(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 November 2012 (15.11.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/152293 A1

(51) International Patent Classification:
G06Q 10/00 (2012.01) *G06K 19/073* (2006.01)

(21) International Application Number:
PCT/EP2011/002266

(22) International Filing Date:
6 May 2011 (06.05.2011)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **KEONN TECHNOLOGIES S.L.** [ES/ES]; Gran Via de les Corts Catalanes, 529, 1°, 2a, E-08011 Barcelona (ES).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **VIVES PRAT, Ausias** [ES/ES]; Keonn Technologies S.L., Gran Via de les Corts Catalanes, 529, 1°, 2a, E-08011 Barcelona (ES). **POUS ANDRÉS, Rafael** [ES/ES]; Keonn Technologies S.L., Gran Via de les Corts Catalanes, 529, 1°, 2a, E-08011 Barcelona (ES). **DE PORRATA-DORIA I YAGÜE, Ramir** [ES/ES]; Keonn Technologies S.L., Gran Via de les Corts Catalanes, 529, 1°, 2a, E-08011 Barcelona (ES).

(74) Agent: **MILTÉNYL, Peter**; Grünecker, Kinkeldey, Stockmair & Schwanhäusser, Leopoldstraße 4, 80802 München (DE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: INVENTORY SYSTEM USING RADIOFREQUENCY ENABLED INVENTORY IDENTIFICATIONS

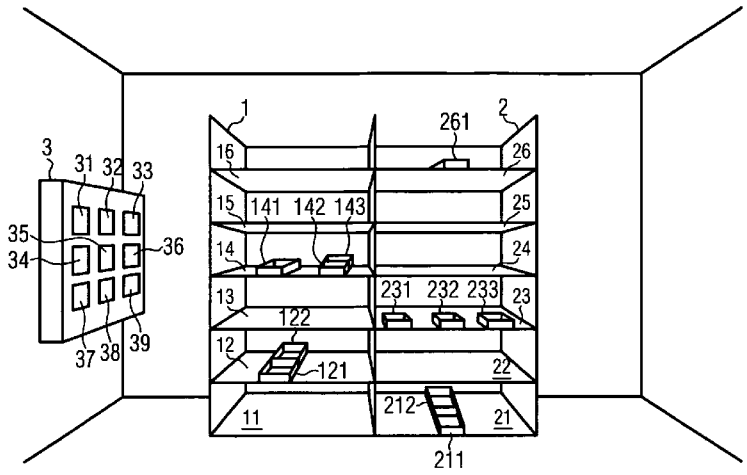

FIG. 1

(57) **Abstract**: An inventory management comprises a set of inventory identifications, at least one of them comprising a radiofrequency transponder, a set of storage containers, one, two or more containers for removed inventory identifications, each one comprising at least one antenna, at least one radiofrequency interrogator capable of communicating with the radiofrequency transponders and means for avoiding that the container for removed inventory identifications identifies the transponder of inventory identifications placed at or in storage containers and/or at a support structure. A method for using an inventory management system and a storage container that can be used in an inventory management system are also disclosed.

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INVENTORY SYSTEM USING RADIOFREQUENCY ENABLED INVENTORY IDENTIFICATIONS

Field of the invention

The present invention relates to an inventory management system, e.g. a product tracking and management system and a method for using an inventory management system, e.g. a product tracking and management system and a storage container. In particular, the invention may be used in retail stores, hospitals, warehouses, factories, manufacturing plants and storage facilities.

Background

Keeping an optimized inventory of items in a storage space has always been a challenge for companies and institutions of any kind. If too few products are stored, the probability of running out of a specific item increases. Conversely, if too many products are stored, their cost may be excessive. This problem is especially critical when the stored items are very expensive, or when the lack of one product can lead to serious consequences, or when the available storage space is relatively small. For instance, healthcare institutions such as hospitals are severely affected by the aforementioned problems. A hospital needs to have a number of storage rooms in its premises, since nurses and doctors need to be able to pick medical products in a short time, without having to walk a long distance. A hospital also needs to maximize the space dedicated to patients, and limit as much as possible the space for product storage. Furthermore, running out of a medical product can have dramatic consequences on the life of a patient. Therefore, strong care must be taken to ensure that products are always in stock. Finally, medical products may be very expensive, which makes it important for hospitals and suppliers to keep such costs under control.

There are different methods and systems for tackling the aforementioned challenges. The traditional method is manual inventory. Products are usually entered into the storage space and removed from the storage space freely, without any control or register, and periodically a manual inventory is performed. Manual inventory usually requires a person or group of people that review all the products in stock, either by visual inspection of with the help of barcode readers, and identify which products are below a specific number of units, issuing restocking or reordering commands accordingly. This method has several limitations. First, it is very prone to out of stocks, especially on products with high turnover. Second, it is very vulnerable to human errors. Third, it is costly, since it requires frequent and time consuming manual inventories.

Another method is based on recording every item entering or exiting the storage space, and performing periodical manual inventories to fine tune the stock information. While this method reduces the risk of out of stocks, it has also important drawbacks. First, it is prone to human errors, since there is a significant probability that staff misses recording some stock movements. Second, it is not a very efficient method, since employees must dedicate a significant part of their time recording stock movements. Third, periodical manual inventories are still required, which are costly and time consuming.

Still another method is the use of inventory cards. In this method, products are stored in boxes, drawers, individually identifiable shelf locations or alike (hereafter referred to as "storage containers"), wherein each storage container has an inventory card attached. Usually, each inventory card contains some visual information, such as name of the product in the storage container, product code and bar code. Usually, each SKU (stock keeping unit) has at least two storage containers assigned, and thus, at least two inventory cards. Products are moved in and out the storage space usually without recording any data. When a user or employee picks a product from a storage container, and detects that the remaining number of units of that product in that storage container is zero, below a specific number of units, or meets a certain condition, said user removes the inventory card from that storage container and places this inventory card in a container for removed inventory cards, such as a panel, shelf, or drawer. Periodically, a person reviews the inventory cards located in the container for removed inventory cards, and reorders or restocks the associated products accordingly. This system is more efficient than the two previously described, since staff need to dedicate very little time to stock management, and manual inventories are not needed. Also, the risk of out-of-stocks is low, as long as the number of storage containers per SKU is correctly chosen as a function of product consumption and lead time. However, this method still requires human intervention, both for removing the inventory cards and for placing them in the containers for removed inventory cards. Also, the containers for removed inventory cards must be inspected often, which is costly and time consuming.

A completely automated inventory system, based on smart shelves, smart cabinets, or alike, is also an alternative. A radiofrequency transponder is attached to each product, and a set of antennas connected to an interrogator are installed in the support structure, e.g. shelves, that supports the stored products. Said interrogator and antennas send an electromagnetic signal, and the transponders respond with the code that identifies the product. As a result, this system can obtain the inventory in real time, and can detect instantly any product movement without any human intervention. This system offers many operational advantages compared to the

above described methods and systems. However, this system requires a significant economic investment in interrogators and antennas. In addition, the cost of the transponders may be significant, as well as the cost of attaching and associating each transponder to the corresponding product.

In this context, it is therefore desirable to describe an inventory management system that minimizes stock-outs, optimizes stock levels, requires minimum human intervention, requires low investment, and has very low recurrent costs.

Object of the invention

The object of the present invention is to control in real-time or near real-time the presence of products stored in a given space.

Another object of the present invention is to provide a radiofrequency-based system capable of identifying accurately the products that need to be restocked or reordered in order to avoid out-of-stocks.

A further object of the present invention is to provide a radiofrequency-based system with high automation requiring minimum cost and minimum human intervention.

Another object of the present invention is to provide means for detecting inventory identifications with radiofrequency transponders when these inventory identifications are placed in a container for removed inventory identifications, while avoiding detecting inventory identifications with radiofrequency transponders located in substantial proximity of the container for removed inventory identifications.

Another object of the invention is to provide a storage container which can be used in an inventory system.

Summary

The present invention comprises an inventory management system according to claim 1, a method of using an inventory management system according to claim 19 and a storage container according to claim 21.

Preferred embodiments are disclosed in the dependent claims.

An inventory management system according to the present invention comprises a set of inventory identifications that can e.g. be in the form of inventory cards, wherein one, two or more of the inventory identifications comprises a radiofrequency transducer, such as a transponder or tag. It also comprises a set of storage containers wherein products, items or objects can be stored. The storage containers can be placed on a support structure, which in some embodiments may and in other embodiments may not be part of the present system. One, two or more storage containers comprise optionally a place, container or holder for one or more inventory identifications, all three of which are referred to as holder in the following. The described system further comprises one, two or more containers for removed inventory identifications. It further comprises one, two or more radiofrequency interrogators capable of communicating with the radiofrequency transponders which are connected to the antennas of the container for removed inventory identification. These interrogators may, e.g. in turn, communicate with one or more processing units or other electronic devices, such as computers, routers, telephones or portable devices either using a hardware connection such as a cable or by using a wireless data link.

In other embodiments, the holders may also be attached to the support structure, so that there is e.g. a holder attached to the support structure for every storage container. In this way, a system may be built which is independent of the used storage containers as the inventory identification holders are affixed to the shelves or other supporting structure. In some embodiments, the support structure may be part of the inventory management system and may comprise holders or places at or in which inventory identifications can be stored. The expression inventory identification at the support structure or similar are meant throughout the text to comprise the option of the inventory identification being in a holder attached to the storage box or in a holder or place comprised by the support structure in which inventory identifications can be stored.

The system further comprises means of avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or placed at the support structure. Whenever in the application the word transponder is used, it is meant to comprise the possibility that the transponder can be in the form of any other radiofrequency transducer or tag as well. With the wording "that the container for removed inventory identification identifies the transponders" it is meant throughout the text that "the system identifies the transponders by using the antennas of the container for removed inventory identifications".

Each inventory identification is preferably unique and by using the radiofrequency transducer each inventory identification can be identified unambiguously because of its uniqueness. E.g. each inventory identification may have a number or a code uniquely identifying the transponder which may allow identifying inventory identification unambiguously. In other embodiments the codes or numbers used for storage containers with the same or similar storage goods might be identical.

The container for removed inventory identifications can preferably identify only the inventory identifications located in it, and preferably does not detect inventory identifications attached to storage containers and/or at the support structure, even if the storage containers and/or the support structure are in substantial physical proximity of the container for removed inventory identifications, which may in some cases be as near as 20 cm or 1 m or 3 m. This may be achieved in different ways that may be used independently or combined together.

In a preferred embodiment the means for avoiding that the container for removed inventory identification identifies the transponder of inventory identifications placed at or in storage containers and/or at the support structure comprises shielding the transponders from detection by a non-dielectric shield, e.g. a metal grid or metal pieces.

"Non-dielectric" is used in this description to describe materials which are generally able to substantially conduct electric current, including for instance metallic, semiconductor and superconductor materials and metamaterials. The properties of the materials referred to are the properties at the usual storage conditions. "Dielectric" on the other hand is used in the description to indicate a typically isolating material, which does not substantially conduct the electric current.

A storage container that can be used in the present invention may comprise one or more holders for one or more inventory identifications. If an inventory identification with a radiofrequency transducer, such as a transponder or tag, is in that holder, it may be shielded from detection by a detector that uses a radiofrequency-based detector. For example, the transponder on the inventory identification might not be detected when an inventory identification is in the holder of a storage container.

In a preferred embodiment, the shielding is achieved by a non-dielectric piece of material at or in the storage container and/or at the support structure, e.g. in the holder for the inventory identification or attached to the storage container and/or the support structure in the holder for inventory identification or outside the holder for inventory identification or placed in close

vicinity to the storage container and/or the support structure. If, for example, a non-dielectric material is affixed to the storage container in close vicinity to the inventory identification, it might shield the transponder from the detector signal and/or reduce the signal from the transponder received at the detector. Alternatively, in another preferred embodiment a non-dielectric part of the support structure may be used to achieve the shielding, which is not exclusively used for shielding since it also forms part of such support structure.

Convenient places for non-dielectric material shielding the inventory identification are in close proximity to the inventory identification, preferable right next to the transponder. Useful embodiments might comprise for example a thin metal shield or grid which is placed in or at or attached to the storage container and/or the support structure, or the holder for inventory identification, preferably at a substantially close position to where the inventory identification is placed. A non-dielectric piece of material may be placed at the storage container and/or the support structure in the holder for the inventory identification, may be attached to the storage container and/or the support structure, or the holder for an inventory identification, inside or outside the holder, or may be placed in close vicinity to it, preferably in a way that it will lie parallel to and in vicinity to an inventory identification that is in a holder.

For example, if the inventory identification was to be placed at the bottom of the box, the non-dielectric piece of material may be placed on the support structure, or may be a part of such support structure such as a metallic shelf, so that the inventory identification enclosed in the box may be placed on the support structure in a way that the inventory identification lies within the vicinity of the non-dielectric material and is shielded by it although it is not affixed to the storage container.

In another embodiment, the storage container comprises non-dielectric materials, said materials are in close proximity to the inventory identification, and said materials shield the transponders from detection. In another embodiment, the inventory identifications are attached to the support structure, the support structure comprises non-dielectric materials and said materials shield the transponders from detection. The support structure may in some embodiments comprise dielectric materials like wooden or plastic support structures like shelves.

"Close", "vicinity" and "proximity" refers to distances between the inventory identification and the non-dielectric piece of material that are in this case still close enough to shield the inventory identification from the detector. The size of the distances that fulfil the criteria of "close", "vicinity" and "proximity" between identification and non-dielectric medium usually

depends on the used radiofrequency transponder, radiofrequency interrogator, the used antennas, the piece of non-dielectric medium, the used frequency and the distance between the transponder and the antennas. Typically, a distance is considered close or an item in vicinity or proximity to another if the distance is less than a tenth of the free space operating wavelength or a fraction thereof such as $\lambda/20$ or $\lambda/100$ or smaller than a fifth of the length of a typical half-wavelength antenna or a fraction thereof as 1/10 or 1/50 or 1/100 thereof.

Such non-dielectric piece of material may substantially block radiofrequency signals on the transponder attached to the inventory identification partially or completely, or may hinder in any other way the ability of the transponder to receive and/or send radiofrequency signals to the interrogator, or both, which may prevent said transponder from being detected by the interrogator.

In some embodiments the system comprises as shielding holders for inventory identification made of non-dielectric materials, in which one or more inventory identifications can be inserted. In this case, one or more holders are preferably attached to a storage container and/or support structure and preferably made of thin or light material so that the storage container's weight does not increase unduly if the holders are attached to it.

Such holders may block radiofrequency signals e.g. from the interrogator partially or completely, or hinder the transponder's ability to receive them and/or respond to them, or both, thus preferably preventing the transponder attached to the inventory identification from being detected by the interrogator.

In a preferred embodiment the means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or at the support structure comprises a surface made of non-dielectric material placed somewhere between the container for removed inventory identifications and the storage containers and/or the support structure. Such a surface may block radiofrequency signals e.g. from the interrogator partially or completely, thus preferably preventing the transponder attached to the inventory identification from being detected by the interrogator.

A container for removed inventory identifications comprises preferably one, two or more inventory identification holders for the inventory identifications and comprises one, two or more antennas capable of detecting the presence of one or more inventory identifications with a radiofrequency transponder at and/or in the container for removed inventory identifications. An inventory identification holder in the sense of this application is any container or place where

one or more inventory identifications can be placed. It may have the shape of a drawer, box, other container, or even a table or a board.

In preferred embodiments the antennas are near-field antennas. This might be advantageous as their field may decay quickly, thereby preferably preventing the detection of the transponders more distant from the container for removed inventory identifications. Near-field antennas may emit electromagnetic fields whose power decays rapidly with distance, which may prevent the detection of transponders attached to inventory identifications located at a certain distance from the antennas.

In some embodiments the one or more antennas are oriented such that they radiate substantially in the direction of the space where inventory identifications can be placed at and/or in the container for removed inventory identifications, and that they radiate with substantially less power in another direction. This means that in the direction in which the antennas radiate substantially the radiated power is higher than the power radiated in the direction in which the antennas radiate with substantially less power. The substantial radiation is preferably high enough to detect the inventory identifications that are placed at and/or in the container for removed inventory identifications, while in the direction in which the antennas radiate with substantially less power, the power is preferably low enough so that inventory identifications placed somewhere in the other direction cannot be detected. This may be advantageous because if the container for removed inventory identifications is affixed to a well chosen space or placed in a chosen direction it might not detect inventory identifications in a chosen direction. This might be useful to avoid detecting inventory identifications not at and/or in the container for removed inventory identifications, if for example the container for removed inventory identifications is arranged in a way that it does not detect inventory identifications in the direction where the storage containers are stored.

This alone may be enough so that no responses are received from the transponders in or at the storage containers and/or at the support structure. However, the distance from which the shielding fully works usually depends on the antennas, on the power radiated by the antennas and their orientations. As features from different embodiments can be combined, this can be combined with other means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or at the support structure. The distance from which the shielding fully works may be less than 20 cm or 1 m or 3 m.

When the number of items in a storage container meets certain criteria, e.g. falls below a specific threshold, a user or a robot may remove the inventory identification from the storage container, and place it in a container for removed inventory identifications, such as a panel, shelf, or drawer. A container for removed inventory identifications is equipped with one or more antennas that are connected to an interrogator. An interrogator may send an electromagnetic signal that is radiated through the antennas, and the transponders located at and/or in the container for removed inventory identifications may respond by sending another signal with their electronic code.

Such codes may be transmitted by the interrogator to a processing system, and may be used for purposes that may be related to the criteria fulfilled by the inventory identifications placed at and/or in the container for removed inventory identifications, e.g. to reorder or restock products in the storage containers. One possible underlying technology for achieving this is radiofrequency identification (RFID).

Each inventory identification may have a passive or active transducer such as a tag or transponder containing an electronic code.

In some embodiments, one or more than one or all transponders are active or passive transponders. Passive transponders may have the advantage that they do not need to include any supply of power, since they may extract the energy from the electromagnetic wave coming from the interrogator.

In some embodiments, the antennas are connected to a signal selector. This may allow selecting the active antenna every time before a signal is sent.

In some embodiments, one interrogator may be connected to more than one container for removed inventory identifications. This might reduce the number of parts required for the system, increase efficiency and make the administration of the system easier.

In preferred embodiments, one or more interrogators are connected to one or more processing units or one or more other electronic devices such as computers, routers, telephones or portable devices either using a hardware connection such as a cable or by using a wireless datalink. The processing unit or devices can then process the received signals and create, display and/or collect information based on the criteria according to which the inventory identifications are placed at and/or in the container for removed inventory identifications. This

may for example lead to an automatic ordering of out-of-stock material or generate a report, or generate an alarm of some kind.

In a preferred embodiment, the inventory management system comprises an interrogator which operates at frequencies above 100 MHz. This may have the advantage that the system reliability may be increased as it may not be as easily influenced by non-dielectric, dielectric or magnetic objects in the vicinity and as it may not suffer such important variations depending on the number of inventory identifications placed at and/or in the container for removed inventory identifications in comparison to systems with lower frequencies. It may also have the advantage that antennas for frequencies above 100 MHz may be easier to manufacture than antennas for frequencies below 100 MHz.

In preferred embodiments the container for removed inventory identifications comprises several inventory identification holders for inventory identifications, wherein each of the holders for inventory identifications may be accessed without having to move the other holders or without being disturbed by the other holders. Optionally those holders may be affixed to an element which can be affixed to a wall, column, stand, furniture, machine, or anything able to hold its weight.

In some embodiments the container for removed inventory identifications has a container-like shape or the shape of a drawer, tray or shelf. In further embodiments the container may also be in a vertical position or may be in the shape of a vertical panel comprising one or more inventory identification holders. The inventory identification holders may be open at the top and/or the sides. Vertical position means that the holder(s) of the container will have an opening preferably at the top when installed. Open at the top and/or the sides means that the inventory identification holders have an opening on one side or more than one side so that when the container is installed, e.g. affixed to a wall, the open side faces the top or the sides. It is also possible that the inventory identification holders have an opening that in the case of the installed panel the openings face in a direction between to the top and to the sides. Optionally the antennas may be affixed to the side of the container for removed inventory identifications opposite to the inventory identification holders or the inventory identifications in some embodiments.

In some embodiments each inventory identification holder of the container for removed inventory identification and/or of the storage containers and/or of the support structure or other holders of the system can hold only one inventory identification. In other embodiments, each inventory identification holder can hold more than one inventory identification. In other

embodiments one or more inventory identification holders can hold only one inventory identification and one or more inventory identification holders can hold more than one inventory identifications. For example, in one embodiment each inventory identification holder at the container for removed inventory identifications may be capable of holding two or more inventory identifications while the holders at the storage containers and/or support structure each may be capable of holding one inventory identification only.

In some embodiments the container for removed inventory identifications comprises different areas or zones or groups of holders, so that each inventory identification can be placed in one of the areas, which can be assigned a certain meaning. In one embodiment one or more areas or zones or groups of holders of the container for removed inventory identifications may be used to place the inventory identification the information of which to be most urgently processed. In another embodiment one or more areas or zones or groups of holders may be used to place the inventory identifications associated with storage containers with items that need a special process to reorder. In another embodiment one or more areas or zones or groups of holders may be used to place the inventory identifications that belong to products of one particular supplier or group of suppliers. In one embodiment the different areas or zones may be connected to different processing units, or the same processing unit may take different actions for the inventory identifications placed in different areas or zones or groups of holders of the container for removed inventory identifications. The system preferably comprises means, e.g. several antennas, that allow determining which area, zone or group of holders an inventory identification is placed at and/or in.

The method for using an inventory management system, preferably the system described in the application, comprises steps of removing the inventory identification from its holder at or in a storage container and/or at the support structure, for example when realizing that the storage container meets certain criteria, e.g. that the stock level is low, placing the removed inventory identification at and/or in the container for removed inventory identifications, identifying the transponders of the inventory identifications at and/or in the container for removed inventory identifications by using the antenna(s) of the container for removed inventory identifications, employing means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or at the support structure, optionally taking appropriate actions in view of this criteria according to which the inventory identifications have been placed at and/or in the container for removed inventory identifications, and optionally place the inventory identifications in a place, container or holder at or in a storage container and/or at the support structure, preferably after the

actions in view of the criteria according to which the inventory identifications were placed at and/or in the container for removed inventory identifications have been taken. The storage container in or at which the inventory identification may be placed may be the storage container from which the inventory identification originated or another storage container. In addition to those steps in some embodiments other steps may be comprised which correspond to the steps described in this application when describing the system.

The method according to the invention may also comprise the step of determining in which area or zone or group of holders an inventory identification is placed at and/or in the container for removed inventory identifications, wherein the area or zone or group of holders are comprised in a container for removed inventory identifications. Optionally this step may be followed by the appropriate steps according to the meaning of the area, zone or group of holders described for the system according to the invention, such as processing information quickly, e.g. ordering items quickly, and/or such as starting the special reordering process and/or ordering items at a particular supplier or group of suppliers.

The invention further comprises a storage container which can be a part of the system for inventory management described before or which can be provided alone.

The storage container comprises a storage portion for receiving goods to be stored and an inventory identification holder, wherein inventory identification comprising a transponder and placed in that inventory identification holder is shielded from detection by a detector using a radiofrequency-based approach. The storage portion is made of a dielectric material and the storage identification holder comprises a non-dielectric material which provides the shielding. Shielding usually means in this case that the inventory identification placed in the holder is not detected while in the holder. The inventory identification holder is preferably at the side of the storage container and may preferably be accessed from there. Side of the storage container herein means preferably a part that is approximately vertical or inclined when the storage container is filled in the storage system, but in any way may prevent goods stored in the storage container from sliding out of the box in a horizontal direction when the storage container is filled and in the storage system.

In some embodiments the shielding is achieved by a piece of non-dielectric material placed in the inventory identification holder or directly outside of it, optionally affixed to the storage container or the holder, and/or attached to the inventory identification holder from the inside or the outside. A possible form of the piece would for example be a flat metal piece or a metal grid.

In some embodiments the shielding is achieved by the holder for the inventory identification being made out of non-dielectric material.

In the case of the storage container made out of non-dielectric material the electromagnetic fields are relatively uninfluenced by the container. This might be a disadvantage with regard to shielding of the inventory identification, but may allow the storage containers to be made out of materials like plastic, glass or cardboard. This might be advantageous as storage containers made out of those materials are usually typically cheap in production and easily produced. They also might be easy to clean, e.g. in the case of plastic or glass, or easy to dispose, e.g. in the case of cardboard. They also might have a conveniently light weight.

In other embodiments the storage container comprises a volume that can be filled with storage goods, the volume having a minimal volume of 0.01 litre or 0.1 litre or 0.5 litre or 1 litre or 2 litres or 10 litres and/or a maximal volume of 0.1 litre or 1 litre or 10 litres or 100 litres or 1000 litres.

The described inventory management system can help minimize out of stocks in storage spaces, may have a high automation, may require very little human intervention, may operate in real-time or near real-time, and may involve little investment and recurring costs. Also, its installation may be easy and fast.

The term "storage space" is used in the context of the present application to mean a physical space comprising support structures on or in which items, objects or products can be held permanently or during a period of time. The term "inventory identification" is used in the context of the present application to mean an object of any size, usually made of dielectric materials, to which a radiofrequency transponder can be attached. The term "storage container" is used in the context of the present application to mean an object that can hold or contain items or products. A storage container might be in the form of a box, a drawer, a tray, an urn, a bowl, a bag, a bottle, a basket, a rack, a shelf, a part of a shelf, a table, a part of a table, or any individually identifiable location or alike. All these terms are not meant to be limiting as to the physical characteristics of any element that may be used to implement embodiments of the present invention, but used merely for convenience in explaining the embodiment.

Brief description of the drawings

Figure 1.- Storage space comprising support structures for storage containers and a container for removed inventory identifications;

Figure 2.- Storage container comprising an inventory identification holder;

Figure 3.- Container for removed inventory identifications;

Figure 4.- Exemplary block diagram of the rear view of a container for removed inventory identifications, comprising a processing unit, an interrogator and a set of antennas;

Figure 5.- Exemplary block diagram of an embodiment of a container for removed inventory identifications, comprising a processing unit, a control unit, an interrogator, a signal selector and a set of antennas;

Figure 6.- Exemplary block diagram of two containers for removed inventory identifications sharing the same interrogator;

Figure 7a.- Frontal view of a storage container wherein a piece of non-dielectric material is placed in a position substantially close to the inventory identification holder;

Figure 7b.- Side view of a storage container wherein a piece of non-dielectric material is placed in a position substantially close to the inventory identification holder;

Figure 8.-Storage container comprising an inventory identification holder wherein an inventory identification can be inserted;

Figure 9.-Container for removed inventory identifications with a door made of a non-dielectric grid that substantially shields electromagnetic signals;

Figure 10.- Container for removed inventory identifications comprising antennas positioned substantially in front of the inventory identifications, substantially radiating towards said inventory identifications.

Detailed description of the invention

Preferred embodiments and applications of the invention will now be described. Although the preferred embodiments disclosed herein are based on RFID technology, the invention may be embodied in other technologies, e.g. in any technology having the same or similar functionalities.

Figure 1 shows an exemplary storage space comprising two support structures 1 and 2, which comprise a set of shelves 11, 12, 13, 14, 15, 16 and 21, 22, 23, 24, 25, 26. Some of these shelves may comprise storage containers 121, 122, 141, 142, 143, 211, 212, 231, 232, 233,

and 261. The support structures 1 and 2 may also use object holders different from shelves, such as bars, racks or any other element that can be used to hold objects. Storage containers may have different structures, like drawers, boxes or containers in general.

The storage space may also comprise a container for removed inventory identifications 3 which may have the shape of a vertical panel, and in this example comprises inventory identification holders 31 to 39, on its external surface. The container for removed inventory identifications can be made by using different structures, such as a panel, shelf, drawer, and in general, any structure that can be used to contain or hold inventory identifications. In other embodiments, the container for removed inventory identifications may be in a different room or storage space than the storage containers and/or the support structure.

Figure 2 illustrates a storage container 121 containing products 42, 43, 44, 45, 46. Said storage container also comprises a holder 410 that holds inventory identification 411. The inventory identification 411 has a radiofrequency transponder attached, such as a RFID tag. In a preferred embodiment, there are at least two storage containers for each stock keeping unit (SKU). Storage containers containing the same SKU can preferably be placed close to one another, like storage containers 121 and 122, 142 and 143, 211 and 212 in figure 1. Storage containers may come under the shape of boxes, drawers, trays, bags, bowls, baskets, containers, or any physical element that can hold or contain objects, items or products.

Objects, items or products may be picked from storage containers by users or employees. When the number of items in a storage container falls below a specific threshold or the storage container or its contents meet another specified condition, the user or employee may remove the inventory identification from that storage container, and may place said inventory identification in the container of removed inventory identifications. In the example of figure 1, if a user or employee picks up an item in storage container 121, and the number of remaining items falls below the specified threshold for that storage container, the user may remove the inventory identification from storage container 121 and places it into one of the holders 31 to 39 of the container for removed inventory identifications 3.

Figure 3 shows an exemplary container for removed inventory identifications 3, with the shape of a vertical panel, comprising a set of inventory identification holders 511 to 526. The container may not be in a vertical position, or may have a container-like shape. In these cases, inventory identification holders may not be necessary. In one embodiment, each inventory identification holder can hold only one inventory identification. In another embodiment, each inventory identification holder can hold more than one inventory identification. In one

embodiment the inventory identification holders 511 to 526 are grouped into areas or zones of one or more holders each, such that when an inventory identification is placed at or in a holder, it may trigger a different course of action depending on the area or zone to which the holder belongs.

The container for removed inventory identifications comprises at least one antenna optionally connected to or embedded within an interrogator. Figure 4 shows an exemplary block diagram of the rear view of a container for removed inventory identifications 3. Said container for removed inventory identifications comprises four antennas 611, 612, 613, 614 connected to an interrogator 62 through radiofrequency cables 621, 622, 623, 624. In one embodiment, interrogator 62 is connected to a processing unit 63 through cable 64. In another embodiment, interrogator 62 is connected to a processing unit 63 through wireless technology. The processing unit 63 may send a command to the interrogator 62 to identify the electronic codes of the transponders of the inventory identifications that are placed in the holders of the container for removed inventory identifications 3. The interrogator 62 may transmit an electromagnetic signal that is radiated by the antennas 611, 612, 613, 614. Said signal may activate the transponders attached to the inventory identifications located at the holders of the container for removed inventory identifications, and the transponders may respond by transmitting a signal with their electronic code. Such signal may be received by the antennas 611, 612, 613, 614, and may reach the interrogator 62, which may extract the electronic codes of the detected transponders and may send such codes to the processing unit 63. The container for removed inventory identifications 3 comprises at least one antenna. In a preferred embodiment, the container for removed inventory identifications 3 comprises more than one antenna in order to increase redundancy, i.e. the number of antennas that identify the same transponder. This may increase the reliability and inventory accuracy of the system. In another embodiment, the container for removed inventory identifications 3 comprises more than one antenna in order to be able to detect the holder or group of holders at or in which every inventory identification is placed, so that an area or zone can be assigned to it, and the appropriate course of action can be selected for each detected inventory identification. This may increase the versatility and applicability of the system to different environments and use cases.

In an embodiment of the present invention, a signal selector is used to connect the interrogator to the antennas.

Figure 5 shows an exemplary block diagram of such an embodiment. The container for removed inventory identifications 3 in this example comprises 8 antennas, 611 to 618, connected to a signal selector 65, which in turn is connected to interrogator 62. The processing unit 63 may send proper commands to interrogator 62 and control unit 66, in order to activate the antennas and interrogate the inventory identifications. The control unit 66 may send an electronic signal to signal selector 65, and signal selector 65 may select one of its outputs for activating the antenna connected to said output. In one embodiment, the control unit 66 is connected to the interrogator 62 instead of being connected to the processing unit 63. In one embodiment the control unit may operate one or more visual signs like lights, displays or screens, and/or one or more acoustic signals like buzzers, alarms, bells, or sound reproduction devices, and/or one or more of any other output device. In one embodiment the control unit may receive input from one or more buttons, switches, keys, keyboards, and/or any other input device.

In a preferred embodiment, the interrogator 62 is integrated in the container for removed inventory identifications 3. In another embodiment, the interrogator is located outside the container for removed inventory identifications.

In one embodiment of the present invention, the interrogator has more than one port, and different ports of the interrogator are connected to different containers for removed inventory identifications. In another embodiment, a signal selector is connected to one port of the interrogator, and such signal selector selects the container for removed inventory identifications to which the interrogator is connected at a specific instant. Both embodiments allow sharing a single interrogator among several containers for removed inventory identifications, which may reduce costs when several containers for removed inventory identifications are needed. Figure 6 shows an exemplary diagram of the first of these two embodiments. The containers for removed inventory identifications 3a and 3b comprise 6 antennas each, 611a to 616a and 611b to 616b, respectively. The six antennas of each container for removed inventory identifications are connected to a signal selector 65a and 65b, respectively. Both signal selectors 65a and 65b are connected to interrogator 62, wherein each signal selector may be connected to a different port of the interrogator. Each signal selector may also be connected to a control unit 66a and 66b, respectively, that may select the desired output of the associated signal selector, as well as operate input and output devices. In other embodiments the control units 66a and 66b may be connected to the processing unit 63 instead of being connected to the interrogator 62.

As shown in figure 1, the distance between the container for removed inventory identifications 3 and the storage containers 121, 122, 141, 142 and 143, and/or the support structure can be substantially short, in some cases in the order of a few centimetres. This poses an important problem, since the container for removed inventory identifications 3 should detect the inventory identifications that have been removed from storage containers and/or from the support structure, but it should not detect the inventory identifications still placed at or in storage containers and/or at or on the support structure. A possible solution is to design the container for removed inventory identifications to operate in a low radiofrequency band, below 100 MHz, like the HF (High Frequency) band. Antennas operating at such frequencies operate usually with magnetic field, and can be designed to have a short range, which allows detecting only the inventory identifications placed at and/or in the container for removed inventory identifications. However, antennas operating at such frequencies have important shortcomings. These antennas are usually difficult to tune, can be easily detuned, and their performance can be influenced by any non-dielectric or magnetic object in the vicinity, which can make their performance difficult to predict and thus, reduce the system reliability. More particularly, the range and performance of the antennas may suffer important variations depending on the number of inventory identifications placed at and/or in the container for removed inventory identifications. Containers for removed inventory identifications operating at frequencies below 100 MHz can sometimes be a solution, but they may create unwanted interferences with other equipments, such as medical equipment. Conversely, when interferences with other equipment are to be avoided, other solutions are needed. The present invention includes several embodiments that may be applied independently or combined, in order to ensure that the container for removed inventory identifications detects the inventory identifications placed at or in it, and does not detect the inventory identifications placed at or in storage containers and/or at the support structure. The present invention includes several embodiments that may be applied independently or combined, in order to ensure that the container for removed inventory identifications detects the inventory identifications placed in it, and does not detect the inventory identifications placed at or in storage containers and/or at the support structure.

In one embodiment of the present invention, a piece of non-dielectric material is placed in a position very close to the inventory identification holder which may be attached to a storage container or attached to the support structure or part of the support structure. Figure 7a shows an exemplary diagram of such an embodiment. A storage container 121 with four stored items 42, 43, 44, 45 comprises an inventory identification holder 410, which includes a piece of non-dielectric material 412. Figure 7b illustrates an exemplary side view of a storage container 121,

wherein the inventory identification 411 has a radiofrequency transponder 413 attached, which is in a close physical distance to a piece of non-dielectric material 412. As a result, the piece of non-dielectric material 412 may alter the electromagnetic fields in the vicinity of the transponder 413, and may prevent transponder 413 from being activated by the electromagnetic signal radiated by the antennas of the container for removed inventory identifications, and/or may hinder the ability of the transponder to respond to the interrogator. Conversely, the inventory identifications placed at and/or in the container for removed inventory identifications do not have a non-dielectric material at a short distance, which allows such inventory identifications being detected.

Those embodiments may have many benefits: they may be used at substantially high frequency bands, above 100 MHz, where the antennas can be designed to be substantially stable and their performance may be substantially immune to the presence of metallic or dielectric objects or materials in their environment. This can make the system very stable and reliable. Also, this embodiment may have a substantially low cost, as it may only be necessary to place pieces of non-dielectric material in the inventory identification holders of storage containers and/or of the support structure.

In other embodiments, the inventory identification holders attached to storage containers and/or to the support structure and/or part of the support structure are replaced by an inventory identification container made of non-dielectric materials, such that the inventory identification is inserted inside said inventory identification container, for instance, through a slot. Such inventory identification container may substantially block radiofrequency signals partially or completely, thus preferably preventing the transponder attached to the inventory identification in this example from being detected by the interrogator. Figure 8 illustrates such an embodiment. Storage container 121, in this example containing items 44, 45, 46, comprises an inventory identification container 410 made of non-dielectric materials, which has a slot 414 in its top side wherein the inventory identification can be inserted.

Other embodiments based on partially or completely surrounding the inventory identifications placed at or in storage containers and/or at the support structure with non-dielectric materials can also be used.

The previous embodiments may substantially shield the inventory identifications placed at or in storage containers and/or at the support structure to prevent them from being detected. Other embodiments of the present invention will be now described that prevent the electromagnetic fields radiated by the antennas from reaching the inventory identifications placed at or in

storage containers and/or at the support structure. Those embodiments can also be combined with features of embodiments shielding the inventory identifications placed at or in storage containers and/or at the support structure to prevent them from being detected.

One embodiment of the present invention uses near-field antennas at and/or in the container for removed inventory identifications operating at frequencies above 100 MHz. Said antennas emit electromagnetic fields whose power decays rapidly with distance. Consequently, the signal that reaches the transponders attached to inventory identifications at or in storage containers and/or at the support structure may not have enough power to activate such transponders, which may thus remain undetected. In this way, preferably only the inventory identifications placed in container for removed inventory identifications are detected.

In some embodiments, the electromagnetic fields radiated by the antennas may be prevented from activating the transponders at or in storage containers and/or at the support structure by placing a surface made of non-dielectric materials somewhere between the container for removed inventory identifications and the storage containers and/or the support structure. Such surface may substantially act as a partial or complete electromagnetic shield, and the part of the radiated signal that is able to pass through such surface preferably has a substantially small power, that preferably is insufficient to activate the transponders of inventory identifications at or in storage containers and/or at the support structure. Figure 9 illustrates a container for removed inventory identifications 3, in this example in the form of a panel, with shielding surface 72, here a door made of a non-dielectric grid that may substantially shield electromagnetic signals partially or completely. The shielding surface can have many physical structures known to those skilled in the art. For instance, it can be a grid, a layer, a panel, a hinged door, a sliding door, a curtain, or a set of cylinders or chains. The shielding surface may also prevent interference to other devices in the same room or building due to the electromagnetic fields radiated by the antennas in the container.

In some embodiments of the present invention detecting the inventory identifications placed at or in storage containers and/or at the support structure is avoided by making the antennas of the container for removed inventory identifications radiate substantially low power in the direction of the storage containers and/or the support structure. In this case low means that the power radiated in the direction of the storage is lower than the power radiated towards the inventory identification at and/or in the container for removed inventory identifications. In addition, the radiation emitted in the direction of the storage containers and/or the support

structure is preferably low enough that it does not detect the transponder of the inventory identifications at or in the storage containers and/or at the support structure.

Figure 10 shows the side view of a container for removed inventory identifications 3 whose for example two antennas 82, 83 are positioned substantially in front of the inventory identifications 810 to 815, radiating towards said inventory identifications. Such antennas may be designed to radiate mainly in one direction and radiating very little in the opposite direction. Therefore, these antennas may radiate substantially low power in the direction towards the storage containers and/or the support structure. As a result, the antennas may detect the inventory identifications 810 to 815 placed at and/or in the container for removed inventory identifications 3 and may not detect the inventory identifications at or in storage containers and/or at the support structure. In order to facilitate the access of staff to the inventory identifications 810 to 815, the plane 84 comprising for example antennas 82, 83 can in some embodiments be opened as a door, or can in some embodiments be pulled up, down or sideways. Alternatively, the plane 85 comprising the inventory identifications, e.g. the inventory identifications 810 to 815 can in some embodiments be pulled up, down or sideways.

The inventory management system that has been described in its different embodiments provides many advantages. The inventory management system of the invention may provide a high automation, thereby possible increasing efficiency.

It may require very little human intervention, e.g. only placing the inventory identifications at and/or in the container for removed inventory identifications when the number of items in a storage container meets certain criteria, e.g. falls below a specified number, and moving back that inventory identification at its corresponding storage container when a change of status has been generated, e.g. such box is replenished. Also, the fact that the system may require very little human intervention may make it less prone to human errors. In addition, the described system may operate in real-time or near real-time, since the inventory identifications can be read automatically at any time. Furthermore, the system may require little investment, since the main investments may be the container for removed inventory identifications, the interrogator, antennas and processing unit. Also, the recurrent costs may be very low, since the number of transponders is substantially low (usually one per each storage container), and as the transponders can be constantly reused. Finally, the system installation may be easy and fast, requiring basically the installation of the container for removed inventory identifications.

Claims

1. An inventory management system comprising

a set of inventory identifications, one, two or more of them comprising a radiofrequency transponder;

a set of storage containers that can be placed on a support structure, wherein one, two or more storage containers optionally comprise a place, container or holder for one or more inventory identifications;

one, two or more containers for removed inventory identifications each one comprising one or more antennas;

one, two or more radiofrequency interrogators capable of communicating with the radiofrequency transponders, wherein the interrogators are connected to the antennas of the container for removed inventory identifications;

means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or at support structures.

2. An inventory management system according to claim 1, wherein the means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or placed at the support structure comprises shielding the transponders from detection by a non-dielectric shield.

3. An inventory management system according to claim 2, wherein the means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or placed at the support structure comprises a piece of non-dielectric material placed at a position close to the inventory identifications located at or in storage containers and/or at the support structure.

4. An inventory management system according to any of claims 2 to 3, wherein the means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or at the support structure comprises a container made of non-dielectric material placed wherein at least one inventory identification can be inserted.

5. An inventory management system according to any of claims 2 to 4, wherein the means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or at the support structure comprises a surface made of non-dielectric material placed somewhere between the container for removed inventory identifications and the storage containers and/or the support structure.

6. An inventory management system according to any of claims 1 to 5, wherein the container for removed inventory identifications comprises one, two or more antennas capable of detecting the transponders of one or more inventory identifications in the container and one, two or more inventory identification holders for the inventory identifications.

7. An inventory management system according to any of claims 1 to 6, wherein the antennas are near field antennas.

8. An inventory management system according to any of claims 1 to 7, wherein the one or more antennas are oriented such that they radiate substantially in the direction of the space where inventory identifications can be placed at and/or in the container for removed inventory identifications, and that they radiate with substantially less power in another direction.

9. An inventory management system according to claim 8, wherein the container for removed inventory identifications is oriented in a way that the direction in which the antenna(s) radiate with less power lies in the direction of the inventory identifications placed at or in storage containers and/or at the support structure.

10. An inventory management system according to any of claims 1 to 9, wherein the transponders are active or passive transponders.

11. An inventory management system according to any of claims 1 to 10, wherein the antennas are connected to a signal selector.

12. An inventory management system according to any of claims 1 to 11, wherein one interrogator is connected to more than one container for removed inventory identifications.

13. An inventory management system according to any of claims 1 to 12, wherein at least one interrogator is connected to a processing unit.

14. An inventory management system according to any of claims 1 to 13, wherein the interrogator operates at frequencies above 100 MHz.

15. An inventory management system according to any of claims 1 to 14, wherein the container for removed inventory identifications comprises several inventory identification holders for inventory identifications wherein optionally each of the holders can be accessed without having to move the other holders and wherein optionally those holders are affixed to an element which can and/or may be affixed to a wall or another vertical barrier.

16. An inventory management system according to any of claims 1 to 15, wherein the container for removed inventory identifications has a container-like shape or the shape of a drawer or a shelf and/or wherein the container is in a vertical position or in the shape of a vertical panel comprising one or more inventory identification holders, and wherein optionally the antennas are affixed to the side of the container for removed inventory identifications opposite to the inventory identification holders.

17. An inventory management system according to any of claims 1 to 16, wherein each inventory identification holder can hold only one inventory identification or wherein each inventory identification holder can hold more than one inventory identification or wherein one or more inventory identification holders can hold only one inventory identification and one or more inventory identification holders can hold more than one inventory identification.

18. An inventory management system according to any of claims 1 to 17, wherein the container for removed inventory identifications comprises different areas or zones or groups of holders, in which inventory identifications can be placed.

19. A method of using an inventory management system, preferably the system according to any of claims 1 to 18 using inventory identifications with radiofrequency transponders comprising the steps of:

removing the inventory identification from its place, container or holder at or in a storage container and/or at a support structure;

placing the removed inventory identifications in a container for removed inventory identifications;

identifying the transponders of the inventory identifications at and/or in the container for removed inventory identifications by using an antenna or antennas of the container for removed inventory identifications;

employing means for avoiding that the container for removed inventory identifications identifies the transponders of inventory identifications placed at or in storage containers and/or at the support structure;

removing the inventory identifications from the container for removed inventory identifications and optionally placing the inventory identifications at or in a storage container and/or at the support structure.

20. A method according to claim 19 including the step of determining the group or holders, area or zone of the inventory identifications at and/or in the container for removed inventory identification that may cause the identification to trigger a different course of action dependent on such group, area or zone.

21. A storage container, characterized in that it comprises an inventory identification holder and a storage portion for receiving goods to be stored, wherein an inventory identification comprising a transponder and placed in that inventory identification holder is shielded from detection by a detector using a radiofrequency-based approach, wherein the storage portion is made of a dielectric material, wherein the inventory identification holder comprises non-dielectric material which provides the shielding.

22. A storage container according to claim 21, wherein the shielding is achieved by a piece of non-dielectric material placed in the inventory identification holder or directly outside of it and/or attached to the inventory identification holder from the inside or the outside.

23. A storage container according to any of claims 21 or 22, wherein the shielding is achieved by the holder for the inventory identification being made out of non-dielectric material.

24. A storage container according to any of claims 21 to 23, wherein the storage container comprises a volume that can be filled with storage goods, the volume having a minimal volume of 0.01 litre, 0.1 litre, 0.5 litre, 1 litre, 2 litres or 10 litres and/or a maximal volume of 0.1 litre, 1 litre, 10 litres, 100 litres or 1000 litres.

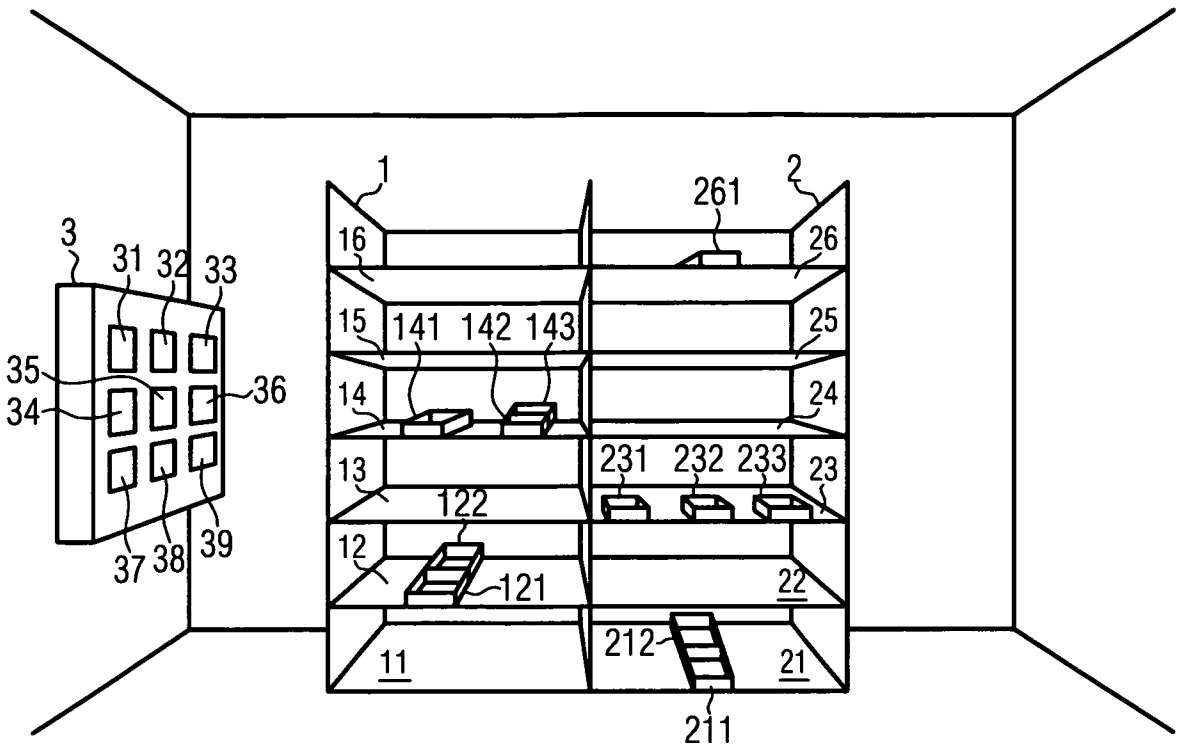
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FIG. 1

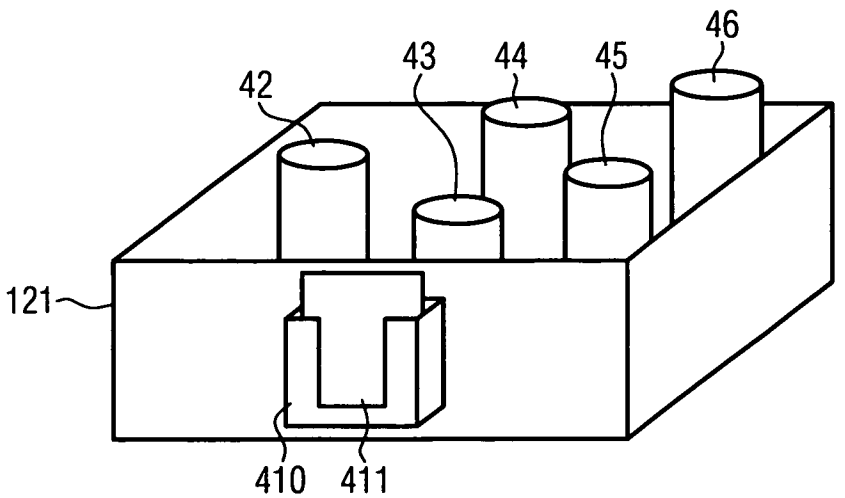
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FIG. 2

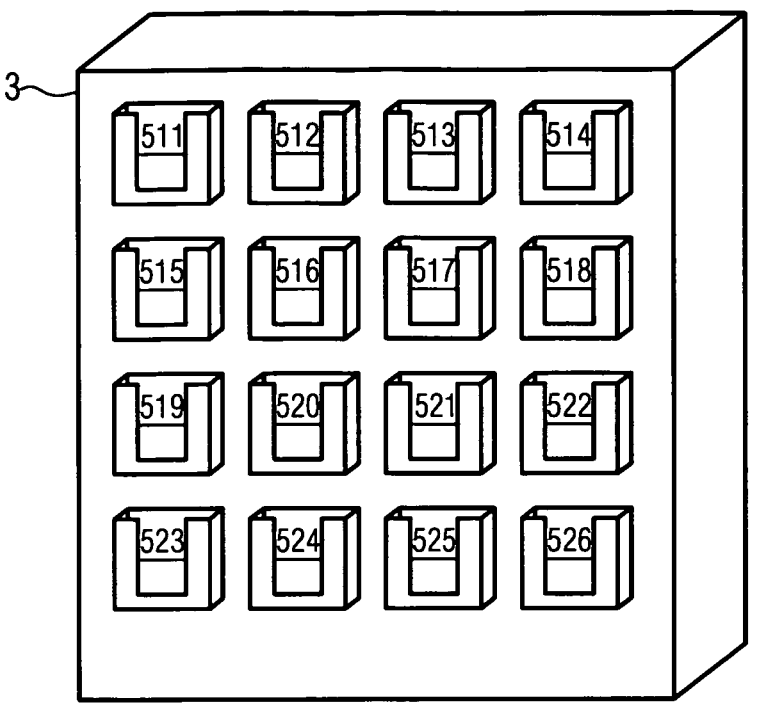
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FIG. 3

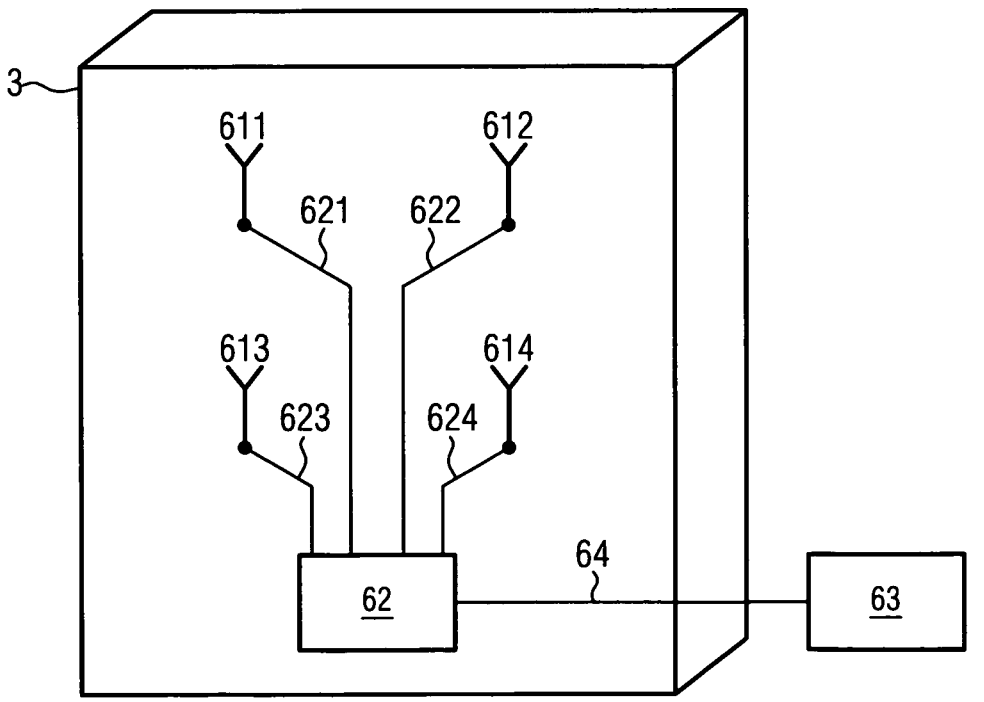
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FIG. 4

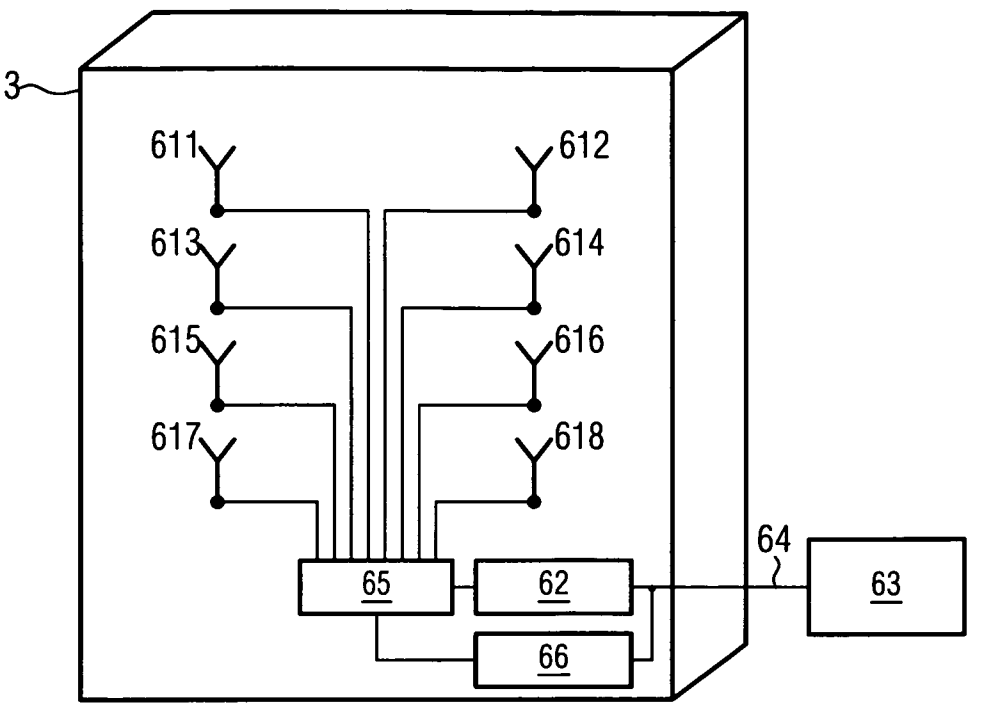
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FIG. 5

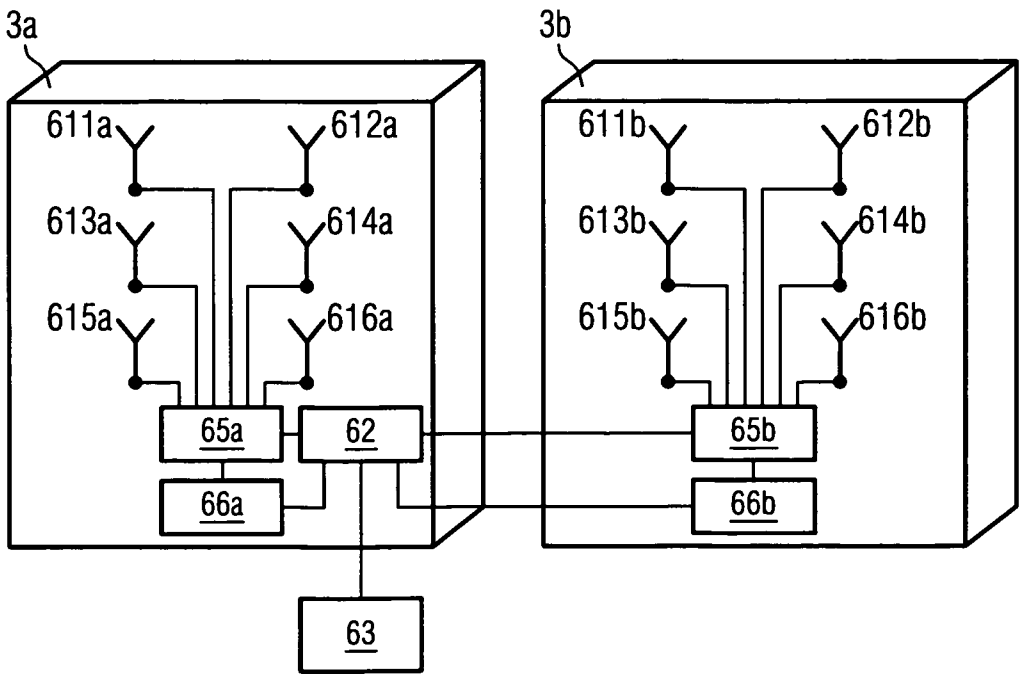
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FIG. 6

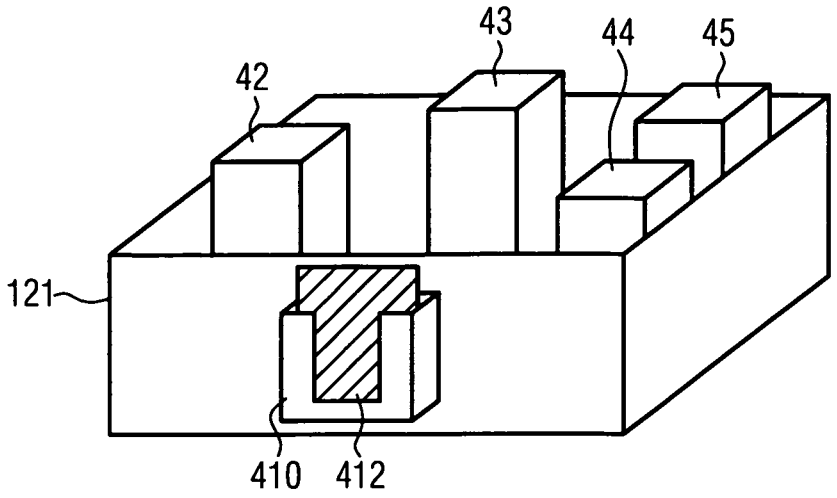

FIG. 7a

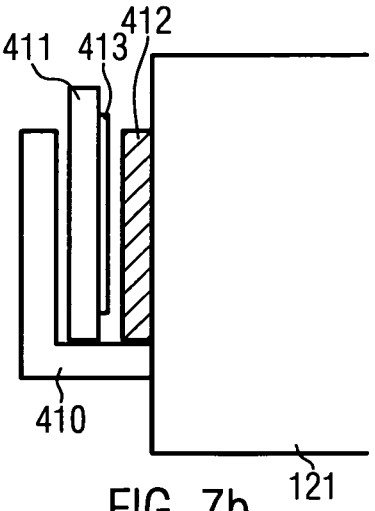

FIG. 7b

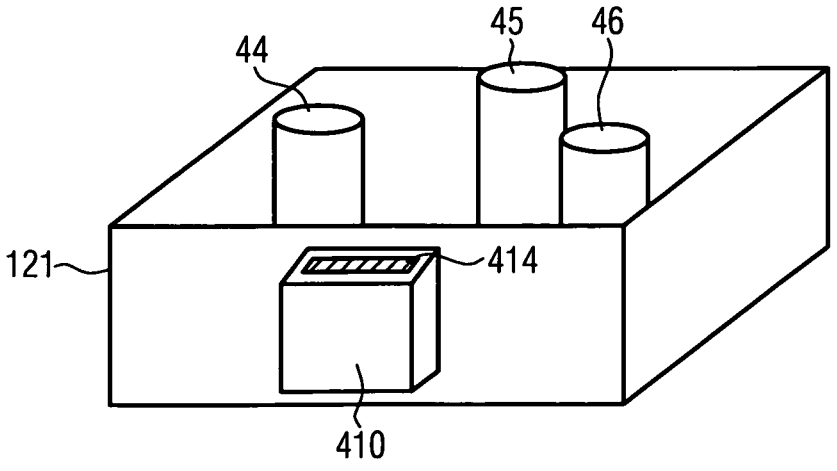

FIG. 8

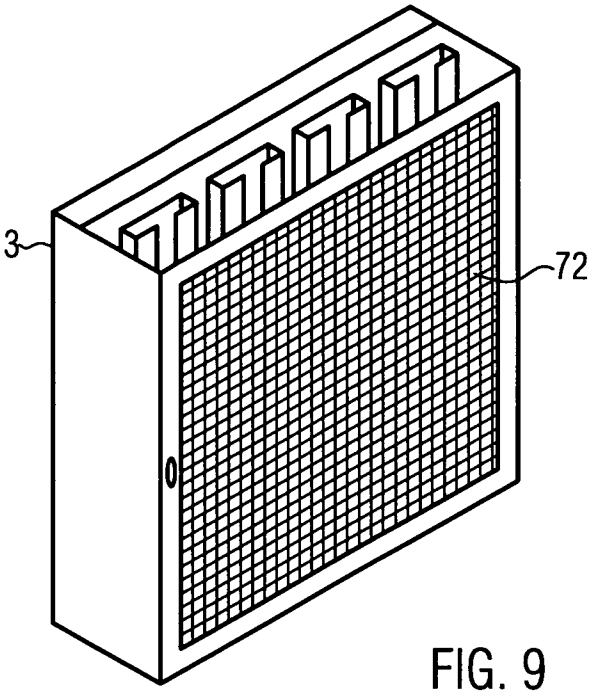

FIG. 9

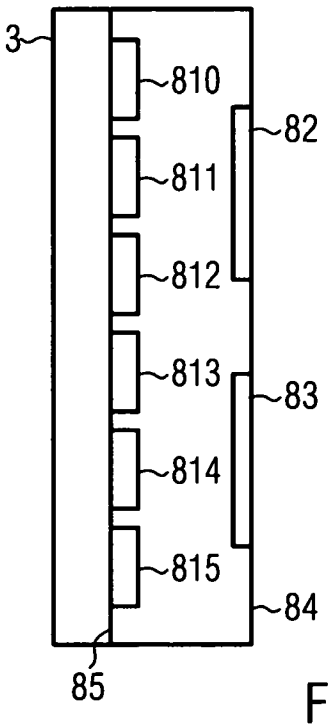

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/002266

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06Q10/00 G06K19/073
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06Q G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2007/008073 A1 (POASEVARA CLAUDE [FR]) 11 January 2007 (2007-01-11) abstract figure 4 paragraph [0001] - paragraph [0022] paragraph [0053] - paragraph [0065] -----	1-20
X	US 2009/230020 A1 (CLAYMAN HENRY [US]) 17 September 2009 (2009-09-17)	21-24
Y	abstract figure 3 paragraph [0022] - paragraph [0026] paragraph [0011] - paragraph [0013] -----	1-20
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 December 2011	30/12/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	van der Weiden, Ad

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/002266

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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