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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 May 2005 (26.05.2005)

PCT

(10) International Publication Number
WO 2005/048167 A2

(51) International Patent Classification[7]: G06K

(21) International Application Number:
PCT/US2004/032834

(22) International Filing Date: 6 October 2004 (06.10.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/701,745 4 November 2003 (04.11.2003) US

(71) Applicant *(for all designated States except US)*: **CHEP INTERNATIONAL, INC.** [US/US]; 8517 South Park Circle, Orlando, FL 32819 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **HOLLON, Dale** [US/US]; 8517 South Park Circle, Orlando, FL 32819 (US).

(74) Agent: **PASSLER, Mark, D.**; Akerman Senterfitt, P.O. Box 3188, West Palm Beach, FL 33402-3188 (US).

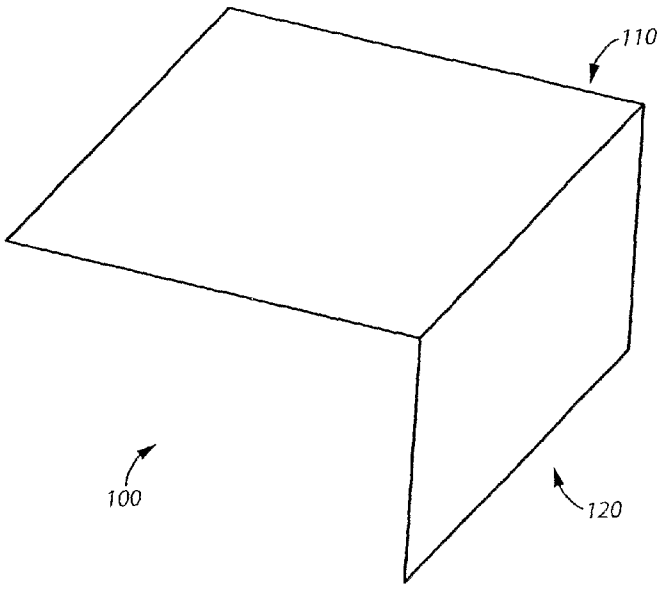
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

[Continued on next page]

(54) Title: RFID TAG-PALLET



(57) Abstract: A radio frequency identification (RFID) tag and systems and methods of using an RFID tag. The RFID tag is a multiplanar tag that may be incorporated with an object, such as a container or pallet. The tag and/or the tag/object combination may then be used in a method to track the location of the object. The multi-planar tag permits an object to be more easily tracked and increases the reliability of the tracking method.

WO 2005/048167 A2

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

RFID TAG-PALLET

FIELD OF THE INVENTION

[0001] The present invention is directed to radio frequency identification (RFID) tags and systems and methods of using these tags.

BACKGROUND OF THE INVENTION

[0002] To achieve highly efficient inventory and transport operations, it is beneficial to accurately track the movements of pallet loads, containers and other objects to be located and/or transferred as they are transported to and from various locations. In a worldwide inventory and transport business, a container, pallet of other object may, at any given time, be located at a manufacturer, in a warehouse, on a truck or ship, or may already be delivered to the final destination. In a worldwide system, the goods to be transported are picked up from one location, transported via truck, train and/or ship and then delivered. Due to the extremely high volume of containers, pallets or other objects, shipped everyday, it is difficult to keep track of these objects.

[0003] Additionally, once goods have been delivered to a particular destination, such as a warehouse, the goods may be located at various locations in the warehouse, such as storage locations, stocking locations, staging areas, and loading docks. In typical inventory and transport operations, the operator of a transport vehicle, such as a fork truck, reach truck, lift truck or pallet truck, receives a set of printed stocking or picking orders, typically generated by a computer, and executes the orders by visually identifying the loads and locations and transporting the loads to and from the locations specified on the orders. In such a system, especially in large-scale warehouses with a large number of locations and loads to handle, there are numerous opportunities for errors.

[0004] Some warehouse management operations use bar codes that are affixed to the loads or that mark specific locations. In a typical example of such a system, the operator uses a hand-held bar code scanner to read the bar code on the loads and, in some cases, on the stock locations. Although such a system is an improvement over purely visual processes, it may be difficult to completely implement, due partly to the need for direct line of sight, close proximity, and proper alignment between the scanner and barcodes. It also requires the operator to participate in the load-identification process. In some case, the operator may need to exit the transport vehicle to scan the barcodes manually, slowing down warehouse operations. Certain locations, for example high storage shelves and loading docks, often are particularly difficult places for using bar codes because of the need for close proximity between the codes and the reader. As a result, loads in those areas are often visually identified instead.

[0005] Radio Frequency Identification (RFID) transponders (tags) have been proposed as an alternative to bar codes. RFID tags are operated in conjunction with RFID base stations for a variety of inventory-control, security and other purposes. Typically an item having a tag associated with it, for example, a container with a tag placed inside it, is brought into a "read zone" established by the base station. The RFID base station transmits an interrogating RF signal that is modulated by a receiving tag. That is, the RFID base station generates a continuous wave electromagnetic disturbance at a carrier frequency and this disturbance is modulated to correspond to data that is to be communicated via the disturbance. The modulated disturbance, or signal, communicates the information at a rate, referred to as the data rate, that is lower than the carrier frequency. The receiving tag modulates the RF signal in order to impart to the signal information stored within the tag and then transmits the modulated, answering, RF signal to the base station.

[0006] In a typical conventional system, RFID tags containing information associated with the identities of inventory items to be tracked are attached to the inventory items. An RFID interrogator is used to detect the presence of an RFID tag and read the identification information from the tag. A typical RFID interrogator includes an RF transceiver for transmitting interrogation signals to and receiving response signals from RFID tags, one or more antennae connected to the transceiver, and associated decoders and encoders for reading and writing the encoded information in the received and transmitted RF signals, respectively. The interrogator may be a portable device, that may be brought near the tags to be read, or it may be a stationary device, that reads the tags as they are brought to the interrogator, as in the case of tagged library books being returned to a return station that is fitted with an interrogator. RFID tags may also be affixed near a location as a location marker. After detecting both a tag attached to an inventory item and a location marking tag, a processing unit associated with the interrogator may determine that the inventory item is positioned near the tagged location. While these conventional object tracking systems are capable of keeping a record of the inventory items and sometimes their locations, they are not effective for tracking and/or managing the movement of the inventory items.

[0007] There also exist warehouse inventory tracking systems that include fixed RFID interrogators at various locations to detect RFID-tagged items when they are positioned near the interrogator-equipped locations. For example, there are warehouses with RFID interrogators positioned at or near the loading dock gates. Such systems are capable of tracking the arrival of tagged items at the various locations, but are not capable of detecting errors remote to these locations. For example, if a fork truck picked up a wrong load because the truck was driven to a wrong pick-up location, the error would not be detected until the load had reached the gate. This delayed error detection negatively impacts the overall efficiency of warehouse operations. Additionally, outfitting each of the numerous loading dock gates with an interrogator is not cost effective.

[0008] RFID tags are categorized as either active or passive. Active RFID tags are powered by an internal battery and are typically read/write, i.e., tag data may be rewritten and/or modified. An active tag's memory size varies according to application requirements. The battery-supplied power of an active tag generally gives it a longer read range. The trade off is greater size, greater cost, and a limited operational life (that may yield a maximum of 10 years, depending upon operating temperatures and battery type).

[0009] Passive RFID tags operate without a separate external power source and obtain operating power generated from the reader. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. Read-only tags are typically passive and are programmed with a unique set of data (usually 32 to 128 bits) that cannot be modified.

[0010] Read-only tags most often operate as a license plate into a database, in the same way as linear barcodes reference a database containing modifiable product-specific information. And, because they do not include a battery, "read-only" passive tags are typically much more "environmentally-friendly".

[0011] Although field-powered passive tag RFID systems provide cost, reliability, and environmental benefits, there are obstacles to the efficient operation of field-powered passive tag RFID systems. In particular, it is often difficult to deliver sufficient power from a base station to a field-powered passive tag via an interrogating signal. The amount of power a base station may impart to a signal is limited by a number of factors, not the least of which is regulation by the Federal Communication Commission (FCC). An RFID tag may employ a resonant antenna in order to best utilize the signal power available to it. Unfortunately, a resonant antenna may require a good deal more area than is available to an RFID tag in many applications.

[0012] Additionally, one of the primary advantages of all types of RFID systems is the non-contact, non-line-of-sight nature of the technology. Tags may be read through a variety of substances such as snow, fog, ice, paint, crusted grime, and other visually and environmentally challenging conditions, where barcodes or other optically read technologies would be useless. RFID tags may also be read in challenging circumstances at remarkable speeds, in most cases responding in less than 100 milliseconds. However, even though line-of-sight is not required, in instances where the tag is blocked by other containers and/or wherein the non-line-of-sight is used to read the tag, the range of the tags is reduced, thereby reducing the effectiveness of the tags and leading to situations wherein a container or series of containers may become "lost" during transport.

[0013] Therefore, it would be beneficial to provide a system that provides increased accuracy to the process of object identification, movement and tracking throughout a transport, inventory, or other similar operation. There is a need for such a system that is adaptable for use with all of the wide variety of locations that are involved in inventory and

transport operations, such as stocking locations, storage racks, floor lanes, warehouses, trucks, ships, and shipping docks.

[0014] The present invention is directed to alleviating one or more of the aforementioned problems, and meeting one or more of the above-identified needs.

SUMMARY OF THE INVENTION

[0015] The present invention provides a system that has increased accuracy and reliability in the method of object identification, movement and tracking throughout a transport, inventory, or other similar operation. The present invention accomplishes this by using a multi-planar RFID tag. Objects that have the multi-planar RFID tag attached thereto are easier to identify and track due to the increased responsiveness of the multi-planar RFID tag. As a result, methods of tracking these objects are more accurate and reliable.

[0016] In particular, one embodiment of the present invention provides a multi-planar radio frequency identification tag including an antenna, a semiconductor chip in electrical communication with the antenna, and a substrate for holding the antenna and the chip. The multi-planar radio frequency identification tag is bent at a location of the tag to form a first portion of the tag that occupies a first plane and a second portion of the tag that occupies a second plane.

[0017] Another embodiment of the present invention provides an object capable of being tracked including an object, and a multi-planar radio frequency identification tag attached to the object. The multi-planar radio frequency identification tag includes an antenna, a semiconductor chip in electrical communication with the antenna, and a substrate for holding the antenna and the chip. The multi-planar radio frequency identification tag is bent at a location of the tag to form a first portion of the tag that occupies a first plane and a second portion of the tag that occupies a second plane.

[0018] Yet another embodiment of the present invention provides a method of tracking an object including the steps of attaching at least one radio frequency identification tag to the object, using a first radio frequency identification interrogator located in a first location to scan the tag attached to the object and transmit data regarding the object to a data storage site, using a second radio frequency identification interrogator located in a second location to scan the tag attached to the object and transmit data regarding the object to the data storage site, and tracking the object using the data scanned by the first radio frequency identification interrogator and the second radio frequency identification interrogator.

DETAILED DESCRIPTION OF THE DRAWINGS

[0019] Other objects, features and advantages of the will become apparent upon reading the following detailed description, while referring to the attached drawings, in which:

[0020] Figure 1 is a perspective view of a multi-planar RFID tag according to one embodiment of the present invention.

[0021] Figure 2 is a side view of the multi-planar RFID tag shown in Figure 1.

[0022] Figure 3 is a plan of a dipole antenna useful in one embodiment of the present invention.

[0023] Figure 4 is a plan of a double dipole antenna useful in another embodiment of the present invention

[0024] Figure 5 is a side view of a rectangular container having a multi-planar RFID tag according to another embodiment of the present invention.

[0025] Figure 6 is a side view of a hexagonal container having a multi-planar RFID tag according to another embodiment of the present invention.

[0026] Figure 7 is a perspective view of a pallet having a multi-planar RFID tag according to yet another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0027] The present invention is more particularly described in the following description that is intended to be illustrative only since numerous modifications and variations therein will be apparent to those skilled in the art. As used in the specification and in the claims, the singular form "a," "an," and "the" may include plural referents unless the context clearly dictates otherwise. Also, as used in the specification and in the claims, the term "comprising" may include the embodiments "consisting of" and "consisting essentially of."

[0028] The object of any RFID system is to carry data in suitable transponders, generally known as tags, and to retrieve data, by machine-readable means, at a suitable time and place to satisfy particular application needs. Data within a tag may provide identification for an item in manufacture, goods in transit, a location, the identity of a vehicle, an animal or individual.

[0029] Communication of data between tags and a reader is by wireless communication. Two methods distinguish and categorize RFID systems, one based upon close proximity electromagnetic or inductive coupling and one based upon propagating electromagnetic waves. Coupling is via 'antenna' structures forming an integral feature in

both tags and readers. While the term antenna is generally considered more appropriate for propagating systems it is also loosely applied to inductive systems.

[0030] Transmitting data is subject to the vagaries and influences of the media or channels through which the data has to pass, including the air interface. Noise, interference and distortion are sources of data corruption that arise in practical communication channels that must be guarded against in seeking to achieve error free data recovery. By increasing the accuracy of data recovery, methods of tracking and transporting inventory become more efficient and customers, suppliers and the like are better able to manage their operations.

[0031] As such, the present invention provides a beneficial multi-planar RFID tag, a container including the multi-planar RFID tag, and a method of tracking objects using a multi-planar RFID tag. By occupying more than one plane, the RFID tag of the present invention is less susceptible to interference during data transmission and, therefore, improves known systems and methods for tracking and transporting objects using RFID tags.

[0032] In a first embodiment, the present invention provides a multi-planar RFID tag. As used herein, the term "multi-planar" is used to indicate that the RFID tag is constructed and arranged to occupy more than one plane of the object. In one embodiment, the tag has a two portions, wherein the second portion is perpendicular to the first portion. In this embodiment, the first portion occupies one plane while the second portion occupies a second plan oriented at 90° to the first plane, thereby resulting in a multi-planar tag. In those embodiments where the tag is placed on an object having a curvilinear shape, the tag occupies a plurality of planes as defined by the tangents of various points along the arc formed by placing the RFID tag on the object having a circular shape. By using a multi-planar tag, the present invention maximizes antenna area on different sides of the object, such that, regardless of the tag's orientation or the orientation of the object in relation to the reader, the tag is better able to receive and transmit a signal. In the embodiments that utilize passive tags, the signal may be stronger as more energy is absorbed by the tag that may then be used to emit a stronger response signal, thereby increasing the distance at which the reader must be located to read the tag. By orienting the antenna of the RFID tag in different planes, the present invention increases the opportunity for the tag to receive incoming signals. As radio frequencies are relatively straight line signals, there is a greater likelihood of having a signal missed if the antenna occupies only one plane of the tag.

[0033] Generally speaking, RFID tags are low power integrated circuits suitable for interfacing to external coils, or utilizing "coil-on-chip" technology, for data transfer and/or power generation. RFID tags may be designed depending on one or more of the following options: means by which the tag is powered, data carrying options, data read rates, programming options, and their physical form.

[0034] The present invention includes embodiments wherein the tags may be either passive or active, the designation being determined entirely by the manner in which the

device derives its power. Active tags are powered by an internal battery. As such, in those embodiments using an active tag, the tag will usually contain a cell that exhibits a high power-to-weight ratio and are usually capable of operating over a large temperature range. The use of a battery indicates that the RFID tag has a finite lifetime. However, in some embodiments, the tags may run as long as ten or more years. In other embodiments, passive tags are used. Passive tags operate without an internal battery source, deriving the power to operate from the field generated by the reader. Passive tags are, therefore, lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. Passive tags are constrained in their capacity to store data and the ability to perform well in electromagnetically noisy environments. Sensitivity and orientation performance may also be constrained by the limitation on available power. Despite these limitations passive transponders offer advantages in terms of cost and longevity. They have an almost indefinite lifetime and are generally lower on price than active transponders. Accordingly, the selection of either a passive tag or an active tag in the present invention will be dependent on one or more of the design features described above. The present invention contemplates that the multi-planar RFID tag is a passive tag. However, in some embodiments, the multi-planar RFID tag may include its own power source.

[0035] The multi-planar RFID tags of the present invention are not limited to any specific size or shape. In general, the tag includes a semiconductor chip having RF circuits, logic, and memory. The tag also has an antenna and a substrate for mounting the components. The tag may include interconnections between components or the interconnections may be obviated based upon the method of manufacturing the tag. The tag may also be enclosed in a physical enclosure. In general, RFID tags are manufactured by mounting the individual elements to a circuit card. This mounting is accomplished by using either short wire bond connections or soldered connections between the board and one or more of the circuit elements: the data storage device, capacitors, diodes, antenna. The circuit card may be formed of any suitable material, such as epoxy-fiberglass composition or ceramic. The circuit card may be attached or enclosed within the substrate.

[0036] The substrate may be manufactured from any suitable material or materials. Suitable materials for the substrate may provide beneficial characteristics. For example, the substrate may be non-conductive between the various components of the circuit pattern to prevent shorting between them. It is beneficial that the substrate and at least a portion of the circuit pattern be flexible such that portions of the substrate may be folded or creased without severing any required electrical connections and/or fracturing the substrate. Examples of materials that may be used to form the substrate include, but are not limited to, paper, cardboard, ethylene acetate, polystyrene, polycarbonate, polypropylene, polyethylene, polyurethane, polyester, polyolefin, polyamide, vinyl, silicones, rubber based adhesives, acrylic adhesive, water soluble adhesives, polyethylene terephthalete (PET), polyethylene

naphthalate (PEN), polyetherimide (PEI), polyetheretherketone (PEEK), polysulfone (PS), polyphenylene sulfone (PPS), and polyethersulphone (PES), polyvinyl chloride (PVC), polyester (MYLAR®), polyimide (KAPTON®), and combinations thereof. Furthermore, the substrate may be a homogeneous structure or the substrate may be constructed of two or more different materials provided as different layers or otherwise.

[0037] The data storage device is typically a microchip that includes information regarding the object tagged. The size and data storage capacity of the microchip will vary depending on what information is to be stored. This information may include, but is not limited to, identification information, delivery and/or pick-up location, time and date information, serial numbers, package content, key process instructions, and combinations thereof.

[0038] The circuit pattern of the multi-planar RFID tag may be made using a variety of techniques for forming electrically conductive patterns. The circuit pattern may, for example, be formed using standard printed circuit methods, wherein an original stencil pattern is screen printed with an etch resistant ink onto a metal layer, and the non-ink coated portions are subsequently etched away. Other techniques suitable for providing electrically conductive patterns may similarly be utilized, such as metal foil patterned by photo-resist/etch techniques, laser ablation, etc. Another suitable technique may, for example, involve stenciling or printing of conductive ink onto the substrate. In still other techniques, the circuit pattern may be built up by pattern-wise plating onto, e.g., a metal foil, seed layer, conductive ink layer, etc.

[0039] The circuit pattern of the RFID tag includes an antenna. The antenna is used to receive and transmit a signal from the RFID tag to the reader or interrogator. Also, in the use of passive tags, the antenna may be used in conjunction with the circuit and/or a charge pump, to convert a portion of the frequency into energy to enable the tag to emit a response signal. The antenna may include loops of wire soldered to the circuit card or may comprise metal etched or plated on a circuit card. The antenna may also comprise a leadframe antenna. A leadframe antenna is generally made from a material that is electrically conductive and has a degree of stiffness that permits the antenna to flex within a given amount when supported at one or more ends. A leadframe antenna is generally a punched and/or etched foil. The materials that may be used in an antenna include, but are not limited to, copper, copper-alloys, or nickel-iron alloys such as alloy-42.

[0040] However, in select embodiments, the antenna is a dipole antenna or a double dipole antenna. As discussed in further detail in Figure 3, below, a dipole antenna is an antenna that includes two small antenna that are connected to the chip at two connections. One of the connections is the active dipole and the other connection is the reflective dipole. As a result, the antenna, when the RFID tag is bent, has substantially all of one antenna in the first portion and substantially all of the second antenna in the second portion, thereby

ensuring the increased reception and signal strength resulting from using the RFID tag of the present invention. In other select embodiments, the antenna is a double dipole antenna. As discussed in further detail in Figure 4, below, a double dipole antenna has two sets of active dipoles and two sets of reflective dipoles. By arranging the dipoles on the RFID tag of the present invention, each of the first and second portions of the multi-planar tag may include an antenna attached to an active dipole and an antenna attached to a reflective dipole, thereby ensuring the increased reception and signal strength resulting from using the multi-planar RFID tag of the present invention.

[0041] The tag is constructed and arranged as a tag that is bent and which, as a result of the bend, may form a fold or crease. In other embodiments, the bend results in a tag having an arc or crescent shape. The bend in the RFID tag creates a tag having a first portion and a second portion, wherein the two portions are angularly oriented to form an orientation angle. As used herein, the term "orientation angle" refers to the angle defined by the second portion of the RFID tag in relation to the first portion of the RFID tag. An orientation angle of 90° would indicate that the second portion and first portion formed a right angle or, in other terms, the second portion was perpendicular to the first portion. Since the RFID tag is multi-planar and may be used on any shape of object, the orientation angle may range from about 45° to about 135°, depending on the shape of the object to which the multi-planar tag is attached. However, it is also to be understood that the orientation angle may be less than 45° (but greater than 0°) or greater than 135° (but less than 180°) if the shape of the object so requires. In those embodiments where the bend forms a tag having a crescent-shape, the orientation angle would be the angle formed by the intersection of the tangents of the end points of the tag. Lastly, it is also contemplated that the multi-planar RFID tag of the present invention may be designed such that the tag has multiple bends, thereby resulting in a multi-planar tag having more than two portions. For example, if the object to be tracked had an equilateral triangle cross-section and the tag were placed on the end of the object, the tag may have three portions, wherein a first portion of the tag is positioned on the end of the object while the second portion and the third portion would be positioned on two of the three sides of the object.

[0042] As discussed, the bend results in a first portion and a second portion. The data storage device, such as a microprocessor, is located in one of these portions, as well as part of the antenna. The other portion includes the other part of the antenna. The bend in the RFID tag is beneficially formed in the tag to maximize antenna area in the non-data storage device portion of the tag. As a result, in selected embodiments, the bend is placed as close as possible to the data storage device without placing to much stress on the data storage device itself. The bend should not be on the data storage device itself as the bend will likely damage the data storage device and/or the data storage device -to-inlay joint. However, it is contemplated that, in some embodiments and depending on the size of the tag, the size of the

orientation angle, the materials comprising the tag, and/or the construction of the data storage device, it may be possible to bend the RFID tag over the data storage device or close to the data storage device as long as the data storage device is not damaged by the bend. In one embodiment of the present invention, the bend is located from about 5 mm to about 10 mm away from the location of the data storage device.

[0043] The size of the tag is not critical. In general, the size of the tag will be large enough to accommodate the chip and the antenna, while also being capable of being bent to form a multi-planar tag. The thickness of the tag is also not critical, again such that the tag is capable of being bent. In one embodiment of the present invention, the tag has a thickness of from about 0.1 mm to about 2.0 mm. In another embodiment, the tag has a thickness of from about 0.3 mm to about 1.2 mm.

[0044] Reference is now made with specific detail to the drawings in which like reference numerals designate like or equivalent elements throughout the several views, and initially to Figure 1. In one embodiment of the present invention, the present invention provides a multi-planar RFID tag 100. The tag 100 includes a first portion 110 and a second portion 120 located on a different plane than the first portion 110.

[0045] As shown in Figure 2, the second portion 120 is oriented in an approximately 90° angle from the first portion 110. However, it is to be understood that the orientation angle of the second portion 120 to the first portion 110 is not limited to a substantially 90° angle.

[0046] Figures 3 and 4 depict a dipole and a double dipole antenna, respectively. As shown in Figure 3, the tag 300 includes a chip 310 having two antenna 320 connected to the chip 310. One of the connections forms the active dipole 330 and the other connection forms the reflective dipole 340. In Figure 4, the tag 400 includes a chip 410 having two sets of antenna 420 connected to the chip 410. By arranging the connections, the two active dipoles 430 and the two reflective dipoles 440 may be on opposite sides of the chip 410.

[0047] The present invention is also directed to an object having a multi-planar RFID tag. The object may be any object capable of having an RFID tag attached within or onto the object. In select embodiments of the present invention, the object is a crate or container and in other embodiments, the object is a pallet. In those embodiments where the object is a container or crate, shape of the crate or container will generally be rectangular or square. However, it is contemplated that the container may also be other geometric shapes, including, but not limited to, cylindrical, oval, hexagonal, or triangular.

[0048] When the RFID tag is attached within or onto the object, the tag is attached such that the tag occupies more than one plane of the object. For example, as shown in Figure 5, if the object was a square or rectangular shipping crate 500, the tag 510 would be attached such that one portion 520 of the tag would contact one side 530, such as the top, and the other portion 540 would contact an adjacent side 550, thereby resulting in an orientation

angle of 90°. However, as shown in Figure 6, if the object 600 had a hexagonal shape, the tag 610 would be attached such that one portion 620 of the tag would contact one side 630 and the other portion 640 would contact an adjacent side 650, thereby resulting in an orientation angle of 120°. If the object were circular or oval, there would be no specific fold or crease in the RFID tag, but the tag would still occupy more than one plane and, therefore would have increased read and/or write performance when attached to the object.

[0049] Figure 7 shows the multi-planar RFID tag of the present invention attached to a shipping pallet. The pallet 700 includes a top 710 and bottom 720, as well as a plurality of supports 730. The multi-planar RFID tag 740 is attached to one of the supports such that a first portion of the tag 750 is located on one side of the support and the second portion 760 is located on another side of the support.

[0050] The tag may be attached to either the exterior of the object or the interior, or the tag may be imbedded in at least one wall of the object wherein the tag is embedded in the wall of the object by overmolding or insert molding the tag into the wall. The tag may be attached using any known attachment means, including, but not limited to, a mechanical fastening means, such as a screw, nail, staple, or combination thereof, or a chemical fastening means, such as a glue or a hot-melt adhesive, or a combination of a mechanical fastening means and a chemical fastening means.

[0051] Once a multi-planar RFID tag has been attached to an object, the present invention also includes a method of tracking the object using the multi-planar RFID tag. Objects to be tracked between locations are outfitted with the multi-planar RFID tags having information relating to the identity of the objects. The information may include, but is not limited to, one or more of the following: the type and/or quantity of goods, serial numbers, load numbers, pallet numbers, dates and/or times of pick-up and/or delivery, pick-up and/or delivery locations, and any special transport requirements, such as temperature.

[0052] The method also includes the use of RFID readers or interrogators. The RFID interrogator may be of any type suitable for receiving the signals. It may be an RF receiver; it may also include a transmitter for providing interrogation signals to passive RFID tags. The interrogator may further be capable of transmitting information to be stored in an RFID tag. Thus, the interrogator may provide updated information about the movement history of the object. The method may also include a transport vehicle that has been equipped to interrogate RFID tags. If a transport vehicle is used that is capable of interrogating RFID tags, then the method of tracking provides additional information as to the location of any particular object at any particular time.

[0053] Accordingly, in the method of the present invention, the object or objects to be tracked have a multi-planar RFID tag attached thereto, either on the exterior, on the interior, or by imbedding the tag within the walls of the object, wherein the tag is oriented such that the tag occupies more than one plane of the object or objects to be tracked. The tag is then

tracked using a series of interrogator units positioned at various locations throughout the transport operation. When a tag is within the range of a particular interrogation unit, the interrogation unit determines the presence of the tag, determines an identification of the tag, and, based on the processing station at which the particular interrogation unit is associated, causes particular process steps related to item location to be noted, for example, completion of a receiving, assembly, shipping, purchase, or sale transaction involving the item. These process steps may be then be sent to a data storage site. The data storage site may then record the data either manually or by using a central processing unit or computer. The computer may then be configured to send information regarding the location of each tag on a consistent basis as the tag is moved. Alternatively, the computer may operate such that the data regarding a particular tag may be retrieved only when requested. Or the computer may be configured in any manner beneficial to tracking objects.

[0054] By using the multi-planar tags, the method of tracking objects of the present invention is more accurate and reliable as fewer data signals are lost, thereby ensuring that the exact location of an object is more likely to be ascertained at any given point in the transport of the object.

[0055] Additionally, the method of the present invention may be accomplished by using a plurality of RFID tags. In this embodiment, the tags may be multi-planar or they may be flat RFID tags that occupy only one plane. By using two or more flat tags and attaching them to different locations of the object, the two or more tags may be oriented in different planes, thereby resulting in increased accuracy of data recovery, which makes the method of tracking and transporting inventory more efficient.

[0056] Although the illustrative embodiments of the present disclosure have been described herein with reference to the accompanying drawings and embodiments, it is to be understood that the disclosure is not limited to those precise embodiments, and various other changes and modifications may be affected therein by one skilled in the art without departing from the scope of spirit of the disclosure. All such changes and modifications are intended to be included within the scope of the disclosure as defined by the appended claims.

What is claimed is:

1. A multi-planar radio frequency identification tag comprising:
an antenna;
a data storage device in electrical communication with the antenna; and
a substrate for holding the antenna and the data storage device;
wherein the multi-planar radio frequency identification tag is bent at a location of the tag to form a first portion of the tag that occupies a first plane and a second portion of the tag that occupies a second plane.

2. The tag of Claim 1, wherein the substrate comprises a material selected from paper, cardboard, ethylene acetate, polystyrene, polycarbonate, polypropylene, polyethylene, polyurethane, polyester, polyolefin, polyamide, vinyl, silicones, rubber based adhesives, acrylic adhesive, water soluble adhesives, polyethylene terephthalete, polyethylene naphthalate, polyetherimide, polyetheretherketone, polysulfone, polyphenylene sulfone, polyethersulphone, polyvinyl chloride, polyester, polyimide, and combinations thereof.

3. The tag of Claim 2, wherein the substrate comprises a material selected from polypropylene and polyester.

4. The tag of Claim 1, wherein the antenna is selected from a leadframe antenna, a dipole antenna and a double dipole antenna.

5. The tag of Claim 4, wherein the antenna is a double dipole antenna.

6. The tag of Claim 1, wherein the tag has a thickness of from about 0.1 mm to about 2.0 mm.

7. The tag of Claim 6, wherein the tag has a thickness of from about 0.3 mm to about 1.2 mm.

8. The tag of Claim 1, wherein the location of the bend is from about 5 mm to about 10 mm away from a location of the data storage device in the tag.

9. An object capable of being tracked comprising:
an object; and
a multi-planar radio frequency identification tag attached to the object;
wherein the multi-planar radio frequency identification tag comprises:

an antenna;

a data storage device in electrical communication with the antenna; and

a substrate for holding the antenna and the data storage device; and

wherein the multi-planar radio frequency identification tag is bent at a location of the tag to form a first portion of the tag that occupies a first plane and a second portion of the tag that occupies a second plane.

10. The object of Claim 9, wherein the object is selected from a crate, a container and a pallet.

11. The object of Claim 9, wherein the tag is located on an interior of the object.

12. The object of Claim 9, wherein the tag is located on an exterior of the object.

13. The object of Claim 9, wherein the tag is embedded in at least one wall of the object.

14. The object of Claim 9, wherein the tag is attached to the object using an attachment means selected from a screw, nail, staple, glue, hot-melt adhesive, and a combination thereof.

15. The object of Claim 9, wherein the substrate comprises a material selected from paper, cardboard, ethylene acetate, polystyrene, polycarbonate, polypropylene, polyethylene, polyurethane, polyester, polyolefin, polyamide, vinyl, silicones, rubber based adhesives, acrylic adhesive, water soluble adhesives, polyethylene terephthalete, polyethylene naphthalate, polyetherimide, polyetheretherketone, polysulfone, polyphenylene sulfone, polyethersulphone, polyvinyl chloride, polyester, polyimide, and combinations thereof.

16. The object of Claim 15, wherein the substrate comprises a material selected from polypropylene and polyester.

17. The object of Claim 9, wherein the antenna is selected from a leadframe antenna, a dipole antenna and a double dipole antenna.

18. The object of Claim 17, wherein the antenna is a double dipole antenna.

19. The object of Claim 9, wherein the tag has a thickness of from about 0.1 mm to about 2.0 mm.

20. The object of Claim 19, wherein the tag has a thickness of from about 0.3 mm to about 1.2 mm.

21. The object of Claim 9, wherein the location of the bend is from about 5 mm to about 10 mm away from a location of the data storage device in the tag.

22. A method for tracking an object comprising:

attaching at least one radio frequency identification tag to the object such that the at least one radio frequency identification tag is oriented on different planes of the object;

using a first radio frequency identification interrogator located in a first location to scan the tag attached to the object and transmit data regarding the object to a data storage site;

using a second radio frequency identification interrogator located in a second location to scan the tag attached to the object and transmit data regarding the object to the data storage site; and

tracking the object using the data scanned by the first radio frequency identification interrogator and the second radio frequency identification interrogator.

23. The method of Claim 22, further comprising at least one additional radio frequency identification interrogator located in at least one additional location to further scan the tag and transmit data regarding the object to the data storage site and to further track the object using the data scanned by the at least one additional radio frequency identification interrogator.

24. The method of Claim 22, wherein the at least one radio frequency identification tag comprises a multi-planar radio frequency identification tag comprising:

an antenna;

a data storage device in electrical communication with the antenna; and

a substrate for holding the antenna and the data storage device.

further wherein the multi-planar radio frequency identification tag is bent at a location of the tag to form a first portion of the tag that occupies a first plane and a second portion of the tag that occupies a second plane.

25. The method of Claim 22, wherein the at least one radio frequency identification tag comprises at least two radio frequency identification tags;

wherein the at least two radio frequency identification tags are attached to the object at different locations such that the at least two radio frequency identification tags are oriented on different planes of the object.

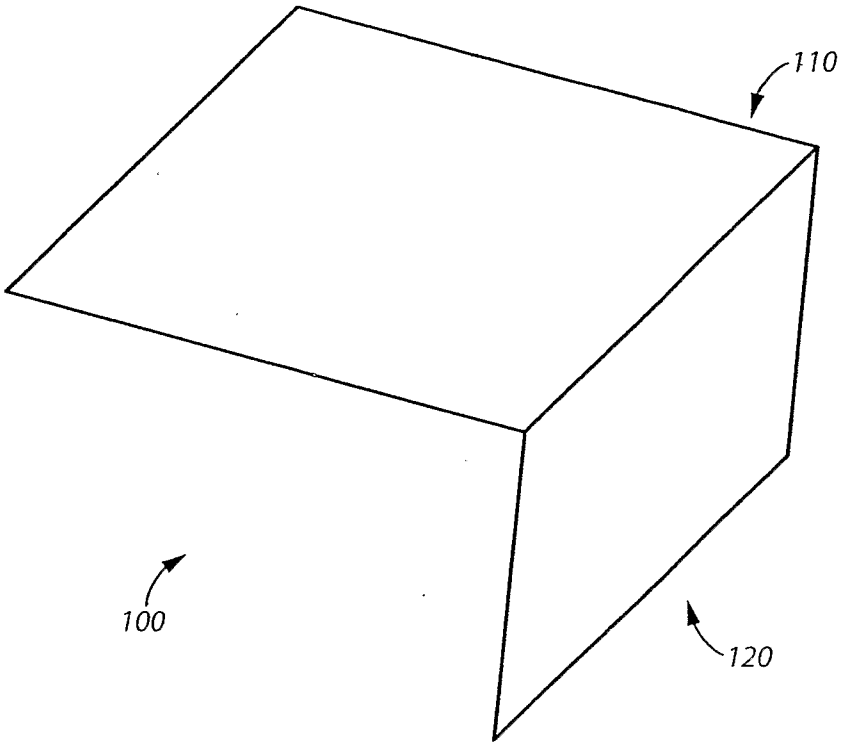


FIG. 1

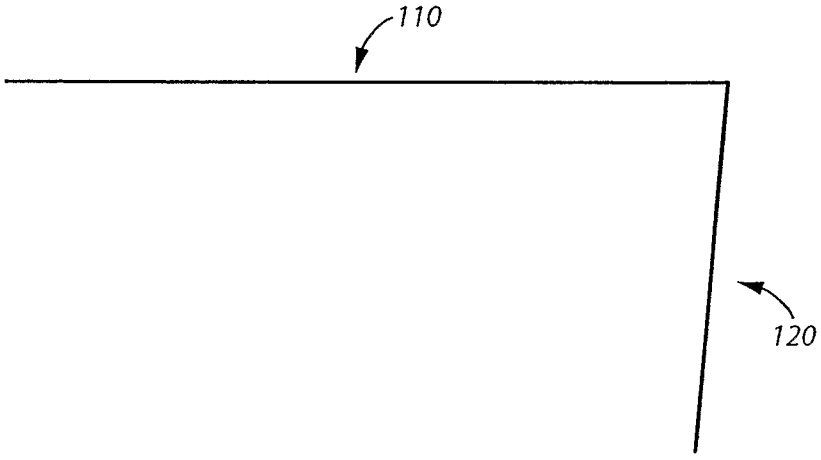


FIG. 2

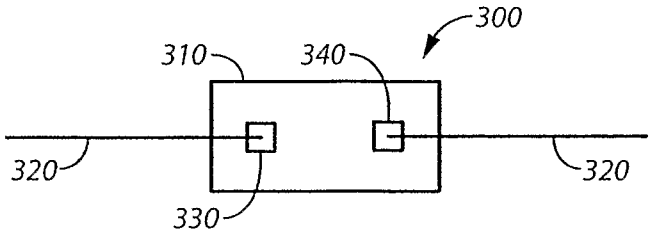


FIG. 3

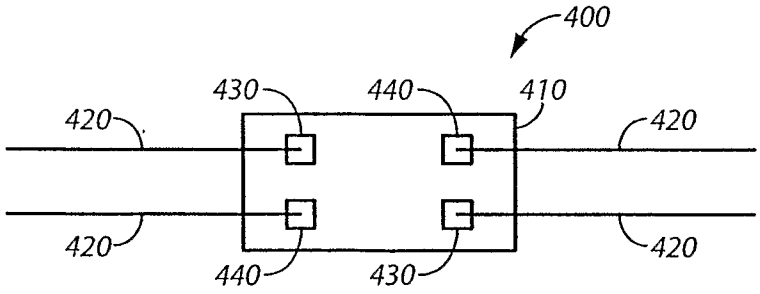


FIG. 4

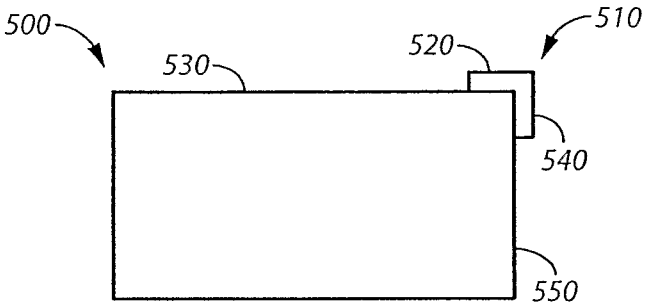


FIG. 5

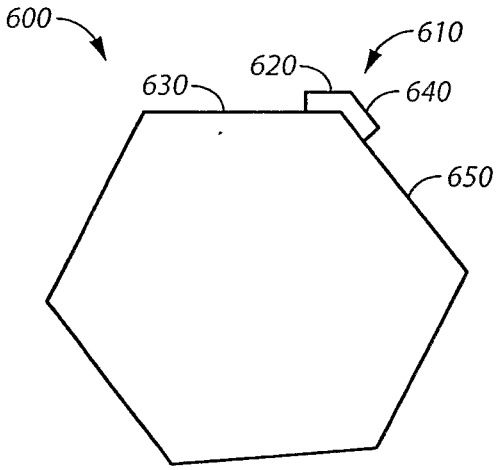


FIG. 6

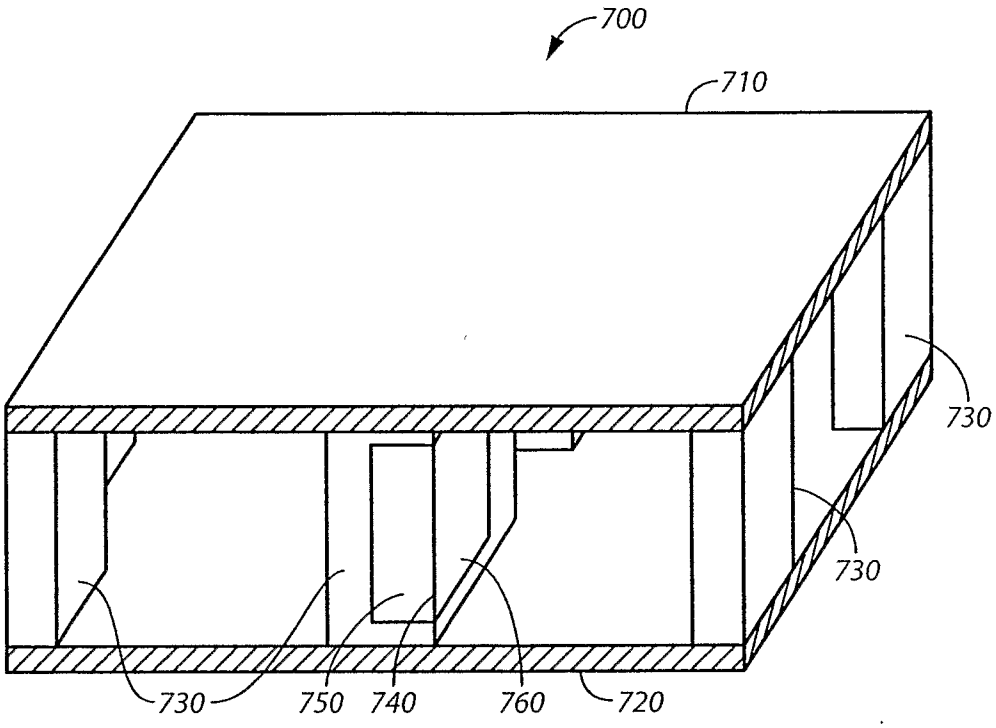


FIG. 7

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
G08B 13/14 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200480039832.9

[43] 公开日 2007 年 1 月 31 日

[11] 公开号 CN 1906645A

[22] 申请日 2004.10.6
[21] 申请号 200480039832.9
[30] 优先权
[32] 2003.11.4 [33] US [31] 10/701,745
[86] 国际申请 PCT/US2004/032834 2004.10.6
[87] 国际公布 WO2005/048167 英 2005.5.26
[85] 进入国家阶段日期 2006.7.4
[71] 申请人 企普国际有限公司
地址 美国佛罗里达州
[72] 发明人 戴尔·霍朗
[74] 专利代理机构 中科专利商标代理有限责任公司
代理人 王新华

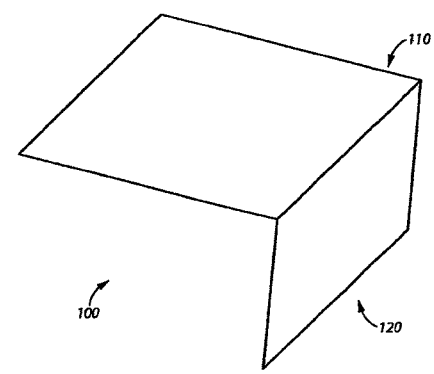
权利要求书 3 页 说明书 13 页 附图 4 页

[54] 发明名称

带有 RFID 标签的货盘

[57] 摘要

一种射频标识(RFID)标签、系统以及使用了 RFID 标签的方法。 所述 RFID 标签是一个多平面标签，它可以与集装箱或货盘之类的物体合并。 然后，在追踪物体位置的方法中可以使用该标签和/或标签/物体组合。 这种多平面标签允许更容易地追踪物体，此外还提高了追踪方法的可靠性。



1．一种多平面射频标识标签，包括：

天线；

与天线进行电子通信的数据存储设备；以及

用于支撑天线以及数据存储设备的基底；

其中所述多平面射频标识标签会在标签中的一个位置弯曲，以便形成占用了第一平面的第一标签部分，以及占用了第二平面的第二标签部分。

2．权利要求1的标签，其中该基底包括从以下材料中选出的一种材料：纸、纸板、乙二醇二乙酸酯、聚苯乙烯、聚碳酸脂、聚丙烯、聚乙烯、聚氨酯、聚酯、聚烯烃、聚酰胺、乙烯基、硅酮、基于橡胶的粘合剂、丙烯酸粘合剂、水可溶粘合剂、对苯二甲酸乙二醇酯、聚萘二甲酸乙二醇酯、聚醚酰亚胺、聚醚醚酮、聚砜、聚苯砜、聚醚砜、聚氯乙烯、聚酯、聚酰亚胺以及这些材料的组合。

3．权利要求2的标签，其中该基底包括从聚丙烯以及聚酯中选出的一种材料。

4．权利要求1的标签，其中该天线是从引脚天线、偶极天线以及双偶极天线中选出的。

5．权利要求4的标签，其中该天线是双偶极天线。

6．权利要求1的标签，其中该标签的厚度是从大约0.1毫米到大约2.0毫米。

7．权利要求6的标签，其中该标签的厚度是从大约0.3毫米到大约1.2毫米。

8．权利要求1的标签，其中弯曲的位置与标签中的数据存储设备所在的位置的距离是大约5毫米到大约10毫米。

9．一种能被追踪的物体，包括：

物体；以及

附着在物体上的多平面射频标识标签；

其中所述多平面射频标识标签包括：

天线；

与天线进行电子通信的数据存储设备；以及

用于支撑天线以及数据存储设备的基底；以及

其中所述多平面射频标识标签会在标签中的一个位置弯曲，以便形成占用了第一平面的第一标签部分，以及占用了第二平面的第二标签部分。

10．权利要求9的物体，其中该物体是从板条箱、集装箱以及货盘中选出的。

11．权利要求9的物体，其中该标签处于物体的内部。

12．权利要求9的物体，其中该标签处于物体的外部。

13．权利要求9的物体，其中该标签嵌入在该物体的至少一个壁内。

14．权利要求9的物体，其中该标签是用从以下装置中选出的附着装置而被附着在物体上的：螺丝、铁钉、肘钉、胶水、热溶性粘合剂、以及这些装置的组合。

15．权利要求9的物体，其中该基底包括从以下材料中选出的一种材料：纸、纸板、乙二醇二乙酸酯、聚苯乙烯、聚碳酸脂、聚丙烯、聚乙烯、聚氨酯、聚酯、聚烯烃、聚酰胺、乙烯基、硅酮、基于橡胶的粘合剂、丙烯酸粘合剂、水可溶粘合剂、对苯二甲酸乙二醇酯、聚萘二甲酸乙二醇酯、聚醚酰亚胺、聚醚醚酮、聚砜、聚苯砜、聚醚砜、聚氯乙烯、聚酯、聚酰亚胺以及这些材料的组合。

16．权利要求15的物体，其中该基底包括从聚丙烯以及聚酯中选出的一种材料。

17．权利要求9的物体，其中该天线是从引脚天线、偶极天线以及双偶极天线中选出的。

18．权利要求17的物体，其中该天线是双偶极天线。

19．权利要求9的物体，其中该标签的厚度是从大约0.1毫米到大约2.0毫米。

20．权利要求19的物体，其中该标签的厚度是从大约0.3毫米到大约1.2毫米。

21．权利要求9的物体，其中弯曲的位置与标签中的数据存储设备所在的位置的距离是大约5毫米到大约10毫米。

22．一种用于追踪物体的方法，包括：

将至少一个射频标识标签附着在物体上，以使所述至少一个射频标识标签定位在物体的不同平面上；

使用第一地点的第一射频标识查询器来扫描附着于该物体的标签，并且将涉及该物体的数据传送到一个数据存储位置；

使用第二地点的第二射频标识查询器来扫描附着于该物体的标签，并且将涉及该物体的数据传送到数据存储位置；以及

使用第一射频标识查询器以及第二射频标识查询器扫描的数据来追踪物体。

23．权利要求22的方法，还包括：处于至少一个附加地点的至少一个附加射频标识查询器进一步扫描该标签，并且将涉及物体的数据传送到数据存储位置，以及使用所述至少一个附加射频标识查询器扫描的数据来进一步追踪该物体。

24．权利要求22的方法，其中所述至少一个射频标识标签包括多平面射频标识标签，其中该标签包括：

天线；

与天线进行电子通信的数据存储设备；以及

用于支撑天线以及数据存储设备的基底。

其中所述多平面射频标识标签会在标签中的一个位置弯曲，以便形成占用了第一平面的第一标签部分，以及占用了第二平面的第二标签部分。

25．权利要求22的方法，其中所述至少一个射频标识标签包括至少两个射频标识标签；

其中所述至少两个射频标识标签附着在物体的不同位置，由此所述至少两个射频标识标签是定位在物体的不同平面上的。

带有RFID标签的货盘

技术领域

本发明涉及射频标识（RFID）标签以及使用这些标签的系统和方法。

背景技术

为了实现高效的盘存和运输操作，较为有利的是在将所要定位和/或传输的货盘载荷、集装箱以及其他物体在不同位置之间往来运送的时候对其移动进行精确追踪。在遍及全世界的盘存和运输事务中，在指定的时间，集装箱、货盘以及其他物体有可能处于制造商所在位置、仓库之中、卡车或轮船之上，此外也有可能已经交付给了最终目的地。在一个遍及全世界的系统中，所运输的货物是从某一个位置提取，并且经由卡车、火车和/或轮船运输，然后才被交付的。由于每天载运的集装箱、货盘或其他物体的体积极大，因此，要对这些物体进行追踪是非常困难的。

此外，一旦将货物交付某个目的地，以仓库为例，那么所述货物有可能处于仓库中的不同位置，例如贮藏地点、库存地点、集结区域以及装卸平台。在典型的库存和运输操作中，对叉式运货车、前伸式叉车、自动装卸车或码垛车之类的运输车辆而言，其操作员将会接收到一组打印出来的库存或拣货定单，这组定单通常由计算机产生，而操作员则亲眼确定载荷和地点，并且将会运输那些来自订单上指定的地点的载荷，此外也会将载荷运输到这些命令所指定的地点。在此类系统中，尤其是在具有大量地点和载荷需要处理的大规模的仓库中，其中极有可能出现差错。

某些仓库管理操作使用了贴在载荷上或是标记特定地点的条形码。在此类系统的典型实例中，操作员使用手持式条形码扫描器来读取载荷上的条形码，并且在某些情况下会读取库存地点的条形码。虽然这种系统是对纯视觉处理的一种改进，但是这种系统是很难完全实现的，这在某种程度上是因为它需要在扫描器与条形码之间具有直达的视线、非常接近的距离

以及恰当的校准。此外，它还需要操作员参与到载荷标识处理中。在某种情况下，操作员可能需要离开运输车辆来手动扫描条形码，由此将会减慢仓库的运作。对某些地点、例如很高的贮存支架以及装卸平台而言，由于使用条形码需要所述码与读取器之间非常接近，因此，要在这些地点使用条形码则尤其困难。这样一来，这些区域中的载荷通常是改用视觉方式来识别的。

目前，射频标识（RFID）应答器（标签）已被提出，以此作为条形码的替代方案。RFID标签与RFID基站结合操作，以便用于多种库存控制、安全性以及其他目的。通常，对具有相关联标签的物品、例如内部放置了标签的集装箱来说，该物品会被带入一个由基站建立的“读取区域”。RFID基站将会传送一个由接收标签调制的查询RF信号。也就是说，RFID基站会在载频上产生一个连续波电磁干扰，并且这个干扰将被调制，以便与借助所述干扰传递的数据相对应。经过调制的干扰或数据会以某个速率来传递信息，其中这个速率被称为数据速率，并且该速率小于载频。执行接收处理的标签则对RF信号进行调制，以便通知标签内部存储的信号信息，此外还会将经过调制的应答RF信号传送到基站。

在典型的常规系统中，包含了与所追踪的库存物品身份相关联的信息的RFID标签是附在所述库存物品上的。RFID查询器则被用于检测RFID标签是否存在，并且从该标签中读取标识信息。典型的RFID查询器包括用于向RFID标签传送查询信号以及从RFID标签接收响应信号的RF收发信机、一个或多个与收发信机相连的天线、以及分别用于在所接收和传送的EF信号中读取和写入已编码信息的相关解码器以及编码器。该查询器可以是一个能被带到所读取标签附近的便携设备，但是它也可以是一个固定设备，其中在将被标签带到查询器那里的时候，该设备可以对其进行读取，这与将带有标签的图书馆图书归还给安装了查询器的归还处的情况是一样的。此外，RFID标签还可以作为地点标记而被附在某个地点附近。当检测到附着于库存物品的标签以及地点标记标签的时候，与查询器相关联的处理单元可以确定该库存物品处于所标记的地点的附近。虽然这些常规的物体追踪系统能够保持记录库存物品，并且有时候还能记录其所在位置，但是对于追踪和/或管理库存物品移动而言，这些系统并不是非常有效。

此外，目前还存在一种仓库库存追踪系统，该系统包含了处于不同地点的固定RFID查询器，以便在带有RFID标签的物品处于配备了查询器的地点附近的时候对其进行检测。举例来说，目前存在这样一些仓库，在其装卸平台大门或附近具有RFID查询器。这种系统能够对带有标签的物体到达不同地点的情况进行追踪，但却无法在远离这些地点的情况下察觉到差错。举例来说，如果因为将叉式运货车开到错误的拣货地点而拣取了错误的载荷，那么在所述载荷到达大门之前是无法察觉这个错误的。这种延迟的差错检测会对仓库运营的总体效率产生不利影响。此外，为众多装卸平台大门中的每一个配备查询器在成本效益方面也是很不划算的。

RFID标签可以分类成有源或无源的。有源的RFID标签由内部电池供电并且通常是可以读/写的，也就是说，标签数据是可以改写和/或修改的。有源标签的存储器大小会根据应用的需求而改变。并且有源标签的电池供电电源通常会为其提供较长的读取范围。作为交换，这种标签具有较大的尺寸、较高的成本以及有限的工作寿命（其寿命最长可达10年，这取决于工作温度以及电池类型）。

无源RFID标签则是在没有独立的外部电源的情况下工作的，并且该标签将会获取读取器产生的工作功率。因此，无源标签要比有源标签轻很多，并且提供了近乎无限的工作寿命。一般来说，只读标签是无源的，并且是用无法修改的唯一一组数据（通常是32～128比特）编程的。

在大多数情况下，只读标签是作为牌照而对某个数据库进行操作的，其工作方式与线性条形码查阅某一个包含了可修改的产品特定信息的数据库的处理相类似。此外，由于它们并不包含电池，因此，“只读”无源标签通常更“适应于各种环境”。

虽然场供电的无源标签RFID系统提供成本、可靠性以及环境方面的益处，但是同样存在影响场供电的无源标签RFID系统有效运作的障碍。特别地，要借助查询信号而将足够电力从基站递送到场供电的无源标签通常是很困难的。基站可为信号提供的电力将会受到多种因素的限制，其中至少会受到联邦通信委员会（FCC）的规章的限制。RFID标签可以使用一个谐振天线，从而以最佳方式来使用可以得到的信号功率。然而不幸的是，在很多应用中，谐振天线所需要的区域要远远大于RFID标签所能得到的区域。

此外，对各种类型的RFID系统来说，这些系统的一个主要优点是该技术具有无接触和非视线的特性。标签可以穿过多种物质而被读取，例如雪、雾、冰、涂料、硬结尘垢以及其他那些具有视觉和环境要求并且条形码或其他光学读取技术无效的状态。此外，RFID标签还能在复杂的环境中以很高的速度来进行读取，并且在大多数情况下，它会在100毫秒以内做出应答。然而，即使对视线处理不作要求，但在标签受到其他集装箱阻碍和/或使用了非视线处理来读取标签的实例中，标签的范围将会减小，由此将会降低标签的有效性，并且导致出现集装箱或集装箱系列在运输过程中“丢失”的状况。

因此，较为有益的是提供一种系统，该系统能在整个运输、库存或其他类似操作的过程中提升物体标识、移动以及追踪处理的精确度。此外还需要一种系统，该系统适于与库存及运输操作中包含的种类众多的所有地点结合使用，其中举例来说，这些地点可以是库存地点、贮藏架、地面搬运车道、仓库、卡车、轮船以及装卸码头。

本发明针对的是缓解前述问题中的一个或多个问题，并且满足上述需求中的一个或多个需求。

发明内容

本发明提供了一种能在整个运输、库存或其他类似操作中提高物体标识、移动和追踪方法的精度以及可靠性的系统。并且本发明是通过使用多平面RFID标签来实现这个目的的。由于多平面RFID标签具有提高的响应度，因此，附加了多平面RFID标签的物体是很容易识别和追踪的。这样一来，用于追踪这些物体的方法将会更加精确和可靠。

特别地，本发明的一个实施例提供了一种多平面射频标识标签，其中包括天线、与天线进行电子通信的半导体芯片、以及用于保持天线和芯片的基底。这个多平面射频标识标签会在标签所在位置弯曲，以便形成占用了第一平面的第一标签部分，以及占用第二平面的第二标签部分。

本发明的另一个实施例提供了一种能被追踪的物体，其中包括物体、附着在物体上的多平面射频标识标签。多平面射频标识标签包含了天线、与天线进行电子通信的半导体芯片、以及用于保持天线和芯片的基底。并且这个多平面射频标识标签会在标签所在位置弯曲，以便形成占用了第一平面的第一标签部分，以及占用第二平面的第二标签部分。

本发明的另一个实施例还提供了一种用于追踪物体的方法，其中包括以下步骤：将至少一个射频标识标签附着在物体上，使用位于第一地点的第一射频标识查询器来扫描附着在物体上的标签，并且将涉及该物体的数据传送到一个数据存储位置，使用位于第二地点的第二射频标识查询器来扫描附着在物体上的标签，并且将涉及该物体的数据传送到数据存储位置，以及使用第一射频标识查询器以及第二射频标识查询器所扫描的数据来追踪物体。

附图说明

在参考附图的同时，通过阅读下文中的详细描述，可以清楚了解本发明的其他目标、特征和优点，其中：

图1是依照本发明一个实施例的多平面RFID标签的透视图。

图2是图1所示的多平面RFID标签的侧视图。

图3是在本发明的一个实施例中使用的偶极天线的平面图。

图4是在本发明的另一个实施例中使用的双偶极天线的平面图。

图5是具有依照本发明另一个实施例的多平面RFID标签的矩形集装箱的侧视图。

图6是具有依照本发明另一个实施例的多平面RFID标签的六边形集装箱的侧视图。

图7是具有依照本发明另一个实施例的多平面RFID标签的货盘的透视图。

具体实施方式

在以下描述中将对本发明进行更具体的说明，其中这些描述仅仅是示范性的，这是因为对本领域技术人员来说，众多的修改和变化都是显而易见的。除非在上下文中清楚地另行说明，否则说明书和权利要求中使用的单数形式“一”、“一个”以及“该”可以包括多个所指事物。同样，说明书和权利要求书中使用的术语“包括”可以包括实施例“由……组成”以及“主要由……组成”。

任何RFID系统的目标都是在以标签著称的适当应答器中传送数据，以及在适当的时间和地点借助机器可读装置来检索数据，从而满足特定应用的需要。标签内部的数据可以为制造中的物品、被搬运的货物、地点、

车辆本身、动物以及个人提供标识。

在标签与读取器之间进行的数据通信是借助无线通信来完成的。并且当前有两种方法可以对RFID系统进行区分和分类，其中一种方法是以非常接近的电磁或电感耦合为基础的，另一种方法则是以传播中的电磁波为基础的。耦合则是借助“天线”结构而在标签和读取器中形成一个组成特征。虽然一般认为术语天线更适合传播系统，但是它也可以宽松地应用于电感系统。

数据传送将会遭遇到数据所要经过的包括空中接口在内的介质或信道的变化无常的行为（vagary）并受其影响。噪声、干扰和失真是在实际通信信道中出现的数据破坏源，并且在寻求实现无差错的数据恢复的过程中必须对此加以防范。通过提升数据恢复精度，用于追踪和运输库存的方法将会更为有效，并且消费者、供应商等各方可以更好地管理其操作。

同样，本发明提供了一种有益的多平面RFID标签，一种包含了多平面RFID标签的集装箱以及一种使用多平面RFID标签来追踪物体的方法。通过占用一个以上的平面，在数据传输过程中，本发明的RFID标签不易受到干扰的影响，由此改进了使用RFID标签来追踪和运输物体的已知系统和方法。

在第一实施例中，本发明提供了一种多平面RFID标签。这里使用的术语“多平面”被用于表示将所述RFID标签构造和调整成占用了物体的一个以上的平面。在一个实施例中，该标签具有两个部分，其中第二部分与第一部分是垂直的。在这个实施例中，第一部分占用了一个平面，而第二部分则占用了以90°角朝向第一平面的第二平面，由此产生了一个多平面标签。在这些实施例中，标签放置在一个曲线形状的物体上，并且标签占用了沿着弧线的不同点的切线所定义的多个平面，而所述弧线则是通过将RFID标签放置在圆形物体之上形成的。通过使用多平面标签，本发明可以将物体不同侧面上的天线区域增至最大，这样一来，无论标签方位或是物体方位是否与读取器相关联，标签都能更好地接收和传送信号。在使用无源标签的实施例中，由于标签吸收了更多的能量，并且这些能量然后可以用于发出更强的响应信号，因此信号有可能更强，由此将会增大读取器读取标签所需要的距离。通过将RFID标签的天线定位在不同的平面中，本发明增加了标签接收输入信号的机会。由于射频信号是相对较直的直线

信号，因此，如果天线仅仅占用了标签的一个平面，那么丢失信号的可能性将会更大。

一般来说，RFID标签是适合与外部线圈对接或是使用“天线整合芯片（coil-on-chip）”技术来进行数据传送和/或发电的低电压集成电路。RFID标签可以依照下列选项中的一个或多个选项来进行设计：为标签供电的装置，数据传送选项，数据读取速率，编程选项以及它们的物理形式。

本发明包含了这样的实施例，其中标签既可以是有源的，也可以是无源的，而这种标识则完全是由设备得到其电力的方式决定的。有源标签是由外部电池供电的。同样，在这些使用了有源标签的实施例中，标签通常包含了一个展现出很高的电力重量比的电池，并且该电池通常能在很大的温度范围中工作。电池的使用表明RFID标签只有有限的寿命。然而在某些实施例中，这些标签的运行时间可以长达十年或十年以上。在其他实施例中，其中使用的是无源标签。无源标签是在没有内部电池源的情况下工作的，由此是通过从读取器产生的场中获得电力来执行操作的。因此，与有源标签相比，无源标签重量更轻，成本更低，并且提供了近乎无限的工作寿命。在存储数据的容量以及在电磁噪声环境中执行任务的能力方面，无源标签是受到限制的。此外，由于在可用电力方面存在限制，因此其在灵敏度和定向性能方面同样也会受到约束。尽管存在这些限制，但是无源应答器在成本和耐久性方面却具有优势。它们具有几乎无限期的寿命，并且与有源应答器相比，其价格通常较低。相应地，在本发明中，选择无源标签还是有源标签将会取决于上文描述的一个或多个设计特征。本发明则将多平面RFID标签设想成是一个无源标签。但在某些实施例中，多平面RFID标签同样可以包含其自身的电源。

本发明的标签并不局限于任何特定的大小或形状。一般来说，该标签包含一个具有RF电路、逻辑电路和存储器的半导体芯片。此外，该标签还具有天线以及用于安装组件的基底。该标签可以包含组件之间的相互连接，此外，根据制造标签的方法，这些相互连接也是可以消除的。所述标签也可以装入某个物理外壳。一般来说，RFID标签是通过将各个部件安装在电路板上而被制造的。这种安装可以通过在所述板与一个或多个电路部件之间使用短线粘合连接或是焊接连接来完成，其中所述电路部件可以是：数据存储设备、电容器、二极管、天线、电路板可以用任何恰当的材

料构成，例如环氧玻璃纤维合成物或陶瓷。此外，该电路板也可以附着或密封在基底的内部。

该基底可以用一种或多种适当的材料制造。用于基底的适当材料可以提供有益的特性。举例来说，在不同的电路图案组件之间，该基底可以是绝缘的，由此可以防止其间出现短路。非常有益的是，该基底以及至少一部分电路图案是可弯曲的，由此这部分基底可以折叠或皱折，而不必提供任何必要的电连接和/或使基底破裂。对可以用于形成基底的材料而言，其实例包括纸张、纸板、乙二醇二乙酸酯、聚苯乙烯、聚碳酸脂、聚丙烯、聚乙烯、聚氨酯、聚酯、聚烯烃、聚酰胺、乙烯基（vinyl）、硅酮、基于橡胶的粘合剂、丙烯酸粘合剂、水可溶粘合剂、对苯二甲酸乙二醇酯（PET）、聚萘二甲酸乙二醇酯（PEN）、聚醚酰亚胺（PEI）、聚醚醚酮（PEEK）、聚砜（PS）、聚苯砜（polyphenylene sulfone）（PPS）、以及聚醚砜（PES）、聚氯乙烯（PVC）、聚酯（MYLAR®）、聚酰亚胺（KAPTON®）以及这些材料的组合，但是并不局限于此。此外，该基底也可以是一种均匀结构，或者该基底也可以由作为不同的层或以其他方式而被提供的两种或多种不同材料构造。一般来说，数据存储设备是一个包含了与带标签的物体有关的信息的微型芯片。微型芯片的大小和数据存储容量会根据所要存储的信息而改变。这个信息可以包括标识信息、交付和/或拣货（pick up）地点、时间和日期信息、序列号、包装内容、关键的处理指令以及这些信息的组合，但是所述信息并不局限于此。

多平面RFID标签的电路图案可以使用多种用于形成电传导图案的技术来产生。举例来说，该电路图案可以使用标准的印刷电路方法来形成，其中原始模版图案是用防蚀刻墨水而以丝网印刷方式印刷在金属层上的，并且随后将会蚀刻掉那些没有覆盖墨水的部分。同样，其他那些适于提供电传导图案的技术也是可以使用的，例如借助光刻胶/蚀刻技术以及激光消融等技术而在金属箔上印制图案。此外，举例来说，另一种适当的技术可以包括将导电墨水印制或印刷在基底上。在其他技术中，电路图案可以用图案式的电镀构建在例如金属箔、种子层、导电墨水层等物体上。

RFID标签的电路图案包括一个天线。该天线用于从RFID标签接收信号，以及将信号发射到读取器或查询器。同样，在使用无源标签的过程中，该天线可以与电路和/或电荷泵结合使用，由此可以将一部分频率转换成

能量，以使标签能够发射响应信号。该天线可以包括焊接在电路板上的线环，也可以包括蚀刻或镀在电路板上的金属。此外，该天线还可以包括引脚（leadframe）天线。引脚天线通常是用这样的材料构成的，其中该材料具有电传导特性，并且当在一个或多个末端支持该天线的时候，其刚度允许在一定幅度以内弯曲该天线。引脚天线通常是穿孔和/或蚀刻的箔片。可在天线中使用的材料则包括铜、铜合金或镍铁合金，例如Alloy-42，但是并不局限于此。

然而，在所选实施例中，该天线是一个偶极天线或双偶极天线。如以下在图3中更详细论述的那样，偶极天线是一个包含了两个小型天线的天线，其中这两个小型天线在两个连接上与芯片相连。这其中的一个连接是有源偶极子，另一个连接则是反射偶极子。结果，在弯曲RFID标签的时候，该天线会使一个天线基本上完全处于第一位置，并且会使第二天线基本上完全处于第二位置，由此确保使用本发明的RFID标签所实现的接收和信号强度的增强。在其他的所选实施例中，该天线是一个双偶极天线。如以下在图4中更详细论述的那样，双偶极天线具有两组有源偶极子以及两组反射偶极子。通过设置本发明的RFID标签上的偶极子，多平面标签的第一和第二部分中的各个部分都可以包括依附于有源偶极子的天线以及依附于反射偶极子的天线，由此确保使用本发明的RFID标签来实现接收和信号强度的增强。

该标签是作为一个弯曲的标签来构造和调整的，并且由于是弯曲的，因此该标签可以形成一个折叠或皱折。在其他实施例中，这种弯曲将会导致标签具有弧形或新月形的形状。在RFID标签中，这种弯曲将会创建一个具有第一部分和第二部分的标签，其中这两个部分是有角度地面向的以形成方位角。这里使用的术语“方位角”指的是由RFID标签的第二部分相对于RFID标签的第一部分所定义的角度。90°的方位角表示第二部分与第二部分形成了一个直角，换句话说，它表示第二部分与第一部分是垂直的。由于RFID标签是多平面的，并且它可以在任何形状的物体上使用，因此根据多平面标签所附着的物体的形状，方位角的范围可以是从大约45°到大约135°。但是也应该理解，如果物体的形状需要，那么方位也可以小于45°（但是大于0°）或大于135°（但是小于180°）。在这些实施例中，所述弯曲将会形成一个新月形状的标签，该方位角则会是由标签端点的切

线交叉形成的角度。最后还应该想到的是，在这里可以对本发明的多平面RFID标签进行设计，以使该标签具有多处弯曲，由此将会产生一个具有两个以上的部分的多平面标签。举例来说，如果所要追踪的物体具有等边三角形的横截面，并且该标签放置在了该物体的末端，那么该标签可以具有三个部分，其中标签的第一部分位于物体的末端，而第二部分和第三部分则会处于该物体所具有的三个侧面中的其中两个侧面上。

如所述，所述弯曲将会导致产生一个第一部分和一个第二部分。而微处理器之类的数据存储设备以及天线的某些部分则处于这其中的某个部分。另一个部分则包含了天线的其他部分。非常有益的是，通过在标签中形成RFID标签中的这种弯曲，可以将标签的非数据存储设备中的天线区域增至最大。这样一来，在选定的实施例中，所述弯曲将会尽可能地接近数据存储设备，但却不会对数据存储设备本身施加很大压力。由于所述弯曲很可能损坏数据存储设备和/或嵌入有数据存储设备的接头，因此所述弯曲不应该处于数据存储设备本身。然而，应该可以预见的是，在某些实施例中，根据标签大小、方位角大小、包含标签的材料和/或数据存储设备的结构，只要弯曲RFID标签的处理不会损坏数据存储设备，那么也可以在数据存储设备之上或是接近数据存储设备的位置弯曲所述RFID标签。在本发明的一个实施例中，所述弯曲与数据存储设备的位置相距大约5到10毫米。

标签的大小并不是至关重要的。一般来说，标签的大小应该足够大，以便容纳芯片和天线，同时还应该能够进行弯曲，以便形成多平面标签。此外，标签的厚度同样也不是至关重要的，由此该标签是能够弯曲的。在本发明的一个实施例中，标签的厚度是从大约0.1毫米到大约2.0毫米。在另一个实施例中，标签的厚度是从大约0.3毫米到大约1.2毫米。

现在将对附图的具体细节加以参考，其中在所有这些附图中，相同的参考数字表示的是相似或等价的部件，并且在这里首先参考图1。在本发明的一个实施例中，本发明提供了一种多平面RFID标签100。该标签100包括一个第一部分110以及与第一部分100处于不同平面的第二部分120。

如图2所示，第二部分120的方位是在与第一部分相差大约90°角的范围以内。但是也应该理解，第二部分120相对于第一部分110的方位角并不仅限于实际90°的角度。

图3和图4分别描述的是偶极天线以及双偶极天线。如图3所示，标签300包括芯片310，它具有两个与芯片310相连的天线320。这其中的一个连接形成了有源偶极子330，另一个连接则形成了反射偶极子340。在图4中，标签400包括芯片410，它具有与芯片410相连的两组天线420。通过调整连接，两个有源偶极子430以及两个反射偶极子440可以处于芯片的对立面上。

本发明还涉及一种具有多平面RFID标签的物体。该物体可以是其内部或是其上能够附着RFID标签的物体。在本发明的精选实施例中，该物体是一个板条箱或集装箱，并且在其他实施例中，该物体是一个货盘（pallet）。在物体是集装箱或板条箱的这些实施例中，板条箱或集装箱的形状通常是矩形或正方形的。然而也可以预见，所述集装箱可以具有其他的几何形状，其中包括但不局限于圆柱形、椭圆形、六边形或三角形。

在将RFID附着在物体内部或是其上的时候，通过附着该标签，可以使该标签占用物体的一个以上的平面。举例来说，如图5所示，如果该物体是正方形或矩形的运输板条箱500，那么可以附着标签510，以使该标签的一个部分520与某一个侧面530、例如顶端相接触，并使另一个部分540与相邻侧面550相接触，由此产生大小为90°的方位角。然而如图6所示，如果物体600的形状是六边形，那么可以附着所述标签610，以使标签的一个部分620与一个侧面630相接触，并使另一个部分640与相邻侧面650相接触，由此产生一个大小为120°的方位角。如果该物体是圆形或椭圆形的，那么在RFID标签不会有特定的折叠或皱折，但是该标签仍旧占用了一个以上的平面，这样一来，在将所述标签附着在物体上的时候可以提升读取和/或写入性能。

图7显示的是附在航运货盘上的本发明的多平面RFID标签。该货盘700包括顶部710和底部720，此外还包括多个支架730。多平面RFID标签740附着在其中一个支架上，由此该标签的第一部分750位于支架的一个侧面，而第二部分760则位于支架的另一侧。

所述标签可以附着在物体的外部或内部，此外它也可以嵌入物体的至少一个壁中，在这种情况下，所述标签是通过重叠注塑（overnolding）或内嵌模压到所述壁中而被嵌入在物体的壁内的。该标签可以通过使用任何已知的附着装置来附着，其中包括但不局限于螺丝、铁钉、肘钉或是其

组合之类的机械固定装置，胶水或热溶性粘合剂之类的化学固定装置，或是机械固定装置与化学固定装置的组合。

一旦将多平面RFID标签附着在了物体上，那么本发明还包括一种通过使用多平面RFID标签来追踪该物体的方法。在不同地点之间受到追踪的物体配备了多平面RFID标签，其中该标签具有与物体本身相关联的信息。该信息可以包括以下信息中的一项或多项信息，但是并不局限于此：货物的类型和/或数量，序列号，载荷数量、货盘数量、拣货和/或交付日期和/或时间、拣货和/或交付地点以及任何特定的传输需求，例如温度。

该方法还包括使用RFID读取器或是查询器。RFID查询器可以采用任何适于接收信号的类型。它可以是一个RF接收机；并且它也可以包括用于向无源RFID标签提供查询信号的发射机。此外，查询器还能够传送那些将要保存在RFID标签中的信息。因此，查询器可以提供关于物体移动历史纪录的更新信息。而该方法还可以包括运输车辆，并且所述运输车辆被配置成对RFID标签进行查询。如果使用能够查询RFID标签的运输车辆，那么这种追踪方法将会提供关于特定物体在特定时间的位置的附加信息。

相应的，在本发明的方法中，在所要追踪的一个或多个物体上附着了多平面RFID标签，其中该标签可以附着于外部，也可以附着于内部，还可以嵌入到物体的壁内，其中通过对标签进行定位，可以使该标签占用所追踪的一个或多个物体的一个以上的平面。然后，在整个运输操作过程中，该标签是用不同地点的一系列查询器单元来追踪的。当标签处于某个查询器单元范围以内的时候，该查询单元将会确定存在标签，并且确定标签的标识，此外还会基于与之关联的处理站来记录与物品位置相关的特定处理步骤，其中举例来说，这些处理步骤可以是涉及该物品的接收完成、装配、装运、购买或销售事务。然后，这些处理步骤可以发送到某个数据存储位置。之后，这个数据存储位置则可以通过手动方式或是通过使用中央处理器或计算机来记录这些数据。随后，计算机可以被配置成在标签移动的时候发送涉及相应的每一个标签位置的信息。作为选择，计算机也可以在收到请求的时候执行操作，以便可以检索涉及某个标签的数据。此外，该计算机还可以采用任何有益于追踪物体的方式来进行配置。

通过使用多平面标签，很少会出现数据丢失的情况，由此本发明中的

追踪物体的方法将会更为精确和可靠，从而确保在传输物体的过程中任何指定时刻上都能确定物体的精确位置。

此外，本发明的方法可以使用多个RFID标签来实现。在这个实施例中，这些标签可以是多平面的，但是它们也可以是仅仅占用一个平面的平面RFID标签。通过使用两个或多个平面标签以及将其附着于物体的不同位置，可以将这两个或多个标签定向在不同的平面上，由此可以提高数据恢复的精度，而这将会使用于追踪和运输库存的方法更为有效。

虽然在这里参考附图以及实施例而对本公开的示范性实施例进行了描述，但是应该理解，本公开并不局限于这些明确的实施例，并且本领域技术人员可以在这些实施例中执行其他不同的变化和修改，而不会脱离本公开的实质范围。并且所有这些修改和变化都是包含在附加权利要求所限定的公开范围以内的。

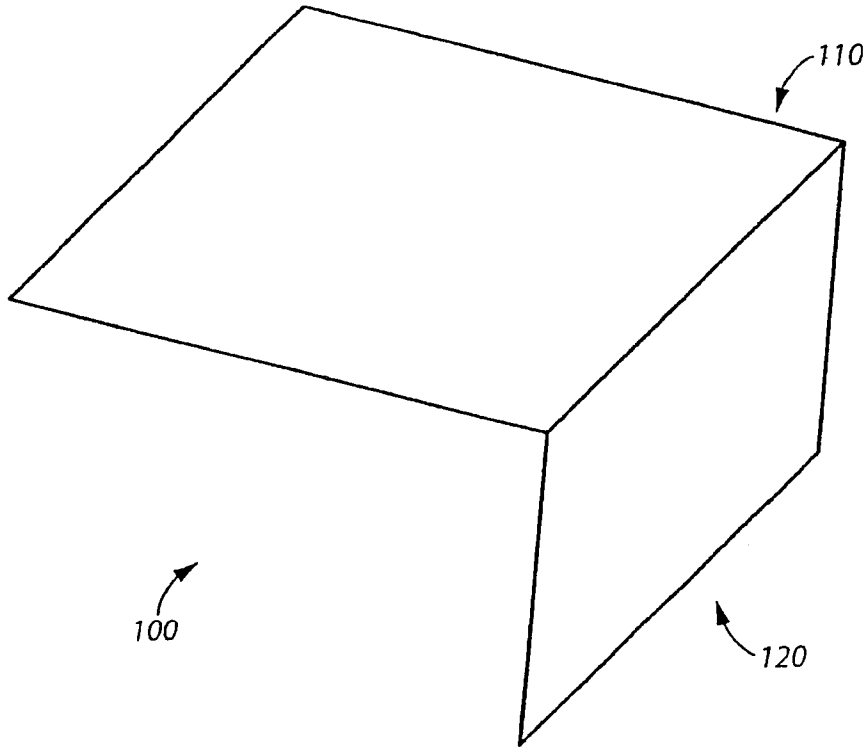


图 1

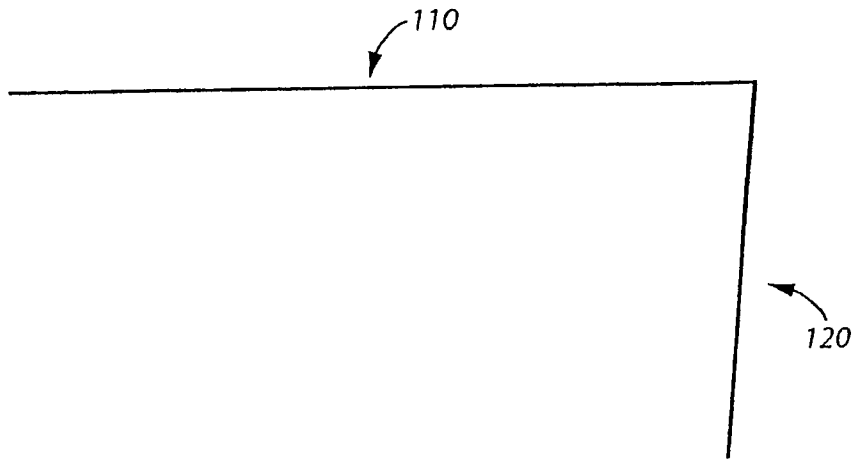


图 2

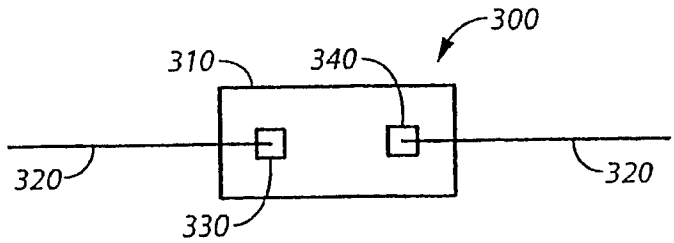


图 3

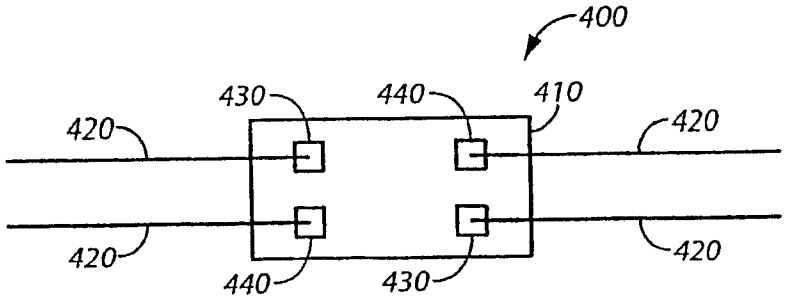


图 4

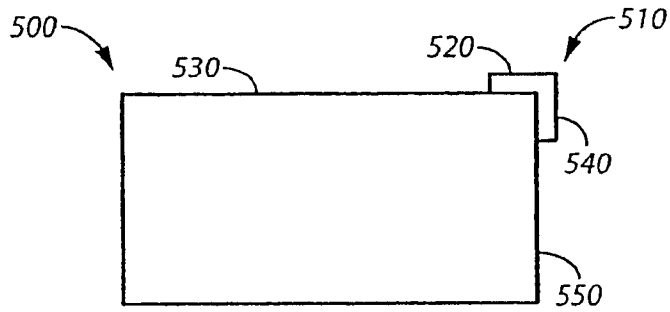


图 5

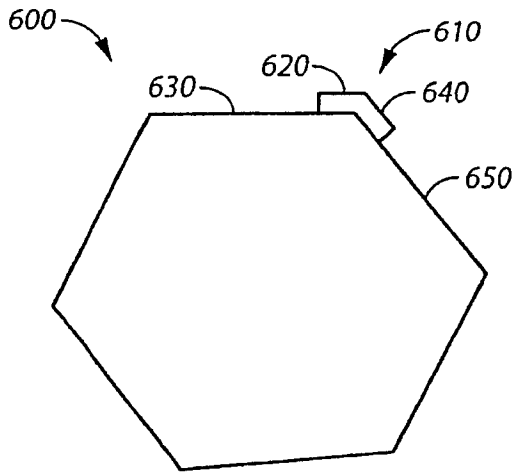


图 6

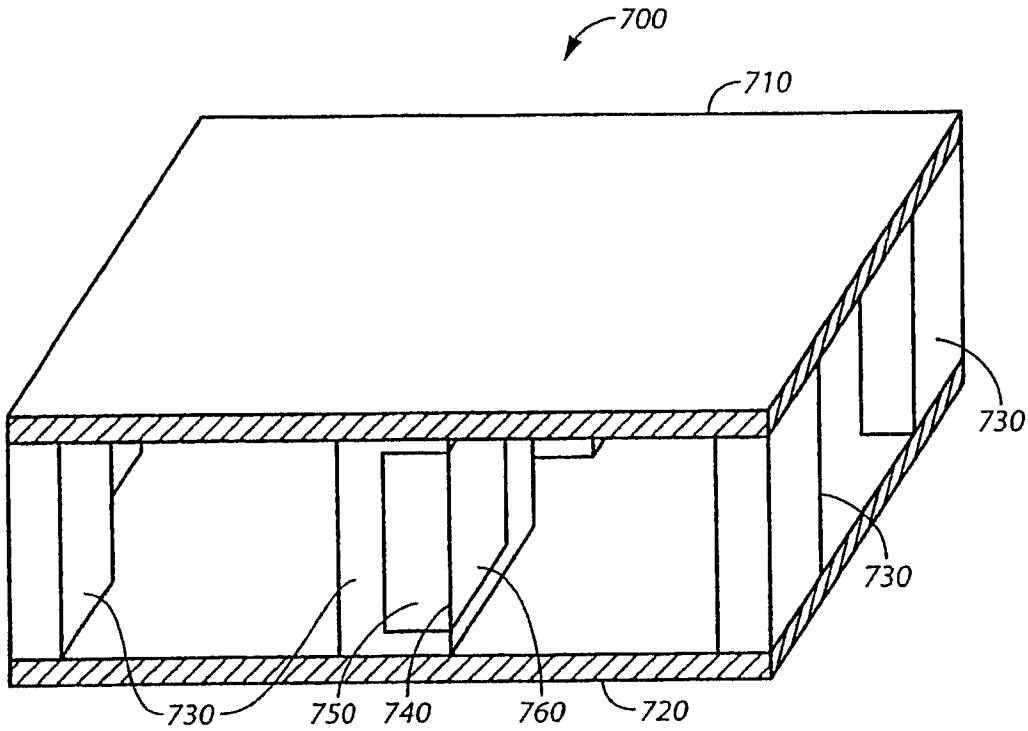


图 7