data may only be of the lock units to be controlled for the collection of said parcels.

[0052] In an aspect, the command unit may be or may form part of a smart phone or smart device or a parcel locker controller or a pin pad or NFC reader or an interactive computer at a PUDO centre or an interactive computer such as a display capable of receiving inputs forming part of a parcel locker.

[0053] An object of the invention is achieved by a computer program product comprising instructions which, when the program is executed by a lock unit according to any of claims 7 to 8, cause the computer to carry out the method of any of claims 1 to 6.

[0054] An object a computer readable medium such as a non-transient computer readable medium, wherein the computer-readable medium having stored thereon the computer program product of claim 15.

Description of the Drawing

[0055] Embodiments of the invention will be described in the figures, whereon:

Fig. 1 illustrates an embodiment of a compartment;
Fig. 2 illustrates a periodic communication cycle;
Fig. 3 illustrates a periodic communication cycle with two groups of lock units;
Fig. 4 illustrates the plurality of lock units and how they communicate with a screen and scanner device;
Fig. 5 illustrates the plurality of lock units and how they communicate with an NFC device;
Fig. 6 illustrates the plurality of lock units and how they communicate with a pin pad;
Fig. 7 illustrates an embodiment of a lock unit;
Fig. 8 illustrates an embodiment of a command unit; and
Fig. 9 illustrates an embodiment of a computer-implemented method for at least one lock unit receiving instructions via synchronised communication; and
Fig. 10 illustrates an embodiment of a method for broadcasting commands to one, two or more lock units of a plurality of lock units.

Detailed Description of the Invention

[0056]

Item	No
Compartment	1a,1b,..., 2a,2b,2c....
Compartment system	9
Lock unit	10
Plurality of lock units	10P
Unique lock unit ID	12
Latch	14
Actuator	15
Clock unit	16
Local energy storage	18
Connector	20
Lock communication unit	22
Lock controller	24
Processor	26
Computer-readable medium	28
Group of lock units	30A, 30B, 30C
Periodic communication cycle	40
Receiver interval	42

(continued)

Item	No
Response interval	44
Communication pause interval	46
Storage space	70
Door	72
Striker	74
Command	82
Response	84
Command unit	90
Command clock unit	91
Command communication unit	92
Command controller	93
Command processor	94
Command computer-readable medium	95
Pin pad	100
NFC	101
Screen	102
Barcode reader	103
Computer-implemented method for at least one lock unit receiving instructions via synchronised communication with a plurality of lock units	1000
Observing	1100
Executing	1200
Transmitting	1300
Method for broadcasting commands to one, two or more lock units of a plurality of lock units	2000
Broadcasting	2100
Receiving	2200

[0057] Fig. 1 illustrates an embodiment of a compartment 1. The compartment 1 is a standard compartment with the exception of the lock unit 10 being according to the invention. The lock unit 10 is either powered by a not shown local energy storage 18 and/or via an electric cord connected to a not shown connector 20 of the lock unit 10.

[0058] The compartment 1 defines a storage space 70 accessible through a door 72. In the present embodiment, the door 72 having a striker 74 complementary to a latch 14 of the lock unit 10. The positioning of the striker 74 and the lock unit could be different such as the lock unit 10 being attached to the door 70 and the latch being attached to a surface of the storage space 70 or the striker 74 and the lock unit 10 are positioned differently as long as the door 72 can be releasable gripped by the lock unit 10 such that the accessibility of the storage space 70 can be controlled.

[0059] The compartment 1 could be one, two, more or all the compartments 1a, 1b... shown in figures 4-6, wherein the compartments 1 form a compartment system 9. The compartment system 9 may be a parcel locker or an automated parcel machine or a lean parcel locker. The compartment system 9 may be configured for indoor use or be configured for outdoor use.

[0060] The lock unit 10 has a unique lock unit ID 12 which may be a numeric number or a number of characters such as letters and/or numbers.

[0061] The lock unit 10 is configured to communicate wirelessly with a command unit 90 (not shown) in accordance with a periodic communication cycle 40. The periodic communication cycle 20 comprises

- a receiver interval 42 for receiving commands from the command unit (90),
- a response interval 44 for responding to the command unit 90, and

- a communication pause interval 46 between the receiver interval 42 and response interval 44.

[0062] The lock unit 10 may share the receiver interval 42 with one or more other lock units 10, wherein the unique lock unit ID 12 is used to ensure that only the lock unit 10 with the matching lock unit ID 12 performs the instructions linked to said lock unit 12. The command may include instructions to one, two or more lock units 10 wherein each instruction is linked to a specific lock unit ID 12.

[0063] The response interval 44 is unique for the lock unit 10 such that there is only one lock unit 10 at a time. This is shown in more detail in figures 2 and 3.

[0064] As mentioned earlier in the description of the invention, the communication pause interval 46 is preferably as long as possible relative to the sum of the receiver interval 42 and the response interval 44, as the power consumption during the idle time of a lock unit 10 consumes very little power.

[0065] The wireless communication may be a WLAN protocol such as Bluetooth or Bluetooth low-energy or similar low energy communication protocols.

[0066] Fig. 2 illustrates a periodic communication cycle 40. The shown figure has time along the vertical axis and the periodicity is represented by the arrow moving back to the top. The horizontal arrows represent communication between a command unit 90 and N lock units 10. The dotted horizontal arrows represent not used communication time slots. The unique lock unit ID 12 is in the figure shown as the number after reference number 10-"number". The N lock units 10 are part of a group of lock units 30A.

[0067] In the shown embodiment, the command unit 90 communicates a command 82, which command 82 includes an instruction for a lock unit 10 with unique lock unit ID 12 being the number "3" hence the arrow to lock unit 10-3. All the lock units 10 receive the command 82 but all lock units 10 except lock unit 10-3 ignores the instructions. The lock unit 10-3 performs an action based on the received instructions contained in the command 82.

[0068] The action may be to request status of latch or to request a sensor value or open compartment or another kind of instruction.

[0069] All lock units 10 have a unique response interval 44, but since only lock unit 10-3 received a command, then it is only lock unit 10-3 which transmits a response 84 to the command unit 90 hence said line is solid. The response 84 may be instructions received and a response containing "action complete" may be transmitted during a subsequent cycle - this will usually be the case when the instruction is to open a compartment 1.

[0070] The communication pause interval 46 is only shown for lock unit 10-N but all lock units 10 have a communication pause interval 46 and most have a communication pause interval 46 on each side of the receiver interval 42 and the response interval 44.

[0071] In the next periodic communication cycle 40 there may not be a command which would happen most often as a parcel locker with 20 compartments may be filled with 20 parcels in the morning resulting in a maximum of 20 commands 82. If all parcels are collected, then there will be additional 20 commands. The sum is thus 40 commands. If the periodic communication cycle 40 is 1 second, then there will be 86400 cycles per day and only 40 will include a command.

[0072] However, the next or a future periodic communication cycle 40 could include a command 82 to one or more of the lock units 10 and it will result in one or more responses 84.

[0073] If no command 90 is sent to a specific lock unit 10 then the command unit 90 may be in idle mode during the response interval of said lock unit 10 as there will be no response 84.

[0074] Fig. 3 illustrates a periodic communication cycle 40 with two groups of lock units 30A, 30B. The first group of lock units 30A has in the shown embodiment the same communication as shown in figure 2.

[0075] The second group of lock units 30B has a lock unit 10 with unique lock unit ID 12 being N+1 to a lock unit 10 with unique lock unit ID 12 being M, wherein M>N+1. During the receiver interval 82 of the second group of lock units 30B a command 90 is broadcasted with instructions for lock units 10 with the unique lock unit IDs being N+1, N+2, N+3 and M. The lock units 10 which have received instructions will execute an action based on the received instructions. The lock units 10 with unique lock unit IDs being N+1, N+2, N+3 and M will transmit a response to the command unit 90 during their respective response intervals 44.

[0076] The command unit 90 may communicate with a third group of lock units 30C or more groups of lock units 30X, however the figure does not disclose a specific communication pattern as it can be represented by figure 2 and figure 3.

[0077] Fig 4 shows a plurality of compartments 1a,1b,..., 2g. Each compartment 1a,1b,..., 2g comprises at least one door 72 enabling access to the storage space 70 (not shown) of the respective compartments 1a, 1b,..., 2g as shown in figure 1. At least one compartment 1a,1b,..., 2g comprises a lock unit 10 according to the invention. The lock units 10 are powered by a local energy storage 18 and/or via a connector to external power such as the power grid. All lock units 10 may be powered by the same local energy storage 18, such as a battery unit similar to known lean parcel lockers.

[0078] The number of compartments 1a,1b,..., 2g could be any other number.

[0079] The shown compartment system 9 includes a command unit 90, which includes a screen 102 such as a touch screen and optionally a barcode reader 103 attached to the command unit 90. Although not shown the command unit 90 can be mechanically attached to the compartments 1a,1b,..., 2g or be a separate unit. The command unit 90 comprises

means for wireless communication with the at least one lock unit 10 according to the invention. The communication is performed as described in figure 2 or 3, wherein the command unit 90 broadcasts a command 82 as a function of input through the screen 102 or input via the barcode reader 103. The shown command unit 90 may be a smart phone or tablet or similar smart device as a smart phone or tablet includes a touch screen and a camera which can function as a barcode scanner 103.

[0080] The command unit 90 may be powered by a separate local energy storage 18, such as a battery unit or the same local energy storage as the lock units 10. The command unit 90 may include a connector for connection with an electric grid.

[0081] Fig 5 shows a plurality of compartments 1a,1b,..., 2g. Each compartment 1a,1b,..., 2g comprises at least one door 72 enabling access to the storage space 70 (not shown) of the respective compartments 1a,1b,..., 2g as shown in figure 1. At least one compartment 1a,1b,..., 2g comprises a lock unit 10 according to the invention. The lock units 10 are powered by a local energy storage 18 and/or via a connector to external power such as the power grid. All lock units 10 may be powered by the same local energy storage 18 such as a battery unit similar to known lean parcel lockers.

[0082] The number of compartments 1a,1b,..., 2g could be any other number.

[0083] The shown compartment system 9 includes a command unit 90, which includes an NFC module 101. Although not shown, the command unit 90 can be mechanically attached to the compartments 1a,1b,..., 2g or be a separate unit. The command unit 90 comprises means for wireless communication with the at least one lock unit 10 according to the invention other than the NFC module 101 as the distance will be too great in most embodiments. The communication is performed as described in figure 2 or 3, wherein the command unit 90 broadcasts a command 82 as a function of input via the NFC module.

[0084] The command unit 90 may be powered by separate local energy storage 18 such as a battery unit or the same local energy storage as the lock units 10. The command unit 90 may include a connector for connection with an electric grid.

[0085] Fig 6 shows a plurality of compartments 1a,1b,..., 2g. Each compartment 1a,1b,..., 2g comprises at least one door 72 enabling access to the storage space 70 (not shown) of the respective compartments 1a,1b,..., 2g as shown in figure 1. At least one compartment 1a,1b,..., 2g comprises a lock unit 10 according to the invention. The lock units 10 are powered by a local energy storage 18 and/or via a connector to external power such as the power grid. All lock units 10 may be powered by the same local energy storage 18 such as a battery unit similar to known lean parcel lockers.

[0086] The number of compartments 1a,1b,..., 2g could be any other number.

[0087] The shown compartment system 9 includes a command unit 90, which includes a pin pad 100. Although not shown the command unit 90 can be mechanically attached to the compartments 1a,1b,..., 2g or be a separate unit. The command unit 90 comprises means for wireless communication with the at least one lock unit 10 according to the invention. The communication is performed as described in figure 2 or 3, wherein the command unit 90 broadcasts a command 82 as a function of input through the screen 102 or input via the barcode reader 103.

[0088] Fig. 7 illustrates an embodiment of a lock unit 10 for controlling access to a storage space of a compartment 1a,1b,... as shown in any of figures 1, 4-6.

[0089] The lock unit 10 comprises a latch 14 for engaging a complementary striker 74, wherein an actuator 15 is configured to displace the latch 14. The actuator 15 may be an electric motor such as a rotary motor.

[0090] The lock unit 10 comprises a clock unit 16 for tracking time for enabling synchronised communication.

[0091] The lock unit 10 comprises a local energy storage 18 and/or a connector 20 for receiving external electric power. The local energy storage 18 may be a battery unit.

[0092] In some embodiments, the actuator is powered via the connector 20 while the other components are powered by the local energy storage 18 such as a battery unit as this would allow a button battery to power the other parts for years - thereby it would always be possible to receive a response 84 from the lock unit 10 even in the case where the connector is damaged.

[0093] The lock unit 10 comprises a lock communication unit 22 with an antenna for wireless communication. The lock communication unit 22 may be or may include Bluetooth or low-energy Bluetooth or similar low energy WLAN protocols.

[0094] The lock unit 10 comprises a lock controller 24 including a processor 26 and a computer-readable medium 28 having stored thereon

- a periodic communication cycle 40 comprising a receiver interval 42 for receiving commands, and a response interval 44 for responding, a communication pause interval 46 between the receiver interval 42 and response interval 44, and
- instructions causing the lock controller 24 to change state of the lock unit 10 based of the periodic communication cycle 40 between the
    - a receiver state during the receiver interval 42, wherein the lock communication unit 22 is activated for wirelessly receiving a command 82;
    - a response state during the response interval 44, wherein the lock communication unit 22 is activated for

wirelessly transmitting a response 84;

- a communication pause state, wherein the lock communication unit 22 is inactive;

wherein the processor 26 is configured to cause the lock unit 10 to execute an action based on the received command 82.

[0095] The action may be to unlock the latch 14.

[0096] Fig. 8 illustrates an embodiment of a command unit 90. The command unit 90 for broadcasting commands 84 to one, two or more of the lock units 10 of a plurality of lock units 10P.

[0097] The command unit 90 comprises a command clock unit 91 for tracking time for enabling synchronised communication.

[0098] The command unit 90 comprises a local energy storage 18 and/or a connector 20 for receiving external electric power. The local energy storage 18 may be a battery unit. The local energy storage 18 can be a battery unit such as a Li-SoCl2 battery enabling power for more than 5 years, such as 10 years or more.

[0099] The command unit 90 comprises a command communication unit 92 with an antenna for wireless communication. The command communication unit 92 may comprise two or more wireless communication modules 92. The command communication unit 92 may be configured to wirelessly communicate with a device of a recipient or a courier, the device may be a smart phone. The command communication unit 92 may include a bar code scanner, and/or a touch screen and/or a pin pad and/or NFC module and/or a Bluetooth module and/or a Bluetooth low-energy module and/or a similar low energy WLAN communication protocol.

[0100] The command unit 90 comprises a command controller 93 including a command processor 94 and a command computer-readable medium 95 having stored thereon permanently or temporarily

- one, two or more periodic communication cycles 40 of one, two or more of the lock units 10 of a plurality of lock units 10P, each periodic communication cycle 40 comprising a receiver interval for receiving commands, and a response interval for responding, a communication pause interval between the receiver interval and response interval,

wherein the command communication unit is configured to broadcast one, two or more commands to the one, two or more of the lock units in sync with the one, two or more periodic communication cycles.

[0101] Fig. 9 illustrates an embodiment of a computer-implemented method 1000 for at least one lock unit 10 receiving instructions via synchronised communication. The lock unit 10 will in most cases form part of a plurality of lock units (10P). Each lock unit 10 of the plurality of lock units 10P perform a step of

- observing 1100 using an antenna during the receiver interval 22; and upon receiving a command 82 including a matching unique lock unit ID 12 perform steps of
  - executing 1200 an action based on the received command 82; and
  - transmitting 1300 wirelessly a response 84 during the unique response interval 44 based of the received command 82.

[0102] The command may include instructions causing at least one lock unit 10 to perform an unlock action, thereby allowing access to a compartment 1a,1b,....

[0103] The step of transmitting 1300 is performed during a subsequent communication cycle 40.

[0104] Fig. 10 illustrates an embodiment of a method 2000 for broadcasting commands to one, two or more lock units 10 of a plurality of lock units 10P.

[0105] The method 2000 comprises steps of

- broadcasting 2100 commands to the one, two or more lock units 10 during the receiver interval 40, wherein the command includes the unique lock unit IDs 12 of the one, two or more lock units 10; and
- receiving 2200 a response 84 from the one, two or more lock units 10 during the unique response interval 42 of each of the one, two or more lock units 10.

[0106] The step of receiving 2200 may be performed during a subsequent transmission cycle 40.

Claims

1. A computer-implemented method (1000) for at least one lock unit (10) of a plurality of lock units (10P) receiving commands via synchronised and wireless communication, said plurality of lock units (10P) controlling access to respective plurality of compartments (1a,1b,...), wherein each lock unit (10) of the plurality of lock units (10P) has a

periodic communication cycle (20) and a unique lock unit ID (12), wherein each of the periodic communication cycles (20) comprising

- a receiver interval (42) for receiving commands from a command unit (90),
- a response interval (44) for responding to the command unit (90), and
- a communication pause interval (46) between the receiver interval (42) and response interval (44),

wherein each lock unit has a unique response interval (24A, 24B, 24C),
wherein each lock unit (10) of the plurality of lock units (10P) perform a step of

- observing (1100) using an antenna during the receiver interval (22); and upon receiving a command (82) including a matching unique lock unit ID (12) perform steps of

  - executing (1200) an action based on the received command (82); and
  - transmitting (1300) wirelessly a response (84) during the unique response interval (44) based of the received command (82).

2. The method (1000) according to claim 1, wherein the command may include instructions causing at least one lock unit (10) to perform an unlock action, thereby allowing access to a compartment (1a,1b,....).

3. The method (1000) according to claim 1 or 2, wherein the receiver interval (42) is less than 1ms, or 50 to 950 μs, or 100 to 750 μs, or 150 to 500 μs, or 200 to 400 μs, or 300 μs and/or wherein the unique response interval (44) is less than 500 μs such as 50 to 500 μs, or 75 to 400 μs, or 100 to 300 μs, or 125 to 250 μs, or 150 to 200 μs.

4. The method (1000) according to any of claims 1 to 3, wherein at least two lock units (10) have a common receiver interval (22).

5. The method (1000) according to any of claims 1 to 4, wherein the step of transmitting (1300) is performed during a subsequent communication cycle.

6. The method (1000) according to any of claims 1 to 5, wherein periodic communication cycle (40) is equal to or less than 20 s, equal to or less than 10 s or between 0.5 s to 5 s, or between 0.75 s to 2.5 s or between 1 s to 2 s or between 1.25 to 1.75 s.

7. A lock unit (10) for controlling access to a storage space of a compartment (1a,1b,...), the lock unit (10) comprising

- a latch (14) for engaging a complementary striker;
- an actuator configured to displace the latch (14);
- a clock unit (16) for tracking time;
- a local energy storage (18) and/or a connector (20) for receiving external electric power;
- a lock communication unit (22) with an antenna for wireless communication;
- a lock controller (24) including a processor (26) and a computer-readable medium (28) having stored thereon

  - a periodic communication cycle (40) comprising a receiver interval (42) for receiving commands, and a response interval (44) for responding, a communication pause interval (46) between the receiver interval (42) and response interval (44), and
  - instructions causing the lock controller (24) to change state of the lock unit (10) based of the periodic communication cycle (40) between

    - a receiver state during the receiver interval (42), wherein the lock communication unit (22) is activated for wirelessly receiving a command (82);
    - a response state during the response interval (44), wherein the lock communication unit (22) is activated for wirelessly transmitting a response (84);
    - a communication pause state, wherein the lock communication unit (22) is inactive;

wherein the processor (26) is configured to cause the lock unit (10) to execute an action based on the received command (82).

8. A lock unit (10) according to claim 7, wherein the lock unit (10) comprises means for carrying out the method (1000)

according to any of claims 1-6.

9. A compartment (1a,1b,...) for storage of one or more parcels, the compartment (1a,1b,...) comprising a storage space (70), a door (72) through which the storage space (70) is accessible, a lock unit (10) according to claim 7 configured to releasable retaining the door (3).

10. A compartment system (9) comprising a plurality of compartments, wherein at least one of the compartments (1a,1b,...) being according to claim 9.

11. A method (2000) for broadcasting commands (82) to one, two or more lock units (10) of a plurality of lock units (10P), wherein each lock unit (10) of the plurality of lock units (10P) has a periodic communication cycle (40) and a unique lock unit ID (12), wherein each of the periodic communication cycles (40) comprising

- a receiver interval (40) for receiving commands from a command unit (90),
- a response interval (42) for responding to the command unit (90), and
- a communication pause interval (44) between the receiver interval and response interval (44),

wherein each lock unit (10) has a unique response interval (42) and optionally at least two lock units (10) have a common receiver interval (40);
the method (2000) comprising steps of

- broadcasting (2100) commands to the one, two or more lock units (10) during the receiver interval (40), wherein the command includes the unique lock unit IDs (12) of the one, two or more lock units (10);
- receiving (2200) a response (84) from the one, two or more lock units (10) during the unique response interval (42) of each of the one, two or more lock units (10).

12. The method (2000) according to claim 11, wherein the step of receiving (2200) is performed during a subsequent transmission cycle (40).

13. A command unit (90) for broadcasting commands to one, two or more of the lock units (10) of a plurality of lock units (10P); wherein the command unit (90) comprises

- a command clock unit (91) for tracking time;
- a local energy storage (18) and/or a connector (20) for receiving external electric power;
- a command communication unit (92) with an antenna for wireless communication;
- a command controller (93) including a command processor (94) and a command computer-readable medium (95) having stored thereon permanently or temporarily

- one, two or more periodic communication cycles (40) of one, two or more of the lock units (10) of a plurality of lock units (10P), each periodic communication cycle (40) comprising a receiver interval (42) for receiving commands, and a response interval (44) for responding, a communication pause interval () between the receiver interval and response interval (44),

wherein the command communication unit (92) is configured to broadcast one, two or more commands (20) to the one, two or more of the lock units (10) in sync with the one, two or more periodic communication cycles (40).

14. The command unit (90) according to claim 13, wherein the command unit (90) is or forms part of a smart phone or smart device or a parcel locker controller or a pin pad or NFC reader or an interactive computer at a PUDO centre or an interactive computer forming part of a parcel locker.

15. A computer program product comprising instructions which, when the program is executed by a lock unit (10) according to any of claims 7 to 8, causes the computer to carry out the method of any of claims 1 to 6.

16. A computer readable medium such as a non-transitory computer readable medium, wherein the computer-readable medium having stored thereon the computer program product of claim 15.

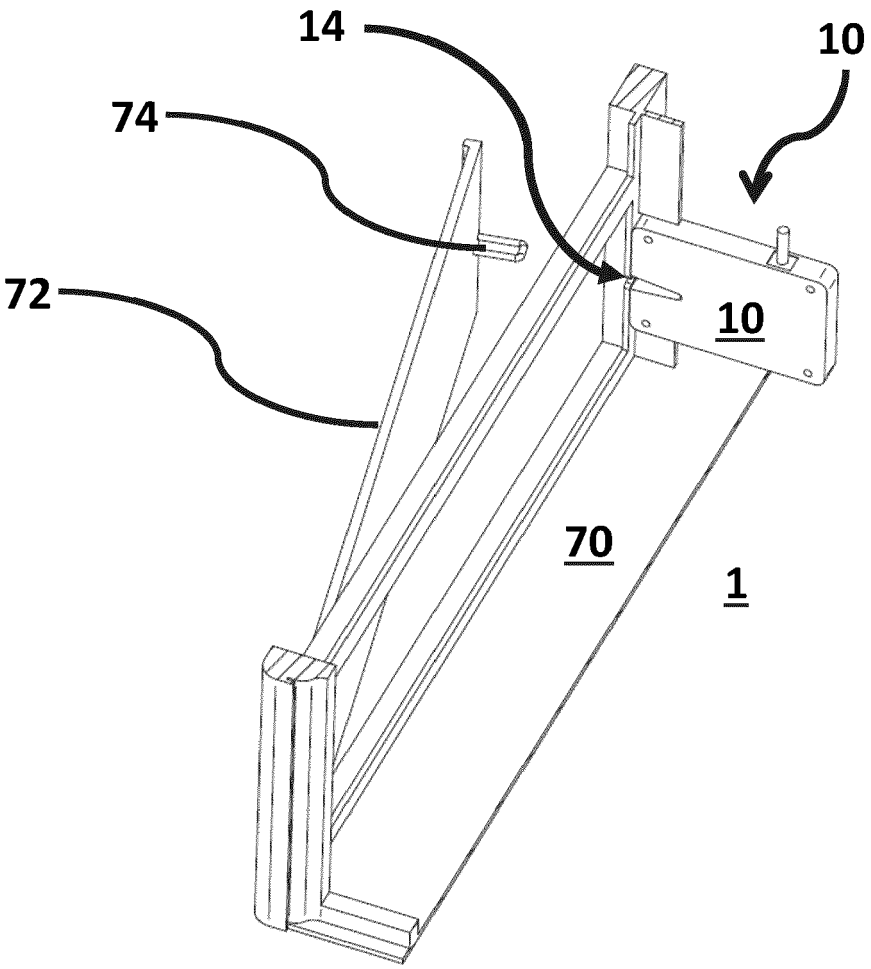


Fig. 1

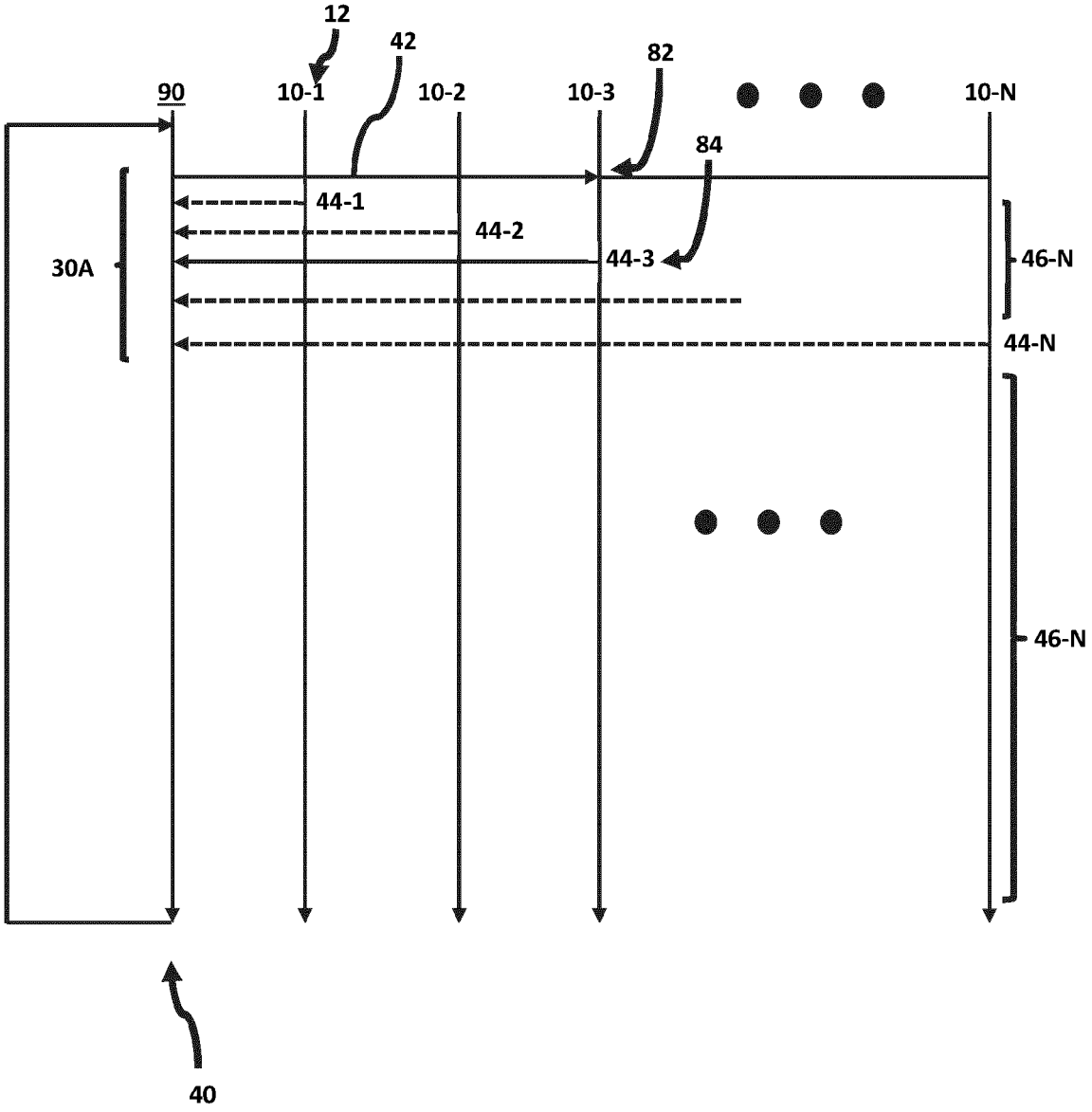
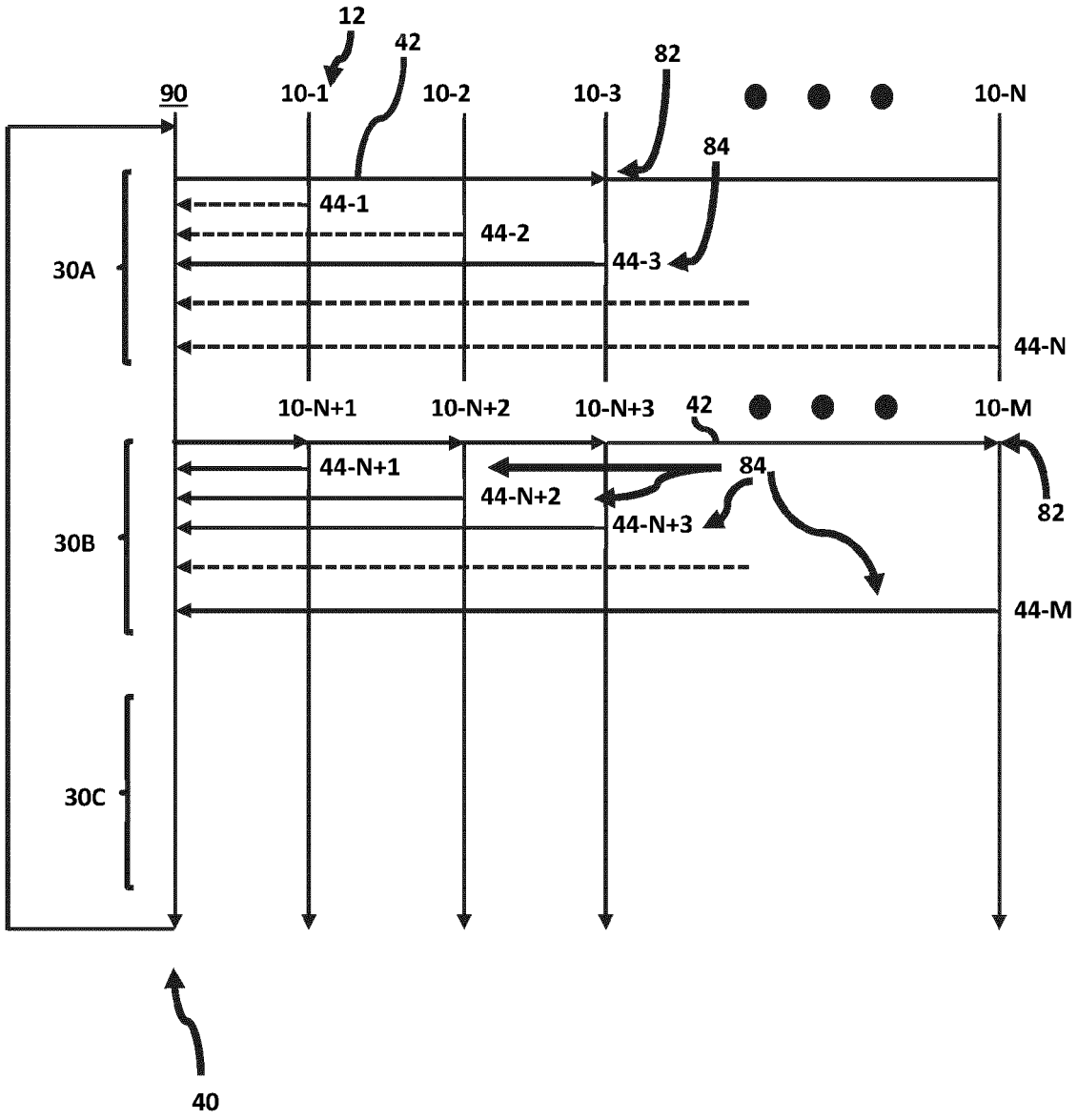


Fig. 2


12
42
82
90
10-1
10-2
10-3
10-N
84
44-1
44-2
44-3
30A
44-N
10-N+1
10-N+2
10-N+3
42
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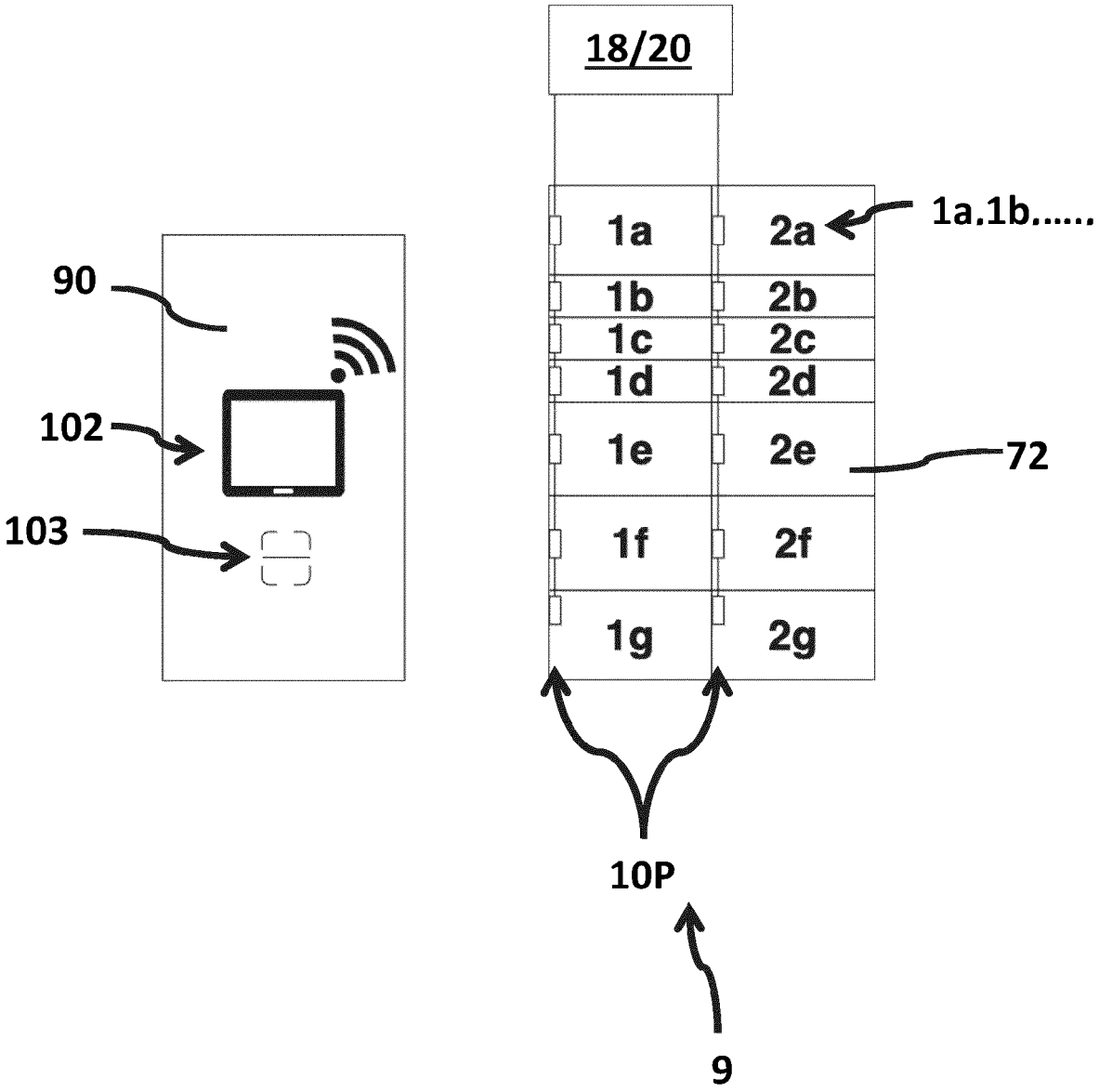
44-N+1
84
44-N+2
82
44-N+3
30B
44-M
30C
40

Fig. 3


18/20
1a
2a
1a.1b.....
1b
2b
1c
2c
1d
2d
1e
2e
72
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1g
2g
10P
9
90
102
103

Fig. 4

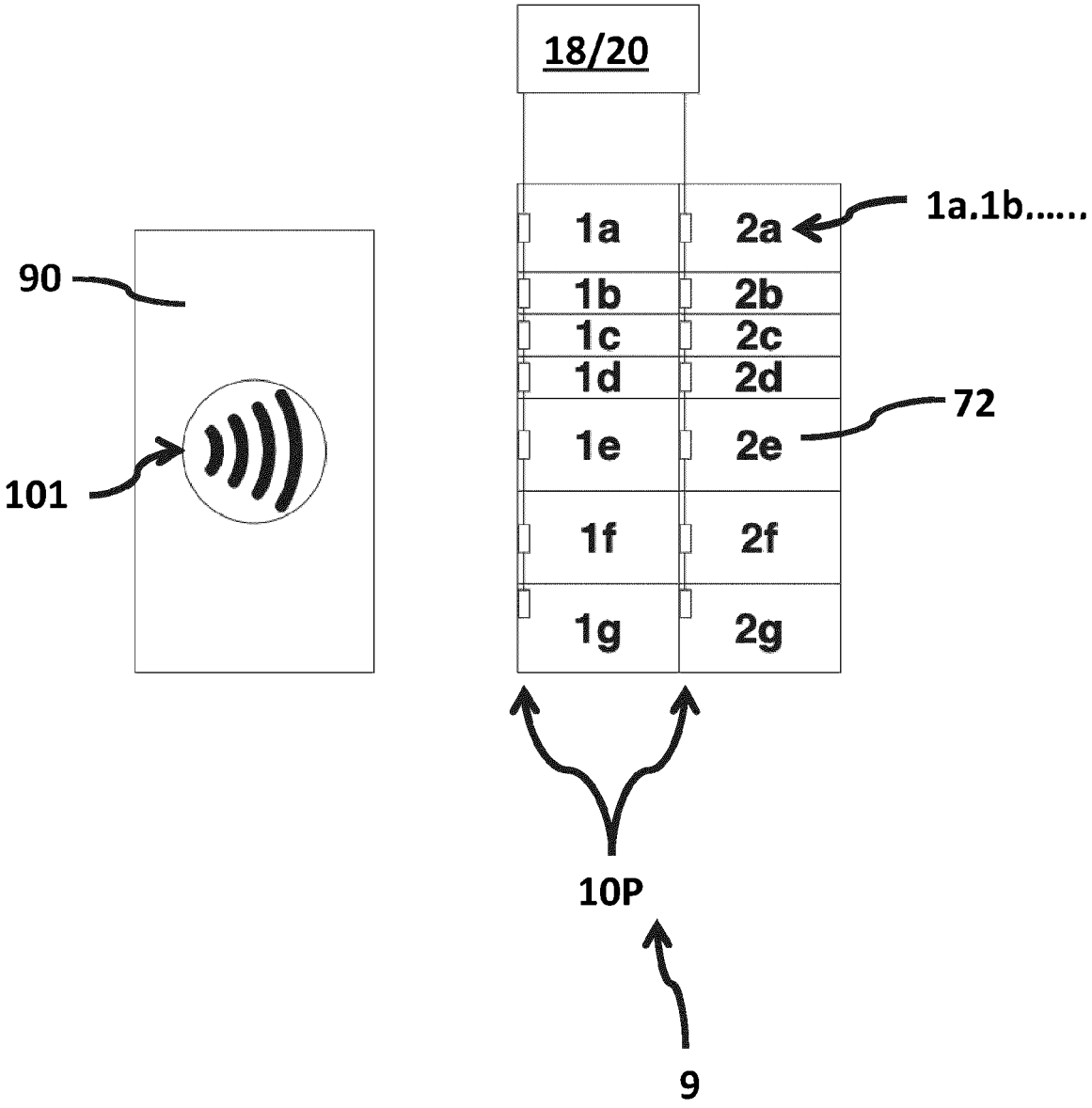

Fig. 5

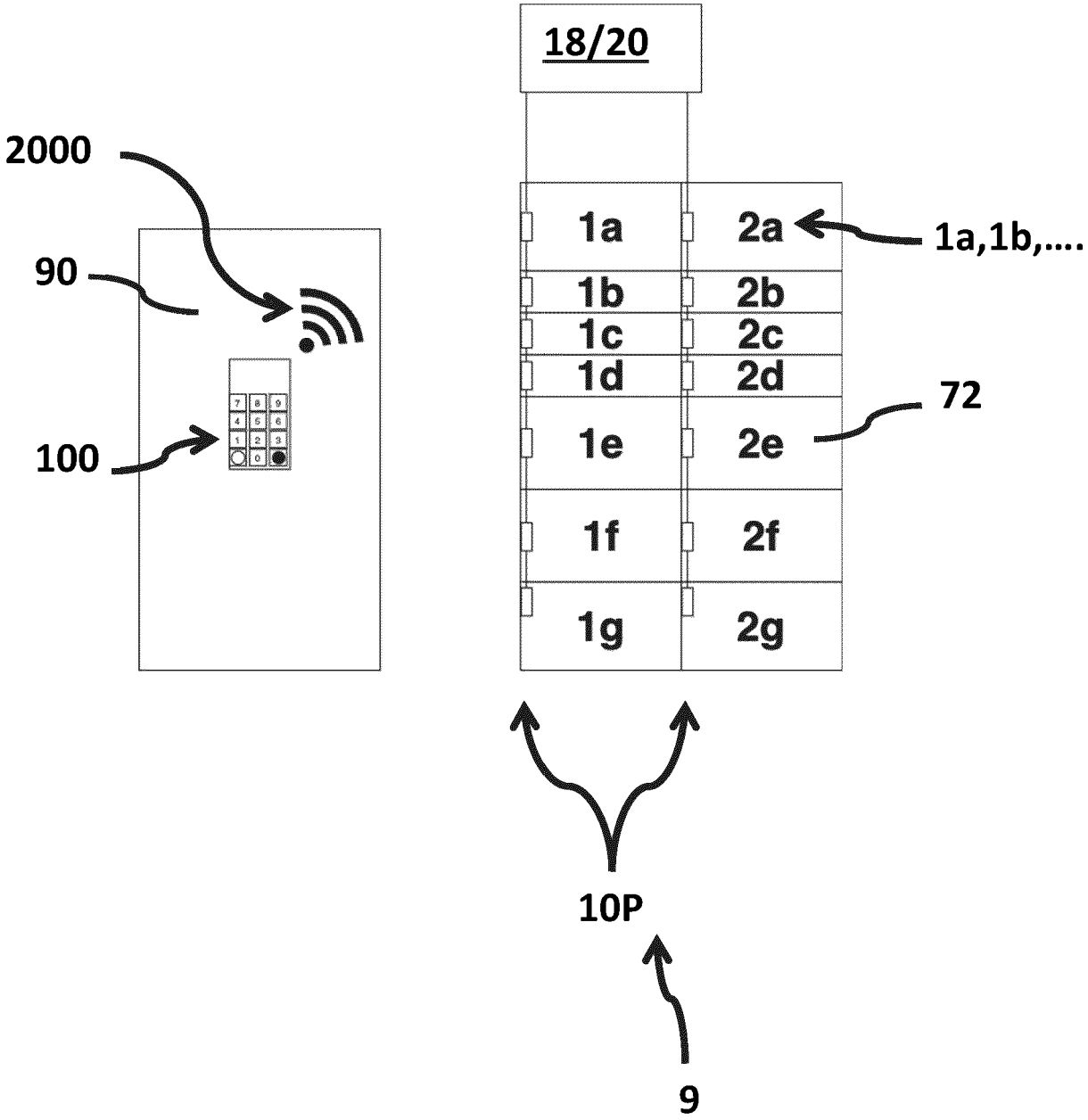
18/20
2000
90
100
1a
2a
1a,1b,....
1b
2b
1c
2c
1d
2d
72
1e
2e
1f
2f
1g
2g
10P
9

Fig. 6

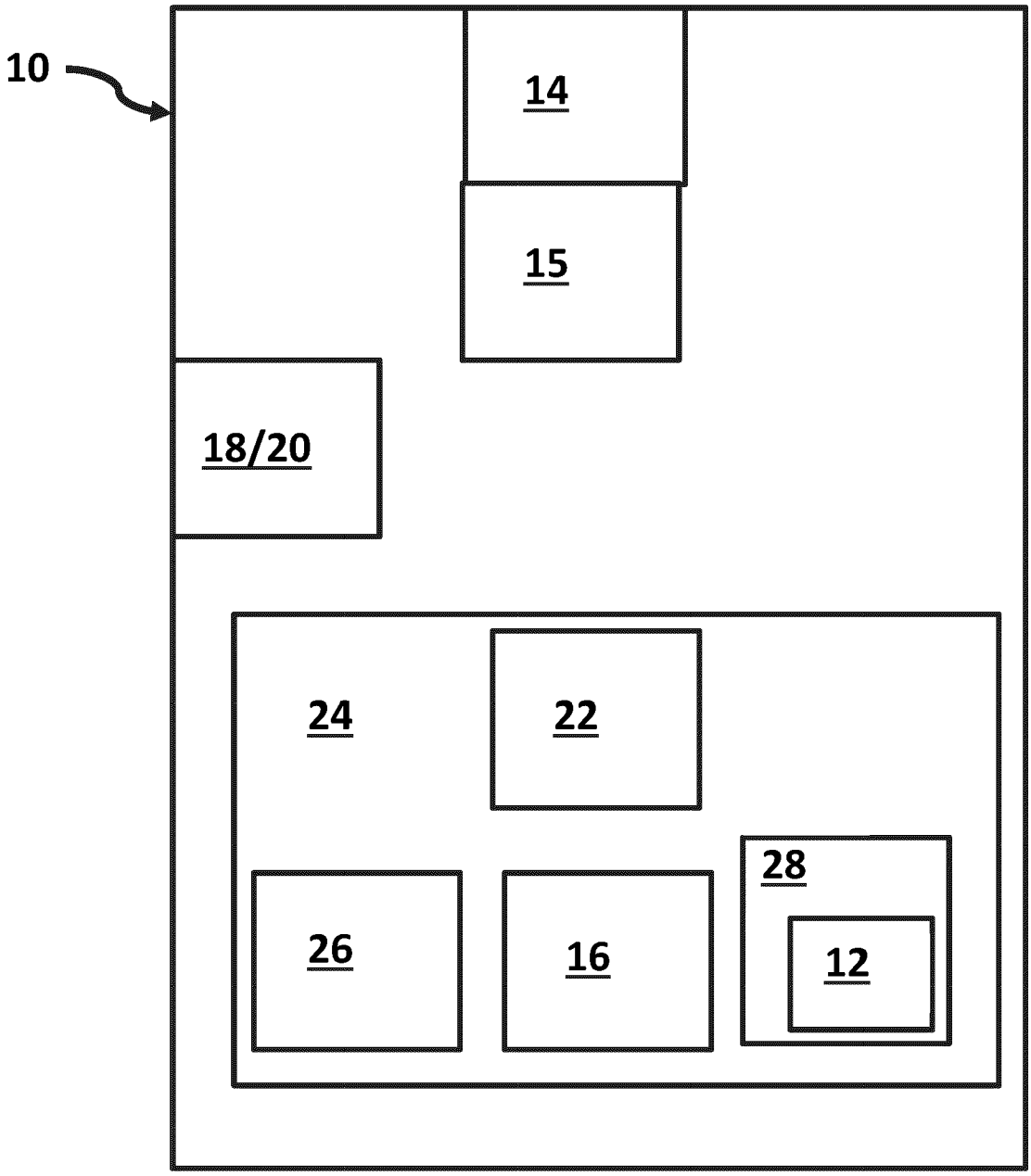

Fig. 7

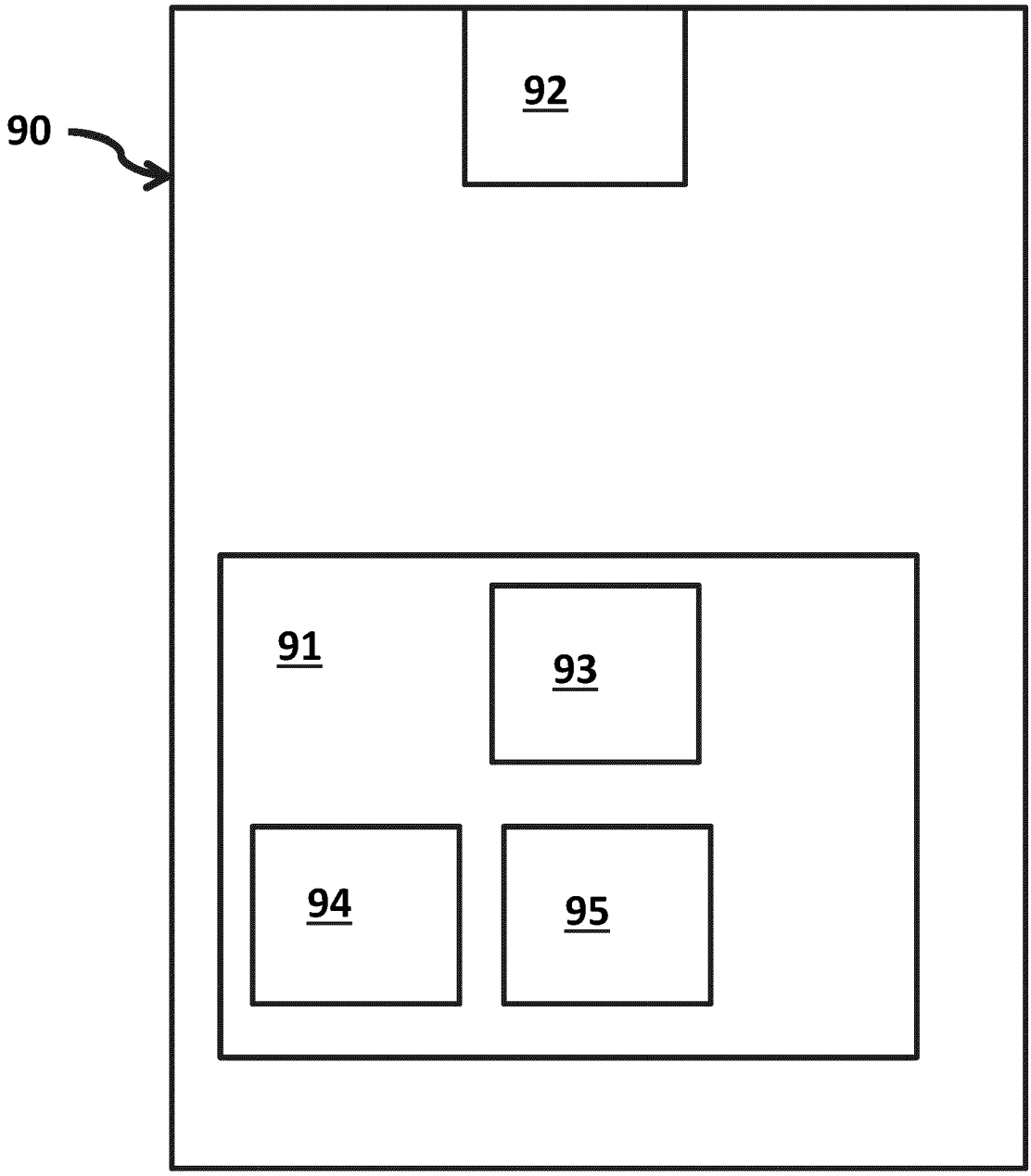

Fig. 8

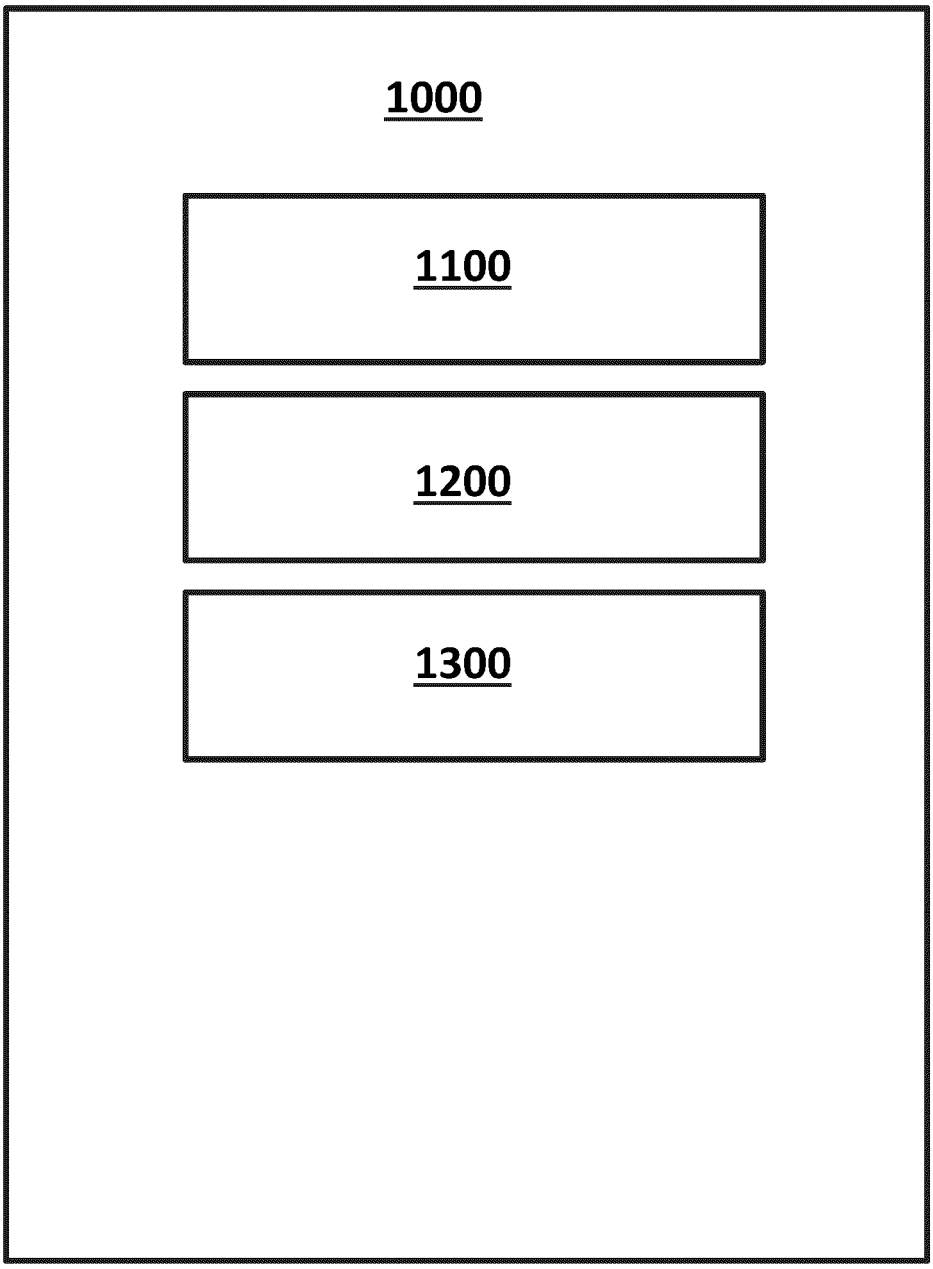

Fig. 9

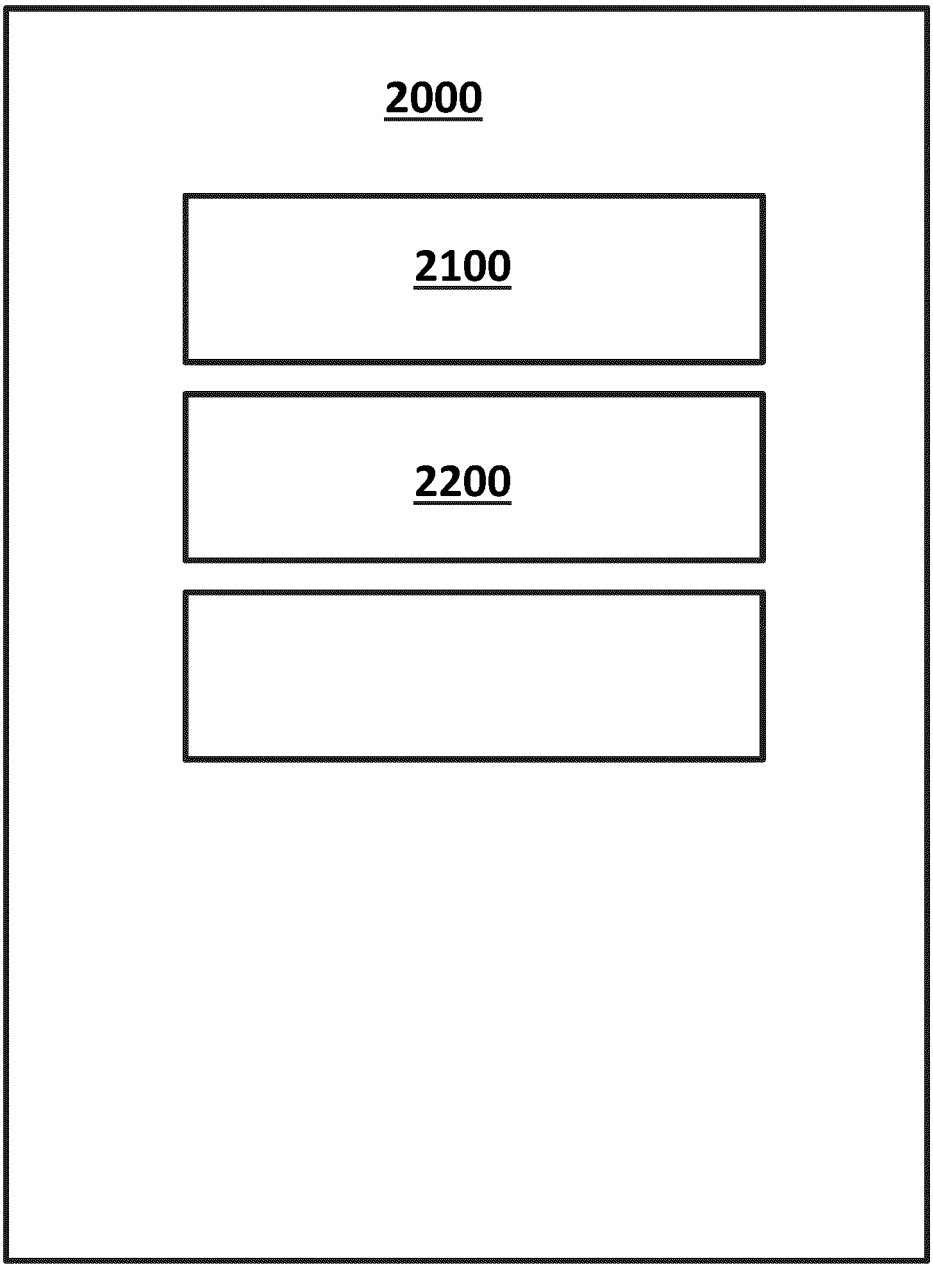

Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 9237

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X	EP 3 671 665 A1 (NEOPOST TECH [FR]) 24 June 2020 (2020-06-24) * paragraph [0001] - paragraph [0067] * * paragraph [0080] - paragraph [0086] * * claims 1-15 * * figures 1-5 *	1-16	INV. G07C9/00
X	US 2020/187694 A1 (SANTANGELI GABRIEL [FR] ET AL) 18 June 2020 (2020-06-18) * paragraph [0001] - paragraph [0101] * * claims 1-20 * * figures 1-5 *	1-16	
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A	* paragraph [0002] - paragraph [0042] * * paragraph [0106] - paragraph [0144] * * paragraph [0214] * * claims 1-25 * * figures 1-11 *	4,5,12	
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A	US 2021/265843 A1 (BALDASARE DOUGLAS [US] ET AL) 26 August 2021 (2021-08-26) * paragraph [0203] - paragraph [0204] *	1-16	G07C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 May 2024	Neumann, Christoph

CATEGORY OF CITED DOCUMENTS

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27-05-2024

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