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(54) Title: CLIMATE CONTROL CARGO CONTAINER FOR STORING, TRANSPORTING AND PRESERVING CARGO

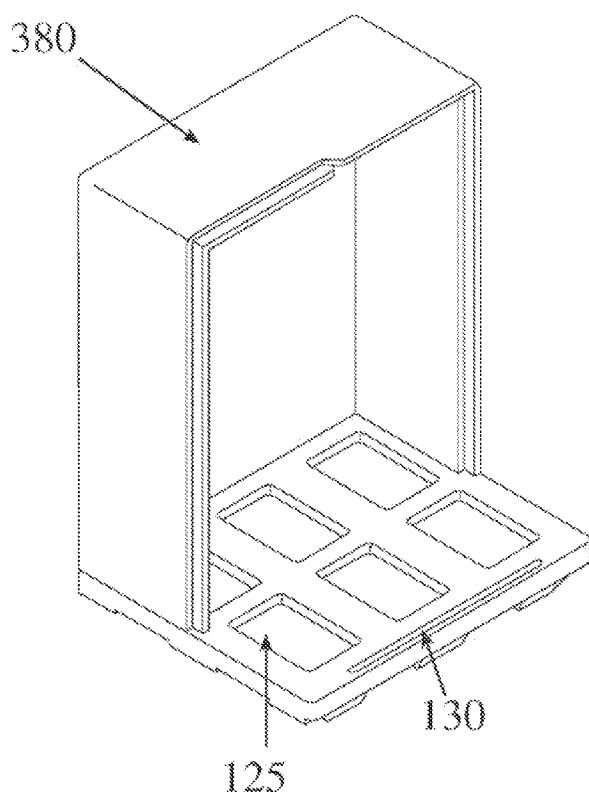


FIG. 3

(57) Abstract: The present invention provides a cargo container that is light weight, strong, which forms an ultra violet light, weather / dust particle barrier and which controls the climate inside the cargo container to protect the integrity of the cargo.



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CLIMATE CONTROL CARGO CONTAINER FOR STORING, TRANSPORTING AND PRESERVING CARGO

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority and benefit of U.S. provisional patent application Ser. No. 61/508,425, filed July 15, 2011, entitled “CLIMATE CONTROL CARGO CONTAINER FOR STORING, TRANSPORTING AND PRESERVING CARGO”; U.S. provisional patent application Ser. No. 61/551,323, filed October 25 2011, entitled “CARGO CONTAINER FOR STORING AND TRANSPORTING CARGO”; U.S. provisional patent application Ser. No. 61/551,340, filed October 25 2011, entitled “A LOAD BEARING STRUCTURE HAVING ANTIMICROBIAL PROPERTIES”; and U.S. provisional patent application Ser. No. 61/590,323, filed January 24, 2012, entitled “SYSTEM FOR FACILITATING SECURITY CHECK OF SHIPMENT OF CARGO”; the contents of all of which are hereby incorporated by reference in their entirety.

[0002] The present application includes claims that may be related to the claims of co-pending United States patent application serial no. 12/xxx,xxx, entitled “CARGO CONTAINER FOR STORING AND TRANSPORTING CARGO”; co-pending United States patent application Ser. No. 12/xxx,xxx, entitled “A LOAD BEARING STRUCTURE HAVING ANTIMICROBIAL PROPERTIES”; and co-pending United States patent application Ser. No. 12/xxx,xxx, entitled “SYSTEM FOR FACILITATING SECURITY CHECK OF SHIPMENT OF CARGO”; the contents of all of which are hereby incorporated by reference in their entirety.

FIELD OF THE INVENTION

[0003] This invention is in the general field of load-bearing structures. A cargo container that is light weight and may be made of a polymer core surrounded by polymer layer to form a load bearing structure and an enclosure to contain the cargo in an acclimatized environment during transportation.

BACKGROUND OF THE INVENTION

[0004] The adoption of International Standardized Phytosanitary Monitoring (ISPM)-15 for wood packaging material (WPM) requires kiln dry treatment of all wood used in shipping crates and dunnage platforms (pallets). The United States in cooperation with Mexico and Canada began enforcement of the ISPM 15 standard on September 16, 2005. The North American Plant Protection Organization (NAPPO) strategy for enhanced enforcement will be

conducted in three phases. Phase 1, September 16, 2005 through January 31, 2006, call for the implementation of an informed compliance via account managers and notices posted in connection with cargo that contains noncompliant WPM. Phase 2, February 01, 2006 through July 04, 2006, calls for rejection of violative crates and pallets through re-exportation from North America. Informed compliance via account managers and notices posted in cargo with other types of non-compliant WPM continues to remain enforce. Phase 3, July 05, 2006, involves full enforcement on all articles of regulated WPM entering North America. Non-compliant regulated WPM will not be allowed to enter the United States. The adoption of ISPM-15 reflects the growing concern among nations approximately wood shipping products enabling the importation of wood-boring insects, including the Asian Long horned Beetle, the Asian Cerambycid Beetle, the Pine Wood Nematode, the Pine Wilt Nematode and the Anoplophora Glapripwnnis.

[0005] Thus the wooden dunnage platform has become unattractive for the international shipment of products. Further, the wooden surface is not sanitary since it potentially can harbor in addition to insects, mould and bacteria. Thus, the wooden crate is ill generally suited for the shipment of foodstuffs and other produce requiring sanitary conditions. In addition, with the concern for carbon emission, lighter weight platforms and containers are more desirable.

[0006] Plastic dunnage platforms or pallets are known, see U.S. Pat. No. 3,915,089 to Nania, and U.S. Pat. No. 6,216,608 to Woods et al., which are herein incorporated by reference in their entirety. Plastic pallet manufacturing techniques typically involve injection molding, which significantly increases the cost of the plastic pallets. In order to justify this initial investment cost of the plastic pallet, the pallet must be extensively re-used. Thus, while the plastic surface of the plastic pallet obviates some of the sanitary problems with wood pallets, because of the required repetitive use the surface can become unsanitary. As a consequence when used for the shipment of foodstuffs and other produce requiring sanitary conditions, the high cost of the plastic pallet requires that the plastic surface be cleaned and kept clean prior to use.

[0007] Some wood pallet manufacturers have attempted to produce a more sanitary surface by combining foam with wooden surfaces. These dunnage platforms still suffer a number of disadvantages including their weight, the presence of wood requiring kiln treatment and the possibility of the foam being stripped away to expose the wood surface.

[0008] Thermoplastic molded dunnage platforms are known. U.S. Pat. Nos. 6,786,992, 7,128,797, 7,927,677, 7,611,596, 7,923,087, and 7,544,262, to Dummett, which is herein

incorporated by reference in its entirety, discloses applying thermoplastic sheets to a preformed rigid structure for manufacturing dunnage platforms.

[0009] U.S. Pat. No. 7,689,481 discloses a dunnage platform bag and system of loading, dispensing and using the bag, which is herein incorporated by reference in its entirety.

[0010] U.S. Pat. No. 7,963,397 discloses a modular knock-down, light weight cargo container, which is herein incorporated by reference in its entirety.

[0011] Omsk is a city at the junction between the northern and southern branches of the Trans-Siberian Railway. Dramatic swings in weather are often experienced with average daily temperatures in July as low as 19 °C. Temperatures in Omsk can reach 45 °C (113 °F) in summer and drop to -45 °C (-49 °F) in winter. In some isolated regions, airport facilities for rapid air cargo transport are often not available.

SUMMARY OF THE INVENTION

[0012] The present invention relates to containers for shipping and/or storage of cargo in which the climate within the container is controlled. Shipping can be by ground or by air.

[0013] In an exemplary embodiment of the invention, cargo being shipped or stored may be damaged by exposure to temperatures that are too low or too high. For example, there is a need to keep the cargo cool when being shipped and/or stored in a hot climate. For another example, there is a need to keep the cargo warm when being shipped and/or stored in a cool or cold climate. There is also a need to keep the cargo in a certain temperature range when being shipped and/or stored alternately in a cool and a warm climate. The temperature change may be due not only to location, but also the time of day, for example, the difference between night and day, or early morning and mid-day or afternoon. In an embodiment of the invention, the cargo container may include materials to provide climate control, for example, gaseous, solid or liquid materials which may cool, melt or becomes gaseous or phase change to control the temperature. In an embodiment of the invention, phase change material(s) are included in the cargo container to keep the contents cool in a hot climate. In another embodiment of the invention, phase change material(s) are included in the cargo container to keep the contents warm in a cool or cold climate. Examples of cargo include food, pharmaceuticals, prescription and off label drugs, electronics equipment, computer parts, batteries and other articles that include chemicals that are temperature sensitive.

[0014] In another exemplary embodiment of the invention, contents of shipments or storage that need to be kept above a certain temperature range, for example, above freezing, the

shipping or storage container may include materials to provide climate control, for example, gaseous, solid or liquid materials which may liquefy, solidify or phase change to keep the contents warm or from getting too cold. This may happen if materials are to be shipped over, for example, trans-Siberian, on a rail system. Examples of contents may include energy storage devices, batteries, electronics, computer parts, electronic circuits, memory storage devices, electronic chips, food stuff, pharmaceuticals and any other articles that need to be kept from getting too cold.

[0015] The container may also be capable of multiple cycles of changes of temperature, for example, from cold to warm and from warm to cold, or from hot to warm and from warm to cold.

[0016] In an embodiment of the invention, a cargo container is disclosed that is light weight, strong, made of insulating thermoplastic polymers and containing phase change materials to protect the cargo from extremes in temperature. In another embodiment of the invention, a cargo container is disclosed that is light weight, strong, made of insulating thermoplastic polymers and containing phase change materials to protect the cargo from temperatures between, for example, -2 °C and -50 °C.

[0017] In another embodiment of the invention, a cargo container is disclosed that is light weight, strong, made of insulating thermoplastic polymers and containing phase change materials to protect the cargo from temperatures between 30 °C and 50 °C.

[0018] In a different embodiment of the invention, a cargo container is disclosed that is light weight, strong, made of insulating thermoplastic polymers and containing phase change materials to protect the cargo from temperatures between -5 °C and 40 °C.

[0019] Phase change materials or combinations of different phase change materials may be suitable for protecting a cargo in a limited confined space over broad ranges of temperatures. A phase change material (PCM), is a substance generally having a high heat of fusion, i.e., when converting from a solid phase to a liquid phase or when converting from a liquid phase to a solid phase at a certain temperature, the PCM may store or release large amounts of energy. the energy released may be in the form of heat absorbed or released. Thus, the PCM may release heat when the material changes from solid to liquid phase in order to keep the interior of the cargo container above the outside ambient temperature.

[0020] Latent heat storage may be achieved through solid-solid, solid-liquid, solid-gas and liquid-gas phase change. A substance exhibiting solid-liquid phase change may be convenient and easy to manage. Liquid-gas phase changes may have a higher heat of transformation than solid-liquid transitions. Typically, liquid-gas phase change transitions are less practical for

use as thermal storage devices as large volumes or high pressures may be required to store the materials. However, when used with cargo containers the volume constraint may be less relevant. Solid-solid phase changes are typically very slow and may also have a rather low heat of transformation.

[0021] For shipment or storage of materials that need to be kept cool during shipping, the solid-liquid PCMs are suitable heat storage materials. As the temperature rises, they absorb heat and when their temperature reaches the temperature at which the change phase occurs (their melting temperature) they absorb large amounts of heat at an almost constant temperature. This process continues without a significant rise in temperature until all the material is transformed to the liquid phase. When the ambient temperature around a liquid material falls, the PCM solidifies, releasing its stored latent heat. Thus, the PCMs not only help to keep the contents of any storage or shipment cool, but may also help to keep the contents from falling below a certain temperature. Thus, PCMs may self-recycle for an almost infinite number of cycles and are advantageous for shipments that may encounter numerous temperature cycles.

[0022] There are numerous PCMs available in a required temperature range from -5°C up to 190°C that may be useful. Within the most common range of 20°C to 30°C , some PCMs are very effective heat storage devices as they may store 5 to 14 times more heat per unit volume than conventional storage materials such as water, masonry or rock.

[0023] Phase change materials with different characteristics may also be used simultaneously in the same cargo container to handle different temperature zone changes while shipping over a long distance. For example, a first phase change material may change phase around freezing temperature while a second phase change material may change phase below freezing temperatures. The containers may also include a third phase change materials that may change phase above freezing temperature.

[0024] The advantages of using PCMs for the present applications are that one may pack into the cargo container PCMs for any temperature requirement needed at various times without any concern that one material will interfere with the function of another. Thus, customization of energy control and temperature regulation is possible.

[0025] The phase change materials may be contained or packed in separate containers, for example, flexible or non-flexible plastic containers or pouches, or metalized containers or pouches, or combinations thereof. The containers may be of any shape and size. Metalized containers may be made of metal or made of plastic containers having metallic coatings for better heat conduction. When used in air freight and if facilitating security check of air cargo

transport of cargo is desirable, containers that are transparent to magnetic scanners, such as non-metal containers, may be used, as further discussed below.

[0026] As phase change materials may perform better in smaller containers, the containers may be further divided into cells or separate smaller containers may be desirable. The cells may be shallow to reduce static head based on the principle of shallow container geometry. That is, the cells may be shallow to minimize pressure exerted by the PCM. The packaging material may be chosen to be an excellent conductor of heat. The packaging material may be durable enough to withstand frequent changes in the PCM volume as phase changes occur. The packaging material may restrict the passage of water through the walls, so the materials will not dry out (or water-out, if the material is hygroscopic) and to resist leakage and corrosion. Common packaging materials showing chemical compatibility with room temperature PCMs include stainless steel, metalized films, polypropylene, polyethylene and other polyolefins, polyesters, combinations and other similar materials to be discussed below. As mentioned above, when used in facilitating security check of air cargo transport of cargo that is transparent to magnetic scanners, non-metal containers may be used.

[0027] The pouches may generally be made of impervious materials, which may include commonly known polymeric materials including polyolefins, such as polyethylene, polypropylene, amorphous polyolefins such as Vestoplast 703.RTM. (Huls), metallocene polyolefins, and the like.

[0028] These containers or pouches of phase change materials may be placed in various places in the cargo container, including the base, top and side walls. They may even be placed in contact with or in close proximity to the cargo item to be protected from temperature changes, inside their packaging, similar to desiccant pouches. The phase change materials in their own packaging may also be arranged in layers. For example, flat, thin pouches may be stacked one on top of another or side by side. The pouches may have PCMs with same or different temperature properties. Thus, the phase change may occur in stages to provide custom protection for the contents being shipped or stored.

[0029] In an embodiment of the present invention, PCMs may be incorporated into the cargo container during construction of the container. In an alternative embodiment of the present invention, PCMs may be incorporated into the cargo container during assembly of the parts of the container.

[0030] In an embodiment of the present invention, customized temperature control may be possible with phase change materials when heat may be absorbed from, or released to, keep the contents of the cargo container within a specified range during transportation.

[0031] When transporting temperature critical cargo items that may be difficult to discern its integrity without subjecting it to partially or substantially destructive testing, somewhat difficult or expensive testing, the cargo item its is own packaging with phase change in contact or in close proximity may also include a critical temperature indicator, which may be used to indicate if the temperature has been reached and thus if the integrity of the cargo item has been breached. The indicator may be presented on the outside of the packaging material.

[0032] For some materials, both temperature and time can be critical. Some indicators may indicate time as well as temperature. Some may even indicate the history of temperature exposure.

[0033] Cargo containers may be of square, polygonal or clam shell shaped. The parts forming the container may include a core and a layer of film or other applied coating material covering the core. Examples of useful containers may include a 'knock down' or collapsible container structure for storage and/or shipping cargo having a base, four load containing structures, for example, four walls, extending therefrom and a top panel to form, for example, a closed enclosure therein, each of which having an inside surface, an outside surface, a width joining the inside and outside surfaces, and four inside edges and four outside edges. The container when collapsed or 'knocked-down' has a foot print not larger than the foot print of the largest individual component of the structure.

[0034] In one embodiment, the container may include those disclosed in U.S. Pat. No. 7,963,397, a modular knock-down, light weight cargo container, which is herein incorporated by reference in its entirety.

[0035] In another embodiment of the invention, each of the base, four walls and top includes a continuous feature extending substantially along a surface no more than approximately 80 percent, of any of the four inside edges of the walls, base and top of each of the components of the container, the features on adjacent members are of opposite interlocking characteristics. That is, if an edge has a groove, the groove is less than 80 per cent of the length of the edge; or each of the base, four walls and top includes a continuous feature extending substantially along a surface no more than approximately 90 percent of any of the four inside edges of the walls, base and top of each of the components of the container, the features on adjacent members are of opposite interlocking characteristics. That is, if an edge has a groove, the groove is less than 90 per cent of the length of the edge.

[0036] Some components of the container may include dunnage platforms and those useful for assembling may include interconnecting or interlocking features or characteristics which mate together to form a container.

[0037] Interlocking or interconnecting features or characteristics may also be defined as a depression in a wall of a container corresponding to a protrusion in the cargo such that the container 'mates' with the cargo without requiring a fastener. Interlocking characteristics may include respective depression and protrusion features on adjacent connecting components. For example, when the features along one side have a receiving characteristic, the features on the adjacent member are of a protruding characteristic so that the interlocking features mate to form a container without any aid from additional clips or fasteners. The phrase 'without requiring a fastener' means that the interlocking features are interlocked without the aid of any component that is not the base, the four walls or the top. Additional securing devices may be employed to insure further integrity of the container, if needed, and such additional securing devices may include straps and/or shrink wrap packaging. The shrink wrap process may also aid in protecting the integrity of the content from tampering, further aiding to facilitate the security checking process, if desired.

[0038] According to one embodiment, each of the walls, top and base of the container described above may be made of a light weight core substantially covered with a polymeric layer, for example, a high impact sheet or coating on at least one of its surfaces to form a load bearing structure having a width as noted above. According to another embodiment, a structural metal mesh may be inserted into the core to resist piercing of the surface, when not intended to be used in facilitating security check. According to a further embodiment, one or more of the walls, top and base portions may be made by injecting a polymer into a mold to form the core and after removing the core from the mold spraying a polymer coating on the polymer core. For example, liquid polyurethane may be injected into a mold to form a polyurethane core containing grooves, protrusions and/or pockets, for example, for locating phase change materials, which after curing is removed from the mold and sprayed with polyurea to form one or more of the load bearing structures. Using this molding process, size and shape may be easily varied.

[0039] In yet another embodiment of the invention, the container may include two halves, each having a substantially L-shaped cross-section. In one embodiment of the invention, the container may include two identical or mirror images L-shaped cross-section halves each having at least two walls and a base or top component, each of the components having corresponding interlocking features to be mated together to form a container having for example, a closed enclosure therein.

[0040] In still another embodiment of the invention, the container includes two halves, such as clam shell halves, in mirror images, each having at least two walls and a base or top

component, each of the components having corresponding interlocking features to be mated together to form a container having for example, a closed enclosure therein. Each of the halves having an inner surface and an outer surface joined by a width.

[0041] The footprint of the knock-down or collapsed container is not larger than the footprint of each of the L-shaped halves or clam shell halves.

[0042] According to one embodiment, each half is made of an inner light weight core covered by at least one layer of strengthened coating. According to another embodiment, a structural metal mesh may be inserted into the core to resist piercing of the surface. According to a further embodiment, one or more of the L-shaped or clam shell halves may be made by injecting a polymer into a mold to form the core and after removing the core from the mold, spraying a polymer coating on the polymer core. For example, liquid polyurethane may be injected into a mold to form a polyurethane core containing grooves, protrusions and/or pockets which after curing may be removed from the mold and sprayed with polyurea to form one or more of the load bearing structure and the half enclosures. The interlocking features may include respective depression and protrusion features on adjacent connecting components.

[0001] In one exemplary embodiment, containers for shipping and/or storage of cargo may have one or more antimicrobial agents to afford antimicrobial properties. The antimicrobial agents may be present on any exposed surfaces of the containers and/or any additional structures. The agents are capable of eliminating, preventing, retarding or minimizing the growth of microbes and also minimizing cross-contamination when the structure is being reused for cargos that are different from previous cargo, for example, different food types, such as poultry, fresh vegetables, and fresh fruits.

[0002] In another exemplary embodiment, the cargo container is a modular, lightweight, strong, container that may be used for facilitating security check of air freight cargo for shipping at the airport.

[0003] In further exemplary embodiment, the cargo container is a modular, lightweight, strong, container that may be in clean rooms for the manufacturing of electronic parts, snacks, food products or similar products that have to be kept clean from dust, dirt or microbes. The products are placed directly on the structure after having been made, thus eliminating steps, saving time, minimizing manpower or robotics, and/or risk of contamination or damage.

[0043] In any of the embodiments, the antimicrobial properties, if present, may be generated from materials including chemical anti-microbial materials or compounds that are capable of

being substantially permanently bonded, at least for a period such as the useful life of the load bearing structures, or maintain their anti-microbial effects when coated with the aid of coating agents, onto the exposed surfaces of the container, either when at least one antimicrobial agent is added to the material used for making the polymeric layer, for example, a sheet or sprayed coating mentioned above, or when at least one antimicrobial agent having some surface activity is coated onto the exposed surface of the polymeric layer, for example, sheet or sprayed coating mentioned above; or maintain their anti-microbial effects when at least one antimicrobial agent is coated with the aid of coating agents, onto the exposed surface of the polymeric layer, for example, sheet or sprayed coating mentioned above. In one example, the chemicals may be deposited on the surface of the loading bearing structures by covalent linkage.

[0044] In an embodiment of the present invention, the contents may be surrounded by traditional insulating materials. In another embodiment of the present invention, the outside of the cargo container may be sealed to isolate the cargo container from the outside atmosphere. In a different embodiment of the present invention, styrofoam may be packed around the outside of the container prior to sealing the cargo container. In a further embodiment of the present invention, two or more enclosures may be used to insulate the container interior with additional PCMs inside each enclosure. In yet a further embodiment, a bag-like enclosure may also be used, to be further discussed below.

[0045] In addition to climate control concerns, shipping by air has additional concerns. Though the time cargos spent in air flight is shorter than other forms of transportation, like passengers and their luggage, need to go through airport security before boarding, the airfreight shipments also has to undergo security scans. Some shippers and loaders have been certified to scan cargo at the airport prior to loading onto an airplane. The large X-ray scanners are expensive and bulky. Smaller scanners are less expensive, but the cargo packed on them need to be unload or unpack to utilize such smaller scanners. Thus, cargo going through security check can be cumbersome and time consuming. In addition to time and manpower cost, some cargo may sustained damage and/or be misplaced. With perishables, time and disturbances such as loading and unloading may increase the possibility of damage. Thus, to facilitate security check, containers used in shipping cargo and for containing the phase change material may also be made of material that is transparent to the scanners.

[0046] The present invention also discloses a system designed to facilitate the security checking process, including a light weight load bearing structure for loading perishable or non-perishable cargo, the load bearing structure having a top deck, a bottom deck and a width joining

the top and the bottom, the bottom deck having a plurality of legs extending therefrom and the cargo is loaded onto the top deck of the load bearing structure; and a bag-like enclosure for covering the cargo and at least a portion of the width of the load bearing structure, with the bag-like enclosure having an opening with an elastic property about its circumference for stretching about the width of the load bearing structure. The load bearing structure and bag-like enclosure in this configuration are both transparent to magnetic imaging scanners used in security scanning to facilitate the security check of perishable cargo or non-perishable cargo, large or small, without the need for unloading and reloading of the cargo from the load bearing structure.

[0047] The package may be tagged with identification tags, similar to those used in transporting passenger check-in bags, or it may also be tagged with an RFID tags. In an embodiment of the invention, RFID tags may be inserted into the core during formation of the core, or prior to coating the core with the thermoplastic layer. In another embodiment of the invention, RFID tags may be inserted both into the core and placed on the bag-like enclosure to insure the integrity of the cargo. This may further improve the security of the cargo. In a further embodiment, the RFID tags may be inserted into the core, placed on the bag-like enclosure and/or the shrink wrap, if present, to insure the integrity of the cargo.

[0047] Other embodiments of the cargo container and methods for its use, within the spirit and scope of the invention, may be understood by a review of the specification, the claims, and the figures.

BRIEF DESCRIPTION OF THE FIGURES

[0048] FIG. 1A shows a line drawing of FIG. 1C the cargo carrier dunnage platform with pockets for locating phase change materials and FIG. 1B a line drawing of in profile, according to an embodiment of the invention;

[0049] FIG. 2 shows a line drawing of the underneath side of the cargo carrier dunnage platform 2A with legs protruding and 2B in profile, according to an embodiment of the invention;

[0050] FIG. 3 shows a line drawing of the empty cargo carrier dunnage platform with a half enclosure positioned on the cargo carrier dunnage platform, according to an embodiment of the invention;

[0051] FIG. 3A shows a line drawing of the cargo carrier dunnage platform of FIG. 3B with phase change material containers positioned in pockets;

[0052]FIG. 4 shows a line drawing of the loaded cargo carrier dunnage platform with a half enclosure positioned on the cargo carrier dunnage platform, according to an embodiment of the invention; and

[0053]FIG. 5A shows a line drawing of 5B the fully enclosed cargo carrier dunnage platform with the enclosure positioned on the cargo carrier dunnage platform, according to an embodiment of the invention.

[0054]FIG. 6 shows an L-shaped half of an embodiment of the container having features for locating cargo or partitions;

[0055]FIG. 6A show a full view of the inside bottom of an embodiment of the container of the present invention having features for locating cargo or partitions;

[0056]FIG. 7 shows fully assembled container of an embodiment of the present invention;

[0057]FIG. 7A shows an L-shaped half of an embodiment of the container having features for locating cargo;

[0058]FIGs. 8A-E show another embodiment of a container of the present invention in various stages of assembly, depicting the interconnecting features;

[0059]FIG. 9 shows a line drawing of the empty cargo carrier dunnage platform with a half enclosure positioned on the cargo carrier dunnage platform, according to another embodiment of the invention; and

[0060]FIGs. 10 and 10A show the embodiment of the present invention with an additional enclosure in various stages of being installed.

DETAILED DESCRIPTION OF THE INVENTION

[0061]The detailed description set forth below is intended as a description of the presently exemplified embodiments of the present invention and is not intended to represent the only forms in which the present invention may be prepared or utilized. The description sets forth the features and the steps for practicing the present invention. However, it is to be understood that the same or equivalent functions and components may be accomplished by different embodiments that are also intended to be encompassed within the spirit and scope of the invention.

[0062]Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs. Although any methods, devices and materials similar or equivalent to those

described herein may be used in the practice or testing of the invention, the exemplified methods, devices and materials are now described.

[0063] A load bearing structure is an article designed to store or transport a load and may include a dunnage platform or pallet.

[0004] An enclosure is an article designed to enclose a cargo loaded onto a load bearing structure so that the cargo container interior may be isolated from the cargo container exterior. The enclosure may be made up of two half enclosures (as in clam shells) or multiple components, as shown in FIG. 3 or 6, or multiple panels such as multiple dunnage platforms, as shown in FIG. 8C.

[0064] Approximately when used with temperatures expressed to one significant figure can include a range between + and – two (2) degrees. Approximately when used with temperatures expressed to two significant figure can include a range between + and – five (5) degrees. Approximately when used with specific heats expressed to two significant figure can include a range between + and – zero point two (0.2). The containers may be suitable for storage or transporting of food, pharmaceuticals, prescription and off label drugs, electronics equipment, computer parts, batteries and other articles that include chemicals that are or are not temperature sensitive.

[0065] Climate control is used to describe the use of chemical and/or physical properties of substances to alter the atmosphere inside the cargo container relative to the atmosphere outside the cargo container.

[0066] The enclosure may be an undivided compartment, as shown in FIG. 8, or may be divided into multiple compartments (not specifically shown), each compartment may be suitable for storage or transport of cargos with different characteristics. In one aspect, one compartment may have climate control while the rest of the compartment may not. In another aspect, one compartment may be padded for extra shock protection while the rest may not. In yet another aspect, a compartment may be sized for a specific article while another compartment may be sized for a different article. In general, any of the exposed surfaces may have anti-microbial properties.

[0067] In an embodiment of the invention, the cargo container may be a modular, lightweight, strong container that may include any or all of the properties stated below: ultra violet light insulating, tamper resistant, receptacle for insulating, preserving, facilitating security check, or tracking and transporting cargo. In an embodiment of the invention, the cargo container may be a modular, lightweight, strong, ultra violet light insulating, tamper resistant load bearing structure with enclosure for insulating, preserving, tracking and transporting cargo.

In one embodiment of the invention, the cargo container is a modular, lightweight, strong, container that may be ultra violet light insulating, tamper resistant dunnage platform with enclosure for insulating, preserving, tracking and transporting cargo. These cargo containers may include two halves or plurality of dunnage platforms or load bearing structures, as shown in the figures, for example, FIGS. 3, 6 and 9.

[0068] FIGs. 1-5 depict embodiments of the cargo carrier in which a loading bearing structure, such as a dunnage platform with pockets for locating phase change materials is integrally attached to an enclosure to seal and preserve the cargo. In FIG. 1A and C a dunnage platform 100 is shown with a top surface 115 and edges 110. The top surface 115 is used to denote both a polymeric layer or sheet or just the top surface of the core without a polymeric layer or sheet. The dunnage platform 100 shown in FIG. 1A has six (6) pockets 125 and two (2) grooves or recesses 130 penetrating the top surface 115, each of which may extend into the core (not shown) of the dunnage platform. In an embodiment of the invention, the pockets 125 may be used to locate phase change materials. In an embodiment of the invention, the grooves or recesses 130 are used to locate one or more enclosures. In FIG. 1B the profile of the dunnage platform 100 is shown where legs 145, 150 and 155 extend from the bottom surface 170 of the dunnage platform 100. In FIG. 2A the underneath of the dunnage platform 100 is shown where legs 145, 150, 155, 240, 245, 250, 255, 260 and 265 extend from the bottom surface 170 and together with the edge of dunnage platform 110 make up the height of the dunnage platform 100.

[0069] The load bearing structures may also include a plurality of wear resistant members that may be affixed to the second side of at least some of the legs of all of the embodiments of loading bearing structures described herein. Details of the wear resistant members may be found in U.S. Patent No. 7,908,979, and 5,868,080, the contents of all of which are hereby incorporated by reference.

[0070] These wear resistant members may be similar to bridges that extend between adjacent legs. In some embodiments, only one of these members may be present. In other embodiments, two of these may be arranged in the shape of a cross. In further embodiments, one of each may be attached to each pair of adjacent legs around the peripheral of the load bearing structure. In still other embodiments, they may be attached to every pair of legs of the load bearing structure.

[0071] In FIG. 2B, the profile of the dunnage platform 100 is shown where legs 145, 150 and 155 extend from the bottom surface 170 of the dunnage platform 100. In FIG. 3 a first half enclosure 380 is located on the dunnage platform using the groove or recess 130, where the

pockets for locating the phase change material 125 are located interior to the first half enclosure 380. The half enclosure 380 has a corresponding feature to mate with the groove or recess 130. FIGs. 3A (a line drawing of 3B) and B show the cargo carrier dunnage platform with phase change material containers or pouches 125a positioned in pockets 125 and a half enclosure positioned on the cargo carrier dunnage platform, according to an embodiment of the invention. These containers or pouches are shown here in substantially rectangular form, but they may be in other forms. Also, the pouches may be located in other locations inside the cargo container including in contact or in close proximity to the cargo item to be protected from temperature changes, or inside the packaging of the cargo item, similar to placement of desiccant pouches. As mentioned before, the thinner and/or smaller the pouches for containing phase change materials, the better the effects exhibited by the phase change materials.

[0072]Phase change materials may include organic materials, inorganic materials, their acids and their salts. Organic materials have their own advantages and disadvantages. Of the organic PCMs, most may be exposed to air, have wider ranges of melting temperatures. However, organic PCMs may be flammable, combustible and may have lower specific heat. Inorganic materials also have their own advantages and disadvantages. Inorganic salts often may have to be enclosed or encapsulated to prevent or minimize water evaporation or uptake. Inorganic PCMs generally have higher specific heats than organic PCMs. Combining organic PCMs and inorganic PCM may have advantages for certain applications. If the phase change materials are correctly utilized, some of the disadvantages may become an advantage for certain applications.

[0073]Both organic PCMs and inorganic PCMs may be used in their pure form, combined or may be formulated with other substances to expand the usefulness over extreme temperature ranges.

[0074]Common organic PCMs include paraffin waxes, 2,2-dimethyl-n-docosane ($C_{24}H_{50}$), trimyristin, $((C_{13}H_{27}COO)_3C_3H_3)$, 1,3-methyl pentacosane ($C_{26}H_{54}$), other polyethylene waxes, ethylene-bis-stearamide, N,N-ethylene-bis-stearamide, which may be used alone or in mixtures thereof. Common inorganic PCMs include anhydrous sodium acetate, sodium acetate solutions, hydrated salts including sodium hydrogen phosphate dodecahydrate ($Na_2HPO_4 \cdot 12 H_2O$), sodium sulfate decahydrate ($Na_2SO_4 \cdot 10H_2O$), ferric chloride hexahydrate ($FeCl_3 \cdot 6 H_2O$), TH29 (a hydrated salt having a melting temperature of 29 °C, available from TEAP Energy of Wangara, Australia), Sodium Sulfate Decahydrate, which

may be used alone or in mixtures thereof. Other inorganic PCMs include metallic alloys, such as Ostalloy 117 or UM47 (available from Umicore Electro-Optic Materials).

[0075]The most commonly used PCMs are salt hydrates, fatty acids and esters, various paraffins (such as octadecane), though ionic liquids may be possible.

[0076]Eutectic or near eutectic mixtures may be formed. Examples include salt solutions, ethylene diamine mixed with a noncorrosive material or materials such as dimethyl sulfoxide and/or dimethyl sulfone and/or H₂O, and/or paraffin mixed with detergent (to permit the paraffin to dissolve in the ethylene diamine), and/or phenyl salicylate, and ethylene diamine solutions in dimethyl sulfone (DMSO). Some of these mixtures may have melting temperatures below approximately 5 °C to approximately -23 °C. More details may be found in U.S. Patent No. 4,719,028, the contents of which is hereby expressly incorporated by reference in its entirety.

[0077]In an embodiment of the invention, PCMs suitable for keeping contents cool may be solids at ambient temperature, having melting points between approximately 30°C and approximately 50°C. Further, eutectic or near eutectic mixtures may be formed.

[0078]In an embodiment of the invention, PCMs suitable for keeping contents cool may be solids at ambient temperature, having melting points between approximately 35°C and approximately 45°C. Other examples, such as those solids with a low melting point, for example, freeze salts may be suitable for keeping contents from being subjected to temperatures that are too cold for the content and/or from freezing.

[0079]In general, a higher specific heat may be advantageous, for example, a specific heat of at least approximately 1.5. In an embodiment of the invention, PCMs for keeping contents cool may have a high specific heat, for example, at least approximately 1.7. In an embodiment of the invention, PCMs, when they are in the state at ambient temperature, may have a specific heat at least approximately 1.9. In an embodiment of the invention, PCMs, when they are in the state at the elevated temperatures may have a specific heat of at least approximately 1.6.

[0080]In an embodiment of the invention, PCMs with a high specific heat may also be advantageous for keeping the contents from being too cold and/or from freezing.

[0081]In general, small volume changes on phase transformation and low vapor pressure changes at operating temperatures to reduce the containment problem may also be advantageous.

[0082]Phase change materials present many suitable options for customized climate control. For each application, a material, a mixture of materials or a formulated material having the

desired melting temperature range in the desired operating temperature range may be chosen along with other desirable properties.

[0083]In addition to containment of phase change materials as previously discussed, encapsulation of PCMs may also be possible, not only for containment, but for increased flexibility and property improvement. For example, micro-encapsulation may allow PCMs to be incorporated into construction materials. Micro-encapsulated PCMs includes coating a microscopic sized PCM with a protective coating. In this form, inorganic PCMs may be transformed into material that may be exposed to air or water, or be transformed from being hygroscopic to non-hygroscopic. Molecular-encapsulation is another technology, developed by Dupont de Nemours that may enclose a very high concentration of PCM within a polymer compound. Molecular-encapsulation allows drilling and cutting through the material without any PCM leakage.

[0084]As noted above, combinations of phase change materials (PCMs) and other (usually solid) structures are generally possible. In an embodiment of the invention, metallic alloys, may be better thermal conductors than other phase change materials even though their heat of fusion are low. Thus a mixture of a metallic alloy with one or more of the other inorganic or organic phase change materials may be used to increase heat conductivity within the phase change material. A simple example is a copper-mesh immersed in a paraffin-wax. The copper-mesh within paraffin-wax may be considered a composite material. Such a composite also adds increased thermal conductivity to the PCMs. Such composites may include using fiber-glass or kevlar-pre-preg and a matrix. The matrix may be any adhesive which may solidify to hold fibers together and provide compressive strength. For use in facilitating security check, metallic materials are not included.

[0085]In an embodiment of the present invention, the PCM material, either in pure form, in mixtures, or in encapsulated form may be held in the cargo container. In an embodiment of the present invention, the PCM material may be included in compartments in the foam used for the construction of the container, similar to that as shown in FIG. 1, where the structure is the core prior to any coating or combination with a layer or sheet material. In an embodiment of the present invention, the PCM material may be added to the foam used for the construction of the container.

[0086]Some of the phase change materials mentioned above may be recyclable in that they may undergo phase changes for an almost infinite number of times. Others may be more endothermic agents and thus may have a limited life cycle unless handled under a controlled environment. These endothermic agents may lose their effectiveness as a phase change

material even when handled under a controlled environment. In an embodiment of the present invention, even the limited life cycle PCM may be useful for cargo containers.

[0087]In other embodiments, phase change materials themselves, whether in pure form, encapsulated, or in combinations of different phase change material, may be enclosed in small and/or thin containers or pouches, as noted above. Separate containers, for example, flexible or non-flexible plastic containers or pouches, or metalized containers or pouches, or combinations, may be used for each phase change material or for combinations of different phase change materials thereof. The containers may be of any shape and size. Metalized containers may be made of metal or made of plastic containers having metallic coatings for better heat conduction. When used in air freight and if facilitating security check of air cargo transport of cargo is desirable, containers that are transparent to magnetic scanners, such as non-metal containers, may be used.

[0088]These containers or pouches are generally of shallow design, each of which may be further divided into cells. The cells may again be shallow to reduce static head based on the principle of shallow container geometry, as mentioned before. These small cells may be present in various parts of the cargo container 500, 600 or 800, as discussed above in various FIGS, as discussed above. They may also be placed next to any items of the cargo or in a form to conform with the shape and size of the cargo item, as noted above concerning customization. When present in such forms, heat conductivity of the sheet or film materials for making the cells may not also be as important as for larger containers or pouches. Cargo items in contact or in close proximity with small pouches having phase change materials may further be enclosed with moisture permeable or breathable material. Examples of packaging materials that are breathable to allow vapor transmission may be found in U.S. Patent no. 7,405,009, the contents of which are incorporated hereby by reference in its entirety. Another example of the material may be a multicomponent film structure, such as that disclosed in U.S. Patent no. 5,447,783, or a non-woven fabric laminate, such as that disclosed in U.S. Patent No. 5,482,765, or a breathable film layer as disclosed in 6,432,547, the contents of which are hereby incorporated by reference in its entirety.

[0089]For example, as disclosed in U.S. Patent no. 7,405,009 discloses a film of ethylene copolymer, such as ethylene vinyl acetate copolymer, ethylene n-butylacrylate carbon monoxide copolymer, ethylene vinyl acetate carbon monoxide copolymer, and combinations thereof, exhibits a good moisture vapor transmission rate.

[0090]Biodegradable, breathable material may also be useful and example is disclosed in U.S. patent no. 7,910,645, the contents of all of which are hereby incorporated by reference in their entirety. These packaging containers are also amenable to facilitating security check.

[0091]In an embodiment of the invention, PCMs are combined with hygroscopic substances to control the humidity in the container. Examples of hygroscopic materials include calcium chloride, zinc chloride, potassium hydroxide, sodium hydroxide, sodium chloride, sodium iodide, and anhydrous copper sulfate.

[0092]PCMs and hygroscopic substances may be enclosed in flexible plastic enclosures. In various embodiments of the invention, the flexible plastic enclosures are made of one or more materials similar to the imperious materials mentioned above. The plastic enclosures may also be selected from the group consisting of cellulose film, polyvinyl chloride film, polyvinylidene chloride film, low density polyethylene film, linear low density polyethylene film and copolymer films that include polyisobutene and/or polyethylene-vinylacetate.

[0093]FIG. 4 shows the cargo 490 loaded on the dunnage platform with the first half enclosure 380 located using the groove or recess 130. In FIG. 5 and 5B the cargo is enclosed using a second half enclosure 380 located on the dunnage platform using the groove or recess 130 to form the cargo container 500. In an embodiment of the invention, the first half enclosure and the second half enclosure are identical and may be interchanged by rotating by 180 degrees around a central axis perpendicular to the plane of the dunnage platform and are therefore described as symmetrical.

[0094]In various embodiments of the invention described above or below, a cargo carrier 100 includes an enclosure with pockets 125 for locating phase change materials which is integrally attached to a dunnage platform 100. In an embodiment of the invention, the dimensions of the dunnage platform 100 may be approximately 1319 mm x 1116 mm x 165 mm. In an embodiment of the invention, the exterior dimensions of the enclosure may be approximately 380, 583 are 1319 mm x 1116 mm x 1574 mm. In an embodiment of the invention, the interior dimensions of the enclosure may be approximately 380, 583 may be approximately 1219 mm x 1016 mm x 1524 mm. In various embodiments of the invention, it will be understood by persons having skill in the art that the use of the term ‘approximately’ when used together with dimensions that indicate a range may vary by up to 50% of the range and the above measurements are only given as an example. Many other dimensions for custom-fitting cargo items may be used.

[0095]In an embodiment of the invention, a corresponding protrusion (not specifically shown here, but similar to 841 in FIG. 8b) extending from a first or a second enclosure 380, 585, as

shown in FIG. 5, may be inserted into a groove or recess 130 in a dunnage platform surface 115 to locate the enclosure 380, 585 on the dunnage platform 100. In an embodiment of the invention, a clasp (not shown) may be used to insure the integrity of the connection between the first and second enclosure 380, 585. In an embodiment of the invention the groove or recess 130 may be approximately 902 mm x 32 mm x 20 mm. In an embodiment of the invention, a mesh, a sheet or a barrier associated with a protrusion may be inserted in the groove or recess of the dunnage platform 130 and a key may pass through a hole in the dunnage platform core (not shown) to lock and/or retain the enclosure 380, 585 onto the dunnage platform 100. In an embodiment of the invention, the protrusion may pass thru a mesh, a sheet or a barrier inserted in the core of the dunnage platform and a key may pass through a hole in the dunnage platform core (not shown) to lock and/or retain the enclosure 380, 585 on the dunnage platform 100. In an embodiment of the invention, a clasp may be fixed on the outside of the enclosure or connect with straps encircling the cargo container. In one embodiment of the invention, the clasp may connect with a mesh, a sheet or a barrier inserted in the core of the first or second enclosure 380, 585. The clasp may then be fixed on the outside of the second or first enclosure 585, 380 or connect with straps encircling the cargo container.

[0096] According to one embodiment, the container 500, 600 or 800 may include an enclosure having one undivided internal compartment, as shown in FIG. 3, 6, 8C or 8E. According to another embodiment, the container 500, 600 or 800, may include an enclosure having more than one internal compartment, not specifically shown. In one aspect, the interior may have dividers molded into the side of the component structures (not specifically shown). In another aspect, the dividers may be added to the container 500, 600 or 800 to form separate compartments. Features 612 or 622, as shown in FIGs. 6, 6A and 7A, may be present or molded into the components of the container 600 to allow for placement of dividers to adjust the size of the compartments.

[0097] FIG. 6, 6A and 7 show embodiments of an L-shaped half of a container 600, which may generally have, for example, a substantially L-shaped cross-section, having a channel or groove, 130, molded or formed on the various sides. Slots 612 or 622 are molded or formed on the interior of all side, base or top components, 610 or 620 of FIGs. 6, 6A and 7A, for attaching dividers (not shown) to create various compartments inside the enclosure, or for attaching shaped features 700 for resting cargo, as shown in FIG. 7A. In one embodiment, the slots 612 or 622, may be formed or molded in fixed distance apart, as shown in FIGs. 6, 6A and 7A, so that same size or multiples of one size compartments may be formed. In another

embodiment, slots 612 or 622 may be formed or molded in varied distance apart (not specifically shown), so that different size compartments may be formed which may or may not be multiples of one size. In one aspect, the slots 612 or 622 are formed at corresponding positions on the inside surfaces of the side, top or bottom components to form compartments that are either substantially parallel to the horizontal or vertical. In another aspect, the slots 612 or 622 are formed at an angle with respect to the horizontal or vertical. These slots may be used to locate cargo items to be protected from temperature changes inside their own packaging and may include pouches of PCMs in contact or in close proximity with cargo items.

[0098] According to one embodiment, features 700 may be formed or molded into the components of the container, 500, 600 or 800, as shown in FIGs. 5A, 7 and 8, for placement of cargo or placement of other components for more secure location of cargo. For multi-compartment containers 500, 600 or 800, the phase change material may be present in one or more of the compartments in the shipping container 500, 600 or 800, or it may be present with the cargo and the container 500, 600 or 800.

[0099] The containers 500, 600 or 800, as shown in FIGs. 5A, 7 and 8, may also be made of the size and shape to accommodate the cargo, or the cargo may be contained in its own packaging and then inserted into the container 380 or 600, as shown in FIGs. 4 and 6, as noted above.

[00100] FIG. 7 shows a closed container 600 by mating two substantially L-shaped cross-sectional halves, such as that shown in FIG. 6 or 7A, similar to FIG. 5. The substantially L-shaped cross-sectional halves may be mirror images or may be identical if turn 180°, as noted above.

[00101] In one embodiment, the enclosure may also be made up of a knock down or collapsible container 800 for storage and/or shipping, as also in FIG. 8, having a base, four walls extending therefrom and a top panel to form an enclosure therein, each of which having an inside surface, an outside surface, a width joining the inside and outside surfaces, and four inside edges and four outside edges, as shown in FIG. 8D.

[00102] FIG. 8 illustrates a perspective view of an assembled container 800 which may generally include a base 812, side pieces 801, 802, 803 and 804, and a top 816. In general, the container 800 may be assembled into the form illustrated in FIG. 8 without the use of adhesives, fasteners and/or other assembly aids and may substantially assemble in a predetermined fashion and retain the illustrated form. In one embodiment, as shown in FIG. 8A, the base 812 may generally be rectangular and may include a plurality of channels or

grooves 831, 832, 833 and 834, each adjacent to an edge of the base 812. The grooves 831, 832, 833 and 834 may each terminate at a corner which is substantially open to the edge, as shown with corners 812a, b, c and d, such that the grooves are open at least one end to insert a side piece. The corners 812a, b, c and d may also include a closed edge which may thus act as a stop such that, for example, a side piece(s) may abut against the closed edge of the corner and be substantially retained and prevented from advancing beyond the corner. As illustrated in FIG. 8B, a side piece, such as side piece 801, may include a corresponding ridge 841, which may slide into and be retained in a corresponding groove, such as groove 831 as illustrated. The side pieces, such as illustrated with side piece 801, may further include a ridge 841a opposite ridge 841 which may correspond and be retained in a corresponding groove of the top 816.

[00103] In general, the side pieces 801, 802, 803 and 804 may include edges orthogonal to ridges which correspond to the grooves of the top 816 and base 812, as illustrated in the top view of the container 800 in FIG. 8C. In general, the orthogonal edges may mate to each other with interlocking connections, as illustrated with connections 853, 854 and 855. In general, to assemble the container 800, for example, the side piece 804 may be inserted into the groove 834, followed by side piece 803 in groove 833, side piece 802 in groove 832 and then side piece 801 in groove 831. Side pieces 801 and 802 may include a non-interlocking junction, as illustrated with abutting edges 851 and 852, such that side piece 801 may be inserted without interference from a protruding piece. The top 816 as illustrated in FIG. 8D, which may include grooves 833a, b, c and d, which may correspond to ridges 842a, b, c and d of the side pieces, respectively, may then be placed such that the corresponding ridges fit into the grooves of the top 816, closing the container 800. The top 816 may also, for example, be placed before all of the side pieces are placed, such as illustrated in FIG. 8E. The side pieces, such as side piece 801 as illustrated in FIG. 8E, may also include handling features, such as the handle depressions 801d, such that the side pieces may be manipulated with greater ease.

[00104] The containers 800 of FIGs. 8, 8A-E may also have formed or molded on the interior of all side, base or top components, slots, such as 610 or 620 of FIG. 6, 6A and 7A, for attaching dividers (not shown) to create various compartments inside the enclosure, or for attaching shaped features 700 for resting cargo, such as shown in FIG. 7A. The slots 612 or 622, may be formed molded in fixed distance apart, such as shown in FIG. 6, 6A and 7A, so that same size or multiples of one size compartments may be formed; or they may be formed or molded in varied distance apart (not specifically shown), so that different size compartments may be formed which may or may not be multiples of one size.

[00105] According to one embodiment, features 700 may be also formed or molded into the components of the container 800 of FIGs. 8, 8A-E, for placement of cargo or placement of other components for more secure location of cargo.

[00106] Also, the containers 800 may be made of the size and shape to accommodate the cargo, or the cargo may be contained in its own packaging, with or without phase change material in close proximity or in contact, as noted above, and then inserted into the container 800.

[00107] Though not specifically shown, the container embodiments of FIGs. 6, 6A, 7A, 8, 8A-E may also have a base component having features such as 125, as shown in FIGs. 3A and B, for locating phase change materials, as discussed above.

[00108] In addition, a knock-down container as described in detail in U.S. Patent No. 7.963,397, the contents of which is incorporated herein in its entirety, may also be used with phase change materials according to any or all of the embodiments described above.

[00109] In various embodiments of the invention, one or more of the dunnage platform, the first enclosure and second enclosure are formed from a core, from one or more of the materials including expanded polystyrene, polyurethane, polyphenylene ether, polystyrene impregnated with pentane, a blend of polyphenylene ether and polystyrene impregnated with pentane, polyethylene, and polypropylene. In various embodiments of the invention, one or more of the dunnage platform, the first enclosure and second enclosure are formed from a core containing one or more materials mentioned above. In various embodiments of the invention, one or more of the dunnage platform, the first enclosure and second enclosure are formed from one or more thermoplastic sheets or layers including high impact polystyrene, polypropylene, polycarbonate, low density polyethylene, high density polyethylene, polypropylene, acrylonitrile butadiene styrene, polyethylene, polyacrylonitrile, polyurea, polybutadiene, polyphenylene ether and polyphony ether alloyed with high impact polystyrene. In various embodiments of the invention, one or more of the dunnage platform, the first enclosure and second enclosure thermoplastic sheets are a blend of any of the polymers mentioned above. In various embodiments of the invention, one or more of the dunnage platform, the first enclosure and second enclosure are formed from a core with an embedded strengthening material selected from the group consisting of a mesh, a perforated sheet and a barrier is embedded in the core. In various embodiments of the invention, one or more of the dunnage platform, the first enclosure and second enclosure are formed from a core with an embedded strengthening material selected from the group consisting of metal, carbon fiber, Kevlar, basalt-web blanket and Formica. As noted above, when used in

facilitating security check of air cargo transport of cargo that is transparent to magnetic scanners, non-metal containers may be used.

[00110] In embodiments of the invention, one or more of the load bearing structure and the half enclosures may be made of an expanded polymer core over which one or more thermoplastic sheets are combined. The expanded core may be made from already manufactured bulk form, such as expanded polystyrene foam which may be cut to the desired shape and size; or may be foamed in place in a mold of the size and shape desired, such as polyurethane foam. The foam density may also be varied, depending on the degree of expansion of the beads used to make the foam. The foam density may also decide the suitable load or cargo to be loaded. In general, the bead density for the foam may vary between 25-30 Kg/m³ if it is polystyrene. It is surmised that, for a give foam material, the higher density of the resulting foams, the higher strength of the resulting load bearing structures. However, higher density foams also increases the weight of the resultant load bearing structure. Thus, it is desirable to tailor the correct density of the foam for the utility at hand.

[00111] For lower density beads, the resultant foam may or may not be structurally weaker with the same degree of bead expansion. Thus, material of the foam may also be considered for the tailoring.

[00112] No matter what the material of the expanded core is, it is in general by itself, unless it is of higher density, for example, the beads are not highly expanded, may not have sufficient structural strength to be useable as a load bearing platform.

[00113] In an embodiment of the invention, one or two high impact polystyrene sheets are combined with an expanded polystyrene core containing grooves, protrusions and/or pockets to form one or more of the load bearing structure and the half enclosures. In an alternative embodiments of the invention, one or more of the load bearing structure and the half enclosures may be made by injecting a polymer into a mold to form the core and after removing the core from the mold spraying a polymer coating on the polymer core. In an embodiment of the invention, liquid polyurethane is injected into a mold to form a polyurethane core containing grooves, protrusions and/or pockets which after curing is removed from the mold and sprayed with polyurea to form one or more of the load bearing structure and the half enclosures. For example, the polyurea spray coating process may form a coating of about 0.1 to about 0.5 mm thick on a about 50 mm core. In various embodiments of the invention, the mold may be made of metal, plastic or natural materials including wood. In an embodiment of the invention, the mold is made of aluminum.

[00114]In one embodiment, at least one antimicrobial agent may be added to the material used for making the polymeric layer, for example. The antimicrobial agent may be in powder form or in liquid form. In another embodiment, at least one antimicrobial agent may be coated onto the exposed surface of the polymeric layer, for example. The antimicrobial agent may be in powder form or in liquid form.

[00115]When the antimicrobial agent or agents are incorporated in the material used in making the polymeric layer, for example, a sheet or sprayed coating, the agent or agents maybe dispersed directly into the material, or with the aid of an appropriate carrier, for example, a binding agent, a solvent, or a suitable polymer mixing aid. These carriers may also be useful for coating aids. Effective binding agents are those that do not interfere with the antimicrobial activities of the antimicrobial agent. In one embodiment, when the antimicrobial agent is incorporated into the material used either for making the polymeric layer, for example, a sheet or sprayed coating mentioned above, the antimicrobial agent maybe master batch in the material or an appropriate carrier at a higher concentration prior to adding to the material for making the polymeric layer, for example, a sheet or sprayed coating in desired proportions. In another embodiment, the antimicrobial agent may be added directly to the material for making the polymeric layer, for example, a sheet or sprayed coating without the intermediate step.

[00116]In other embodiments, the antimicrobial agents, either in coatings or incorporated into the materials for making the polymeric layer, for example, sheets or surface coatings, may include chemical antimicrobial materials or compounds that may be deposited in a non-permanent manner such that they may slowly dissolve, slowly leach or otherwise deliver antimicrobial substances during use. The antimicrobial material may be adequately incorporated, though temporarily and/or in sufficient amounts to last at least for a period such as the useful life of the load bearing structures, either when at least one antimicrobial agent is added to the material used for making the polymeric layer, for example, a sheet or sprayed coating mentioned above, or when at least one antimicrobial agent is coated onto the exposed surface of polymeric layer, for example, the sheet or sprayed coating mentioned above; or maintain their anti-microbial effects when at least one antimicrobial agent is coated with the aid of coating agents, onto the exposed surface of the polymeric layer, for example, a sheet or sprayed coating mentioned above. The suitable agent or agents are those that tend to slowly migrate, or non-leaching as defined below, to the surfaces to provide antimicrobial properties to the surfaces.

[00117] In still other embodiments, the antimicrobial agent either in coatings or incorporated into the material used for making the polymeric layer, for example, sheets or sprayed coatings may include sources of anti-microbial agents which may be non-leaching but leach and/or release in a moist environment or upon contact with moisture. These sources may be incorporated into the substrate materials used for manufacturing the polymeric layer, for example, sheet mentioned above, or included in the coatings spray coated on the exposed surfaces of the core or sheet. Incorporation of these sources may be especially suited to polymeric substrates.

[00118] Antimicrobial materials or compounds may include a variety of substances including, but not limited to antibiotics such as β -lactams (e.g. penicillin), aminoglycosides (e.g. streptomycin) and tetracyclines (e.g. doxycycline), antimycotics such as polyene drugs (e.g. amphotericin B) and imidazole and triazole drugs (e.g. fluconazole), and general antimicrobial agents such as quaternary ammonium cations (e.g. benzalkonium chloride) and compounds such as triclosan, chlorhexidine, and/or any other appropriate compound or mixtures thereof.

[00119] Chemical antimicrobial materials or compounds may include a variety of substances including, but not limited to antibiotics, antimycotics, quaternary ammonium cations, a source of metal ions such as metal ion generating materials, triclosan, chlorhexidine or any other materials capable of generating an antimicrobial effect, and/or any other appropriate compound or mixtures thereof.

[00120] In some embodiments, a layer of substantially non-permanent coating including an anti-microbial compound may be present on top of a layer of a substantially permanent coating including an anti-microbial compound.

[00121] The substantially permanent anti-microbial coating may be, for example, substantially flexible so that the coating substantially covers the working surfaces of the loading bearing structure during use even if the structure flexes. If the anti-microbial compound is not capable of forming a substantially flexible coating by itself, then a binding agent capable of forming a substantially flexible coating may be used to aid in the flexibility of the resulting coating.

[00122] As noted above, the polymeric layer, for example, sheets or sprayed coating or the coatings thereon the polymeric layer, for example, sheets or sprayed coatings may include chemical anti-microbial materials or compounds that are capable of being substantially permanently bonded, at least for a period such as the useful life of the loading bearing structure or maintain their anti-microbial effects when coated with the aid of processing aids

or coating agents, onto the exposed surfaces of the polymeric layer, for example, sheet or coating 115, as shown in FIG. 1. In one example, the chemicals may be deposited on the surface of the polymeric layer, for example, sheet or coating 115 or incorporated into the material of the polymeric layer, for example, sheet or coating 115. Antimicrobial activity may be built into the surface 115 itself by, for example, covalently bonding antimicrobial agents to the surface of the polymeric layer, for example, sheet or coating 115, or if incorporated into the bulk of the material for making the polymeric layer, for example, sheet or sprayed coating, may migrate to the surface. These covalently bonded materials may act to minimize microbial growth on the surface, either disposable or reusable. In addition, any microbial organisms that may chance to be attached to the material may be killed by interaction with the coating. For example, quaternary ammonium cations, such as N-alkyl-pyridiniums, may be used as antimicrobial moieties in covalently attached polymeric surface coatings. In one case, poly(4-vinyl-N-hexylpyridinium) (N-alkylated-PVP) was previously noted to have an optimum alkyl side chain length for antimicrobial activity. Polyethylenimine (PEI) was also previously used as a bacteriocidal coating when both N-alkylated on its primary amino group and subsequently N-methylated on its secondary and tertiary amino groups to raise the overall number of cationic quaternary amino groups. Any such covalently bonded quaternary ammonium cation polymeric coatings may be used to give an antimicrobial property to the surface or surfaces of the loading bearing structures. Further examples of quaternary ammonium compounds include, but are not limited to, benzalkonium chloride, benzethonium chloride, methylbenzethonium chloride, cetalkonium chloride, cetylpyridinium chloride, cetrimonium, cetrimide, dofanium chloride, tetraethylammonium bromide, didecyldimethylammonium chloride and domiphen bromide.

[00123] In yet further embodiments, antimicrobial activity may be achieved by utilizing the antimicrobial properties of various metals, especially transition metals which have little to no effect on humans. Examples may include sources of free silver ions, which are noted for their antimicrobial effects and few biological effects on humans. Metal ion antimicrobial activity may be created by a variety of methods that may include, for example, mixing a source of a metal ion with the polymeric layer, for example, sheet or coating material during manufacture, coating the surface by methods such as plasma deposition, loosely complexing the metal ion source by disrupting the surface of the polymeric layer, for example, coating or sheet to form affinity or binding sites by methods such as etching or coronal discharge, and depositing a metal onto the surface by means such as electroplating, photoreduction and

precipitation. The coated surface may then slowly release free metal ions during use that may produce an antimicrobial effect.

[00124] In some embodiments, the source of metal ions may be an ion exchange resin. Ion exchange resins are substances that carry ions in binding sites on the surfaces of the material. Ion exchange resins may be impregnated with particular ion species for which it has a given affinity. The ion exchange resin may be placed in an environment containing different ion species for which it has a generally higher affinity, causing the impregnated ions to leach into the environment, being replaced by the ion species originally present in the environment.

[00125] In one embodiment, the polymeric layer, for example, sheet or sprayed coating may include an ion exchange resin containing a metal ion source, such as, for example, silver. Ion exchange resins containing metal ion sources may include, for example, Alphasan® (Milliken Chemical), which is a zirconium phosphate-based ceramic ion exchange resin containing silver. An ion exchange resin may be coated onto the polymeric layer, for example, sheet or sprayed coating or it may be incorporated into the material of the sheet or sprayed coating, as discussed above.

[00126] In one embodiment, a porous surface, which may be a porous sheet substrate or surface of the core 115, for example, an expanded polystyrene core or polyurethane core, may be impregnated with a water based antimicrobial composition, having at least one polymeric carrier that may be in the form of an emulsion or dispersion and at least one substantially non-leaching antimicrobial component that is substantially free of environmentally hazardous material. The porous substrate may or may not additionally be overcoated or protected with a film layer after being impregnated with the antimicrobial composition.

[00127] In another embodiment, a porous surface, which may be a porous sheet substrate or surface of the core 115, for example, an expanded polystyrene core or polyurethane core, may be impregnated with a water based antimicrobial composition, having at least one polymeric carrier that may be in the form of an emulsion or dispersion and at least one surface active antimicrobial component that is substantially free of environmentally hazardous material.

[00128] In yet another embodiment, a non-porous sheet substrate 115 may be coated with a water based antimicrobial composition, having at least one polymeric carrier that may be in the form of an emulsion or dispersion and at least one substantially non-leaching antimicrobial component that is substantially free of environmentally hazardous material.

[00129] For load bearing structures having one thermoplastic sheet 115 over the core thereon, the exposed surfaces may be porous, as noted above. The porous material may be impregnated with a water based antimicrobial composition, also as mentioned above, making the surface non-porous.

[00130] In some embodiments, the surfaces of the porous materials impregnated with an antimicrobial composition may be non-porous after drying or setting and may perform as if it has been coated or covered with a thermoplastic sheet or layer mentioned above.

[00131] The same emulsion or dispersion mentioned above may also be coated onto the exposed surfaces of load bearing structures having two thermoplastic sheets over the core thereon.

[00132] Examples of antimicrobial component that is substantially free of environmentally hazardous material may include sodium omadine, sodium borate, zinc omadine, zinc borate, calcium borate, barium metaborate, iodo alkynyl alkyl carbamates, diiodomethyl-p-tolylsulfone, 2-4-thiazolyl-benzimidazole, 2-n-octyl-4-isothiazolin-3-one, zinc dimethyldithiocarbamate, zinc 2-mercaptobenzothiazole, potassium n-hydroxymethyl-n-methyldithiocarbamate, sodium 2-mercaptobenzothiazole, 5-hydroxyemthoxymethyl-1-aza-3,7-dioxa-bicyclooctane, 2,3,5,6-tetra-chloro-4-pyridine, zinc 2-pyridinethiol-1-oxide and N-trichloromethylthiophthalimide, tetrachloroisophthalonitrile, deltamethrin, fipronil, bifenthrin, chlorfenapyr, imidacloprid, and mixtures thereof. For use in facilitating security check, metallic compounds are not used.

[00133] Non-leaching antimicrobial materials are, for example, materials with a very low volatility and very low water solubility such that it would only leach out to the extent sufficient to maintain an effective and uniform concentration throughout the exposed surface(s) of the antimicrobial article when its concentration thereon may be reduced due to its action against microorganisms. In other words, the antimicrobial component may be selected not to be fugitive or migrating once being incorporated into the impregnated article, but to have a very low water solubility so that it may maintain an equilibrium concentration throughout the article on its surface(s) whenever the concentration reduction occurs due to the attack of the microbes. The antimicrobial component may have a water solubility of, for example, from about 0.10 PPM to about 1.0 wt %, depending on each individual antimicrobial component.

[00134] For example, the polymeric emulsion or dispersion may have a medium particle size of from about 0.10 micron to about 4.0 micron. Examples of useful polymeric emulsion or dispersion includes, such as, emulsions or dispersions of styrene acrylic copolymers, such as

Acronal S702 from BASF, Ucar 376 from Union Carbide, and Res 3077 from Rohm & Haas; styrene butadiene block copolymers, such as, DL 313 NA from Dow Chemical, ND-565 and ND-422 from BASF, and Rovene 6105 from Mallard Creek Polymers; ethylene vinyl acetate copolymers, such as Airflex 400/A405/460 from Air Products and Elvace 1875 from Reichhold Chemicals; polyvinyl acetate homopolymer, such as PD-316 from H.B. Fuller Company, and Airflex XX-220/230 from Air Products; acrylate-acrylonitrile copolymers, such as Synthemuls, various grades from Reichhold Chemicals; vinyl acetate-vinyl chloride ethylene copolymers, such as Airflex 728 from Air Products; ethylene vinyl acetate butyl acrylate terpolymers, such as Airflex 809 from Air Products; butadiene-acrylonitrile copolymers, such as Tylac, various grades from Reichhold Chemical; vinyl acrylic-vinyl chloride, such as Haloflex 563 from Zeneca Resins; vinylidene chloride-acrylic-vinyl chloride copolymers, such as Vycar 660X14 and Vycar 460X46 from B.F. Goodrich; chloroprene polymers and copolymers, such as DuPont Neoprene latex 115, 400, 654 and 750 from DuPont; water-borne urethane polymers, such as Neo Rez R-962, 967 and 972 from Zeneca Resins, and mixtures thereof.

[00135] In various embodiments of the invention, a lightweight mesh may be embedded in the polymer core prior to application of the thermoplastic sheet to one or more surfaces of the polymer core. The mesh may be polymeric or metal, except when containers are to be used in facilitating security check of air cargo transport of cargo that is transparent to magnetic scanners, polymeric mesh may be used.

[00136] In an embodiment, a thin perforated sheet or barrier is spaced away from a thermoplastic sheet which forms a part of a mold and the polymer core fills the vacancy between the thermoplastic sheet and the mold surrounding the thin perforated sheet. In an alternative embodiment, a thin perforated sheet or barrier is positioned inside a mold and the polymer core fills the mold surrounding the thin perforated sheet. In an embodiment of the invention, a lightweight mesh is embedded between the expanded polystyrene core and the high impact polystyrene sheet. In an embodiment of the invention, a lightweight mesh is embedded between the polyurethane core and the polyurea coating applied over the lightweight mesh. In one embodiment the mesh, perforated sheet or barrier is metallic. In another embodiment the mesh, perforated sheet or barrier is made of Kevlar. In a different embodiment the mesh, perforated sheet or barrier is made of a basalt web blanket material. In a further embodiment the mesh, perforated sheet or barrier is made of carbon fiber. In another embodiment the mesh, perforated sheet or barrier is made of Formica.

[00137]By imbedding mesh, a perforated sheet or a barrier within the core, the cargo container base, walls and top panel may not be simply punctured or pierced with items such as knives, chisels, crowbars or other such devices (i.e., puncture resistant). As such the cargo container is defined as being 'tamper-resistant' meaning that the integrity of the container is not susceptible to attack by persons wielding instruments that may be concealed under items of clothing. Tamper resistant is a less stringent requirement than safe. Tamper resistant is designed to insure that the container may not be broken into by an opportunistic thief. That is persons having instruments that may be concealed under items of clothing and used to break or disturb the integrity of the container. Tamper resistant does not secure a container against heavy equipment, or power tools.

[00138]In an embodiment of the invention, the mesh, perforated sheet or barrier is made of a conducting material and is connected to a voltage supply such that contact with the surface of the mesh, perforated sheet or barrier will transmit an electric shock. The electric shock may be controlled by a microprocessor to deliver one or more combinations of low voltage low current or high voltage low current shocks. The microprocessor may be inserted in the core or positioned inside the cargo container and connected to the mesh, perforated sheet or barrier. The voltage supply may be inserted in the core or positioned inside the cargo container and connected to the microprocessor circuit and the mesh, perforated sheet or barrier inside the cargo container. In an alternative embodiment of the invention, a warning siren, flashing light or foul odor alarm may be activated by the microprocessor when the integrity of the cargo container is breached. The warning siren alarm may be positioned in the core or inside the cargo container and connected to the microprocessor circuit and the voltage supply. The foul odor alarm may be positioned in the core or inside the cargo container with a cavity connecting the odor reservoir to the outside of the container and a relay valve connected to the microprocessor circuit. The flashing light alarm may be inserted in the core where the light may penetrate through the thermoplastic sheet and may be connected to the microprocessor circuit and the voltage supply. In this embodiment, the mesh, perforated sheet or barrier may be light weight and electrically conducting. When the integrity of the mesh, perforated sheet or barrier is disrupted a voltage meter senses the reduced voltage being conducted and sets off the alarm. A light emitting diode or other warning may be visible on the exterior of the cargo container and may be used to alert handlers that the cargo container is wired to an alarm system. A sensor may relay a signal to the microprocessor and may be used by the client or the shipping agent to disconnect the voltage supply or otherwise disarm the alarm, prior to unloading the cargo container on arrival at the destination.

[00139] In another embodiment of the invention, the cargo container base is made of a polymer core in which either mesh, a perforated sheet or a barrier are imbedded. The core may be combined with a thermoplastic sheet or the core may be injected into a mold in which the thermoplastic sheet forms a portion of the mold. The cargo container walls and top panel may also be made of a core in which either mesh, a perforated sheet or a barrier are imbedded. In various embodiments, the reinforced materials are indistinguishable from the non-reinforced materials when subjected to visual inspection. In this way an opportunistic thief may not be certain how difficult it may be to gain entry to any given cargo container. In various embodiments of the invention, the cargo container exterior surfaces may be imprinted with information warning approximately safety and or theft protection measures required when handling the cargo container.

[00140] As mentioned above, when transporting temperature critical cargo items that may be difficult to discern its integrity without subjecting it to partially or substantially destructive testing, somewhat difficult or expensive testing, the cargo item its is own packaging with phase change in contact or in close proximity may also include a critical temperature indicator, which may be used to indicate if the temperature has been reached and thus if the integrity of the cargo item has been breached. By integrity, it may mean effectiveness against a target, is not decomposed, or no adulteration of any form. In one embodiment, the indicator may be presented on the outside of the packaging material. In another embodiment, the indicator may be present in close proximity or in contact with the cargo item or inside the packaging material. In a further embodiment, the indicator may be present somewhere on the inside of the cargo container 500, 600 or 800. The temperature indicator may operate in various different way, including a visual indicator in various forms, as disclosed in U. S. Patent Nos. 4,457,252; 4,457,253; 4,846,095; 5,816,707; 7,517,146; and 7,528,737, the contents of which are hereby incorporated by referenced in their entirety.

[00141] For example, an indicator may include a device that operates on the principle that a mixture of two or more liquids may have a surface energy value incapable of wetting out a given surface, and may be made to wet out that surface if the temperature of the mixture is reduced sufficiently to solidify a portion of one of the liquids and thus alter the concentration of liquids in the mixture.

[00142] Example of such an indicating device is disclosed in U.S. Patent No. 4,846,095, mentioned above and may include a microporous layer having a multiplicity of micropores therein and a mixture of at least two liquids incapable of wetting the sheet at a given temperature, but capable of wetting the sheet when the temperature of the mixture reaches a

critical value, e.g. the freezing point of one of the liquids. The microporous layer has a large number of voids that scatter transmitted light, making the layer appear opaque to the human eye. When the voids are filled with a material having substantially the same index of refraction as the material of the microporous layer, the transmitted light is not scattered by the layer, which results in making the layer transmissive to visible light.

[00143] For some materials, both temperature and time can be critical. Some indicators may indicate time as well as temperature, such as those disclosed in U. S. Patent Nos. 5,667,303; 4,428,321; 3,954,011; 3,962,920; 6,244,208; 6,435,128; 6,614,728; 6,916,116; and 6,950,028, the contents of which are hereby incorporated by referenced in their entirety.

[00144] For example, in U. S. Patent No. 6,614,728, a time-temperature indicator include a first substrate having a diffusely light-reflective porous matrix disposed thereon, and a second substrate having an amorphous material disposed thereon. When the porous matrix and the amorphous material are in contact with one another at or above a predetermined temperature, the amorphous material migrates into the porous matrix at a rate that increases with increasing temperature, providing a readable indication of cumulative time-temperature exposure.

[00145] As mentioned above, the cargo containers 500, 600 and 800 may include pockets 125 for locating cargo item plus phase change material packages, similar to what has been discussed for phase change material pouches alone.

[00146] After loading the cargo container, the interior may be further sealed from the exterior by wrapping cellulose film, polyvinyl chloride film, polyvinylidene chloride film, low density polyethylene film, linear low density polyethylene film and copolymer films that include polyisobutene and/or polyethylene-vinylacetate.

[00147] In another embodiment of the invention, a Radio Frequency IDentification (RFID) tag is imbedded in the core of one or more of the dunnage platform, the first enclosure and second enclosure. In one embodiment of the invention, the RFID tag operates using an Ultra High Frequency (UHF) signal. In another embodiment of the invention, the RFID tag operates using a microwave frequency signal.

[00148] In one embodiment, the RFID tag may be centered in the middle of the core. In another embodiment, the RFID tag may be placed on the edge of the core. In an embodiment of the invention, the RFID tag may be positioned so that the RFID tag antenna is least affected by any metal in the loaded cargo carrier.

[00149] In one embodiment the RFID tag is read only. In another embodiment, the RFID tag contains an Electrically Erasable Programmable Read-Only Memory (EPROM), which

enables both read and write functions. In an embodiment of the invention, the RFID tag is passive. In another embodiment of the invention, the RFID tag is semi-passive containing a source of energy such as a battery to allow the tag to be constantly powered. In a further embodiment of the invention, the RFID tag is active, containing an internal power source, such as a battery, which is used to power any Integrated Circuits (ICs) in the tag and generate the outgoing signal. In another embodiment, the tag has the ability to enable location sensing through a photo sensor.

[00150]In one embodiment of the invention, means of communication with a base station is imbedded in one or more of the dunnage platform, the first enclosure and the second enclosure. In one embodiment of the invention, the communication means utilizes one or more of a wireless local area network; a wireless wide area network; a cellular network; a satellite network; a Wi-Fi network; and a pager network. In one embodiment of the invention, the device embedded is a modem capable of communicating with one or more of the aforementioned networks. In the following discussion the term 'cellular modem' will be used to describe the device embedded. The term 'cellular modem' will be herein used to identify any device of comparable size capable of communicating over one or more of the aforementioned networks. In one embodiment of the invention, the cellular modem may be a Code Division Multiple Access (CDMA) modem. In an embodiment of the invention, a RFID reader and associated integrated circuit processor are embedded together with the cellular modem in the spreader, the transporter base, the dispenser base, the reloading base and the material of the four walls. In such an embodiment, the RFID tags and RFID reader are positioned to optimize the RFID read of the RFID tags from the other surfaces, which make up the dunnage platform bag.

[00151]In an embodiment of the invention, where a RFID reader and a cellular modem are embedded in one or more of the spreader, the transporter base, the dispenser base, the reloading base and the material of the four walls; the RFID reader is in communication with one or more RFID readers, associated cellular modems and the RFID tags of one or more cargo carriers in the vicinity of the RFID reader. Through communications with the RFID reader and associated integrated circuit processor of the plurality of cargo carriers in the vicinity, a RFID reader and associated integrated circuit processor is able to distinguish the RFID tag from cargo loaded in cargo carriers in the vicinity based on one or more of location, strength of signal, variation of RFID tag signal with position in the cargo carrier relative to the reader, variation of RFID tag signal with time and prior input data. In an embodiment of the invention, one or more antennae inserted into the cargo carrier are used to help

discriminate the location of the cargo carriers. In an embodiment of the invention, the RFID reader and associate processor are in communication with the embedded cellular modem. In an embodiment of the invention, the cellular modem is in communication with a base station and may transmit one or more parameters selected from the group consisting of one or more RFID tag location, one or more RFID tag identification code, number of cargo carriers, cargo carrier information, previous cargo information, dunnage platform condition, enclosure condition, cargo carrier condition and time stamp.

[00152] In one embodiment of the invention the RFID code uses the IEEE format and is Electronic Product Code (EPC) readable. In another embodiment of the invention the RFID code uses the UCC format and is Universal Product Code (UPC) readable. In another embodiment, the format is compatible for EPC, European Article Number (EAN) and UPC read and write functions.

[00153] Various embodiments may be implemented using a conventional general purpose or specialized digital computer(s) and/or processor(s) programmed according to the teachings of the present disclosure, as will be apparent to those skilled in the computer art. Appropriate software coding may readily be prepared by skilled programmers based on the teachings of the present disclosure, as will be apparent to those skilled in the software art. The invention may also be implemented by the preparation of integrated circuits and/or by interconnecting an appropriate network of component circuits, as will be readily apparent to those skilled in the art.

[00154] Various embodiments include a computer program product which is a storage medium (media) having instructions and/or information stored thereon/in which may be used to program a general purpose or specialized computing processor(s)/device(s) to perform any of the features presented herein. The storage medium may include, but is not limited to, one or more of the following: any type of physical media including floppy disks, optical discs, DVDs, CD-ROMs, micro drives, magneto-optical disks, holographic storage devices, ROMs, RAMs, EPROMs, EEPROMs, DRAMs, PRAMS, VRAMs, flash memory devices, magnetic or optical cards, nano-systems (including molecular memory ICs); paper or paper-based media; and any type of media or device suitable for storing instructions and/or information. Various embodiments include a computer program product that may be transmitted in whole or in parts and over one or more public and/or private networks wherein the transmission includes instructions and/or information, which may be used by one or more processors to perform any of the features, presented herein. In various embodiments, the transmission may include a plurality of separate transmissions.

[00155] Stored on one or more of the computer readable medium (media), the present disclosure includes software for controlling both the hardware of general purpose/specialized computer(s) and/or processor(s), and for enabling the computer(s) and/or processor(s) to interact with a human user or other mechanism utilizing the results of the present invention. Such software may include, but is not limited to, device drivers, operating systems, execution environments/containers, user interfaces and applications.

[00156] The execution of code may be direct or indirect. The code may include compiled, interpreted and other types of languages. Unless otherwise limited by claim language, the execution and/or transmission of code and/or code segments for a function may include invocations or calls to other software or devices, local or remote, to do the function. The invocations or calls may include invocations or calls to library modules, device drivers and remote software to do the function. The invocations or calls may include invocations or calls in distributed and client/server systems.

[00157] As noted above, the storage or shipping containers may be square shape or may be of polygonal or clam shell shape. In one exemplary embodiment, a cargo container for insulating and transporting and/or storage of cargo may include a first structure having a load bearing portion and at least a first wall, at least one of the load bearing structure and at least one wall may include at least a first core and a first thermoplastic layer surrounding the first core; and a second structure having a top portion and at least a second wall, at least one of said top and at least one wall may include at least a second core and at least a second thermoplastic layer surrounding the second core; such that at least one of the load bearing portion, first and second wall and top portion includes at least one phase change material to insulate the cargo for climate control. The phase change material may be compounded into a composite, mixed or encapsulated. The encapsulated material may be particularly suited for dispersing with any of the core.

[00158] For cold chain cargo and its container, any tracking system may also help to monitor the cargo's integrity after packing and prior to security check.

[0005] In other embodiments, the cargo container may be covered by a flexible and strong, bag-like material 70 to contain and protect the cargo from being removed and/or misplaced, as shown in FIGs. 10 and 10A . For example, the material may be a film, a woven sheet or a non-woven sheet having sufficient strength for stretching over and covering a cargo and light weight enough not to add unnecessary weight to the cargo.

[00159] The bag-like material 70 may be closed on three sides and opened at one end, with the open end having some elastic property circumferentially about the opening. The cargo may be packed and the bag-like material 70 stretched over the entire cargo with the open end

stretched under the edge of base and tagged at the origin and the complete structure may be shrink-wrapped. The surfaces of the bag-like material may also have anti-microbial properties.

[00160] The bag like enclosure 70, as shown in FIGs. 10 and 10A, may be a modular, lightweight, strong receptacle that may be stretched over the cargo to protect it from dust and/or other elements if desired and to minimize loss. For example, it may also have ultra violet light insulating, fire resistant, tamper proof and similar properties. In some embodiments, it may be desirable for some application for the material for the bag-like enclosure to be moisture resistant, or breathable, i.e., permeable to vapor or gas.

[00161] For a film, the suitable material may be made from any film forming material including may include polymers of monoolefins and diolefins, e.g. polypropylene, polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, polyvinylcyclohexane, polyisoprene or polybutadiene, and polymers of cycloolefins, e.g. of cyclopentene or norbornene, polyethylene (which may optionally be crosslinked), e.g. high density polyethylene (HDPE), medium density polyethylene (MDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), (VLDPE) and (ULDPE); copolymers of monoolefins and diolefins with one another or with other vinyl monomers, e.g. ethylene/propylene copolymers, linear low density polyethylene (LLDPE) and blends thereof with low density polyethylene (LDPE), propylene/but-1-ene copolymers, propylene/isobutylene copolymers, ethylene/but-1-ene copolymers, ethylene/hexene copolymers, ethylene/methylpentene copolymers, ethylene/heptene copolymers, ethylene/octene copolymers, ethylene/vinylcyclohexane copolymers, ethylene/cycloolefin copolymers (e.g. ethylene/norbornene, such as COC), propylene/butadiene copolymers, isobutylene/isoprene copolymers, ethylene/vinylcyclohexene copolymers, polystyrene, poly(p-methylstyrene), poly(alpha-methylstyrene); polyamides and co-polyamides derived from diamines and dicarboxylic acids and/or from aminocarboxylic acids or the corresponding lactams, for example polyamide 4, polyamide 6, polyamide 6/6, 6/10, 6/9, 6/12, 4/6, 12/12, polyamide 11, polyamide 12, aromatic polyamides starting from m-xylenediamine and adipic acid; polyamides prepared from hexamethylenediamine and isophthalic and terephthalic acid as starting materials and with or without an elastomer as a modifier, for example poly-2,4,4-trimethylhexamethyleneterephthal-amide or poly-m-phenyleneisophthalamide; and also block copolymers of said polyamides with polyolefins, olefin copolymers, ionomers or chemically bonded or grafted elastomers; polyamides with polyethers, for example with polyethylene glycol, polypropylene glycol or

polytetramethylene glycol; and also polyamides or co-polyamides modified with EPDM or ABS; polyamides condensed during the preparation (RIM polyamide systems); polyesters derived from dicarboxylic acids and diols and/or from hydroxycarboxylic acids or the corresponding lactones, for example polyethylene terephthalate, polybutylene terephthalate, poly-1,4- dimethylolcyclohexane terephthalate, polyalkylene naphthalate (PAN) and polyhydroxybenzoate, and also block copolyetheresters derived from hydroxyl-terminated polyethers; polycarbonates and polyestercarbonates, polyketones, polysulfones, polyethersulfones and polyetherketones; crosslinked polymers derived from aldehydes on the one hand and phenols, ureas and melamines on the other hand, such as, for example, phenol/formaldehyde resins, urea/formaldehyde resins and melamine/formaldehyde resins; unsaturated polyester resins derived from co-polyesters of saturated and unsaturated dicarboxylic acids, polyhydric alcohols and vinyl components as cross linking agents, and also halogen-containing modifiers thereof having low flammability; crosslinked acrylic resins derived from substituted acrylates, e.g. epoxyacrylates, urethaneacrylates or polyesteracrylates; starch; polymers and co-copolymers of materials such as polylactic acids and its copolymers, cellulose, polyhydroxy alcanoates (PHA), polycaprolactone (PCL), polybutylene succinate (PBS)) polymers and copolymers of N-vinylpyrrolidone such as polyvinylpyrrolidone, poly(vinylpyrrolidone-co-vinyl acetate), and crosslinked polyvinylpyrrolidone, Ethylene Vinyl Alcohol (EvOH).

[00162] The bag-like enclosure may be porous sheeting material and may include various woven or non-woven fiberglass, Brattice cloth, cotton and other fabrics, heavy weight paper, light weight wire mesh, ceramic cloths, or polymeric material, such as, some synthetics, e.g., various woven or non-woven polyester, polypropylene, polyethylene, Nylon, synthetic fiber blend, etc. an emulsion or dispersion of a film-forming polymer that has a glass transition temperature (T_g) of from about -70.degree. F. (about -57.degree. C.) to about 140.degree. F. (about 60.degree. C.). Wire mesh and other metallic materials may not suitable for facilitating security check.

[00163] A suitable material may also be a fibrous nonwoven web formed from any blow microfibers. Suitable for blown microfibers may include semicrystalline polymers such as high and low density polyethylene, polypropylene, polyoxymethylene, poly(vinylidene fluoride), poly(methyl pentene), poly(ethylene-chlorotrifluoroethylene), poly(vinyl fluoride), poly(ethylene oxide), poly(ethylene terephthalate), poly(butylene terephthalate), nylon 6, nylon 66, polybutene, and thermotropic liquid crystal polymers. Examples of suitable thermotropic liquid crystal polymers include aromatic polyesters which exhibit liquid crystal

properties when melted and which are synthesized from aromatic diols, aromatic carboxylic acids, hydroxycarboxylic acids, and other like monomers. Typical examples include a first type consisting of parahydroxybenzoic acid (PHB), terephthalic acid, and biphenol; a second type consisting of PHB and 2,6-hydroxynaphthoic acid; and a third type consisting of PHB, terephthalic acid, and ethylene glycol.

[00164] For example, polyolefins such as polypropylene and polyethylene that are readily available at low cost and can provide highly desirable properties in the microfibrillated articles such as high modulus and high tensile strength. Any polyolefins, such as those noted above. In some cases, multicomponent fibers having an adhesive component region may also be suitable.

[00165] In general, the bag-like enclosure 70 may have at least some stretchability. Non-woven materials may in general be made to be stretchable. A general example of a suitable material may include heat and/or pressure treated, non-woven, high density polyethylene materials, such as Tyvek®, available from DuPont, which may also exhibit other desirable properties such as, for example, water resistance, breathability, resistance to tearing and/or other properties.

[00166] As noted above, the opening may have an elastic property to allow the enclosure to be stretched over the cargo and/or the load structure, as shown in FIGs. 10 and 10A. In one embodiment, the opening may be stretched around the bottom of the cargo. In another embodiment, the opening may be stretched over the load bearing structure. In a further embodiment, it may be stretched and tucked under the edge portion of the load bearing structure, as shown in FIGs. 10 and 10A.

[00167] The elastic property of the opening may be imparted through thermal treatment or attachment of an additional elastic material, either by welding, heating sealing, using an adhesive or by sewing.

[00168] In other embodiments, a gathered fibrous nonwoven web possessing elastic characteristics may be used for imparting the elastic property to the opening. In one embodiment, the fibrous nonwoven gathered web may be formed, in a gatherable condition, directly onto an extendable and contractible forming surface while the forming surface is maintained in the extended condition. In another embodiment, the extendable and contractible forming surface may be a nonwoven elastic web such as, for example, a fibrous nonwoven elastic web. In a further embodiment, the extendable and contractible forming surface may be a extendable and contractible mesh screen forming surface.

[00169] When the gathered fibrous nonwoven web may also be formed directly on a surface of a nonwoven elastic web the nonwoven elastic web may first be formed by, for example, a melt blowing process or any other process for forming a nonwoven elastic web. For example, the nonwoven elastic web may be an apertured web of an elastic film as opposed to a melt blown fibrous nonwoven elastic web. The nonwoven elastic web, as formed, has a normal contracted, nonbiased length. Thereafter, the nonwoven elastic web may be extended by being stretched to an extended, stretched, biased length. The detailed of the process may be found in U.S. Patent No. 4652467, the contents of which are hereby incorporated by reference in its entirety.

[00170] Another embodiment of a stretchable material may be stretchable nonwoven webs based on multi-layer blown microfibers, such as those described in U. S. Patent No. 5,238,733, the contents of which are hereby incorporated by reference in its entirety.

[00171] For helping to keep the cargo fresh, breathable materials may be used. Breathable materials that are also moisture impervious may also be desirable. One example of the material may be a multicomponent film structure, such as that disclosed in U.S. Patent no. 5447783, or a non-woven fabric laminate, such as that disclosed in U.S. Patent No. 5482765, the contents of which are hereby incorporated by reference in its entirety.

[00172] The porous material of the bag-like enclosure 70 may be impregnated with impregnated with a water based antimicrobial composition, having at least one polymeric carrier that may be in the form of an emulsion or dispersion and at least one substantially non-leaching antimicrobial component that is substantially free of environmentally hazardous material, as mentioned above. The porous substrate may or may not be overcoated or protected with a film layer.

[00173] Protective or overcoating may be desirable for bag-like enclosures. In one embodiment, the bag-like enclosure may include a protective or overcoating layer if it is porous.

[00174] The protective or overcoating layer may also be moisture impervious and/or breathable. Examples of impervious layers may be found in U.S. Patent no. 7,699,826, as disclosed above, the content of which is incorporated hereby by reference in its entirety. Breathable packaging material, as disclosed above, may be a multicomponent film structure, such as that disclosed in U.S. Patent no. 5447783, or a non-woven fabric laminate, such as that disclosed in U.S. Patent No. 5482765, or a breathable film layer as disclosed in 6,432,547, the contents of which are hereby incorporated by reference in its entirety. Biodegradable, breathable enclosures may also be useful and example is disclosed in U.S.

patent no. 7,910,645, the contents of all of which are hereby incorporated by reference in their entirety.

[00175] The cargo containers may also include a desiccant to control the humidity of the interior.

[00176] After loading the cargo and the bag-like enclosure 70, the cargo may be further sealed from the exterior by wrapping, as noted above, with similar film material mentioned before, or may also be shrink-wrapped, if desired, to further protect the integrity of the content from tampering to further facilitate security check, to keep the cargo fresh for cold chain cargos, and/or to minimize tampering or introduction of any foreign objects after packing. For minimizing tampering, the bag-like material may be made of a material that is not easily tearable or damaged.

[00177] It will be appreciated by those of ordinary skill in the art that the present invention may be embodied in other specific forms without departing from the spirit or essential character hereof. The present description is therefore considered in all respects to be illustrative and not restrictive. The scope of the present invention is indicated by the appended claims, and all changes that come within the meaning and range of equivalents thereof are intended to be embraced therein.

CLAIMS

1. A climate control cargo container comprising:
 - (a) a load bearing structure having a first core and a first thermoplastic layer surrounding the first core; and
 - (b) an enclosure having at least a second core and a second thermoplastic layer surrounding the second core;wherein one or both the load bearing structure and the enclosure have one or more pockets for locating one or more phase change materials capable of multiple cycles of phase transformation for climate control.
2. The cargo container of claim 1, wherein said phase change material comprises organic material, inorganic material or combinations thereof having a specific heat of at least about 1.5.
3. The cargo container of claim 1 or 2, further comprising grooves in the load bearing structure to locate the enclosure.
4. The cargo container of claim 1, 2 or 3, wherein phase change material exhibits small volume changes on phase transformation and low vapor pressure changes at operating temperatures.
5. The cargo container of claim 1, 2 or 4, wherein said phase change material is contained in at least one thin pouches.
6. The cargo container of claim 5, wherein said thin pouches comprise moisture impermeable film.
7. The cargo container of any of the preceding claims, wherein the outside of the cargo container can be exposed to temperatures in a range between:
 - a lower limit of approximately -30°C; and
 - an upper limit of approximately -5 °Cwhile keeping the interior of the cargo container in a range between:
 - a lower limit of approximately -2 °C; and

an upper limit of approximately 10 °C.

8. The cargo container of any of claims 1-7, wherein the outside of the cargo container can be exposed to temperatures in a range between:

a lower limit of approximately 30°C; and

an upper limit of approximately 40 °C

while keeping the interior of the cargo container in a range between:

a lower limit of approximately 20 °C; and

an upper limit of approximately 25 °C.

9. The cargo container of any of the preceding claims further comprising cargo items to be protected from temperature changes, each of said cargo items is contained in its own packaging and in close proximity with said phase change material.

10. The cargo container of claim 9 further comprising an indicator in close proximity with said cargo items for indicating the integrity of the cargo items.

11. The cargo container of any of the preceding claims, further comprising one or more Radio Frequency IDentification (RFID) tags affixed on or embedded in one or more of the loading bearing structure or enclosure.

12. The cargo container of any of the preceding claims, wherein said container comprises exposed surfaces and at least one of said surfaces exhibits an anti-microbial property.

13. A cargo container for insulating cargo items comprising:

- (a) a first structure having a load bearing portion and at least a first wall, at least one of the load bearing structure and at least one wall comprises at least a first core and a first thermoplastic layer surrounding the first core;
 - (b) a second structure having a top portion and at least a second wall, at least one of the top and at least one wall comprises at least a second core and at least a second thermoplastic layer surrounding the second core; and
 - (c) at least one of the load bearing portion, the first wall, the second wall and the top portion comprise one or more pockets for locating one or more phase change materials to insulate the cargo items for climate control, said phase change material is contained inside at least one moisture resistant container;
- wherein at least one of the load bearing portion, the first wall, the second wall and the top portion of said container comprises features for locating said cargo items.

14. The cargo container of claim 13, wherein the first and second structure comprises L-shape cross-section structures or clam-shell structures.

15. The cargo container of claim 13 or 14, wherein at least one of the first and second thermoplastic layers are sprayed onto one of the first and second core.

16. The cargo container of claim 13, 14 or 15, further comprising a desiccant to control the humidity of the cargo items therein.

17. The cargo container of claim 13, 14, 15 or 16, wherein said phase change material container is in close proximity with one of said cargo items inside its own packaging.

18. The cargo container of claim 17, wherein the packaging is breathable.

19. The cargo container of claim 17 or 18, wherein the packaging is biodegradable.

20. A cargo container for insulating and transporting and/or storage of cargo items comprising:

- (a) a first structure having a load bearing portion and at least a first wall, wherein at least one of said load bearing portion and said at least one wall comprises at least a first core and a first thermoplastic layer surrounding the first core; and
- (b) a second structure having a top portion and at least a second wall, wherein at least one of

the top portion and at least one wall comprises at least a second core and at least a second thermoplastic layer surrounding the second core;
wherein at least one of the load bearing portion, first and second wall and top portion comprises at least one phase change material to insulate the cargo for climate control in a certain temperature range when being shipped and/or stored alternately in a cool and a warm climate, said cargo container is adapted for directly loading cargo items in a clean room.

21. The cargo container of claim 20, wherein the at least one phase change material is formulated into a composite, a mixture or is encapsulated.

22. The cargo container of claim 20 or 21, wherein said phase change material is packaged in a thin, moisture resistant pouch.

23. The cargo container of claim 21 or 22, wherein said mixture comprises at least two phase change material having different thermal properties.

24. The cargo container of claim 20, 21, 22, 23 or 24, wherein said container comprises exposed surfaces and at least one of said surfaces exhibits an anti-microbial property.

25. A container comprising:

an assembly of a plurality of load bearing structures, each having an inside surface, an outside surface, a width joining the inside and outside surfaces, and four inside edges and four outside edges, each of the structures having a continuous feature extending substantially along the inside surface for no more than about 80 percent of any of the four inside edges, wherein said features on adjacent structures are of opposite interlocking characteristics.

26. The container of claim 25, further comprising slots formed or molded onto the inside surface of at least three of the load bearing structures for locating at least one divider to form multiple compartments inside the enclosure.

27. The container of claim 25 or 26, further comprising features on said inside surface of at least one of said load bearing structures for locating a cargo item within said container.

28. The container of claim 25, 26 or 27, wherein the continuous feature extends for no more than about 90 percent of the perimeter of the cargo.

29. A container for loading and transporting a cargo item comprising:

a load bearing structure having a top surface and a bottom surface joined by a width, said top surface having a continuous feature extending substantially along at least one side of the top surface for no more than about 80 percent; and

a plurality of load containing structures locatable on the top surface of the load bearing structure, each having an inside surface, an outside surface, a width joining the inside and outside surfaces, wherein each of the load containing structures include four inside edges and four outside edges.

30. The container of claim 29, wherein each of the load containing structures has a continuous feature extending substantially along the inside surface, where the continuous feature is adapted to allow the cargo item to be contained by the plurality of load containing structures.

31. The container of claim 29 or 30, wherein the continuous feature is of opposite interlocking characteristic compared with the cargo item.

32. The container of claim 29, 30 or 31, wherein the plurality of load containing structures are locatable on the load bearing structure by means of one or more protrusions in at least one of the plurality of load containing structure, where the one or more protrusions fit in the one or more grooves.

33. The container of claim 32, wherein the protrusions and the grooves mate to enclose the cargo without any component that is not part of the load bearing structure and the plurality of load containing structures.

34. The container of claim 29, 30, 31, or 32, wherein the plurality of load containing structures are locatable on the load bearing structure by means of one or more protrusions in the load bearing structure and one or more grooves in at least one of the plurality of load containing structure, where the one or more protrusions fit in the one or more grooves.

35. The container of claim 29, 30, 31, 32, 33 or 34, further comprising a RFID reader able to read one or more RFID tags in the vicinity, wherein the processor can transmit to the base station one or more parameters selected from the group consisting of one or more RFID tag location, one or more RFID tag identification code, cargo information, cargo condition, cargo container condition and time stamp.

36. A container for loading and transporting a cargo item in a volume comprising:
a load bearing structure including a top surface having a feature extending substantially along at least 80% of at least an edge of the top surface, a bottom surface and legs extending from the bottom surface, wherein the cargo is loaded on the top surface;
a pair of identical load containing structures assembled and located on the load bearing structure, said load containing structures mate to form a closed container, defining a volume, each load containing structure having an inside surface and an outside surface; and
at least one divider for dividing the volume.

37. The container of claim 36, wherein the load containing structures are locatable on the load bearing structure by means of one or more protrusions in at least one of the plurality of load containing structure, where the one or more protrusions fit in the one or more depressions.

38. The container of claim 36 or 37, further comprising pocket on the inside surface of any of the plurality of load containing structures and loading bearing structure for containing a phase change material.

39. The container of claim 37, wherein the protrusions and the depressions mate to enclose the cargo without any component that is not part of the load bearing structure and the plurality of load containing structures.

40. The container of claim 16, further comprising a bag-like enclosure for facilitating airport security check.

41. The container of claim 40, wherein any of the exposed surfaces has antimicrobial properties.

42. The container of claim 37 or 39, where the protrusions and the depressions mate to

enclose the cargo without any component that is not part of the load bearing structure and the plurality of load containing structures.

43. A loading bearing structure for use in clean rooms comprising:

an expanded polymer core with a first side, a second side and a width, said first side, second side and width having exposed surfaces; and

at least one polymer layer combined with said expanded polymer core on said first side of said expanded polymer core and at least part of said width, said load bearing structure comprises at least one substantially non-leaching antimicrobial agent having some surface activity;

wherein said load bearing structure receives cargo generated in said clean room to facilitate shipping and minimizing risk of contamination or damage.

44. The load bearing structure of claim 43, wherein said at least one antimicrobial agent is incorporated into the material for making the polymer layer.

45. The loading bearing structure of claim 43 or 44, wherein said at least one antimicrobial is coated onto at least one of the exposed surfaces of the structure.

46. The load bearing structure of claim 43, 44 or 45, wherein said at least one antimicrobial agent is capable of permanent or non-permanent binding.

47. The loading bearing structure of claim 43, 44, 45 or 46, wherein said at least one antimicrobial agent comprises one or both an organic compound and an inorganic compound.

48. The loading bearing structure of claim 43, 44, 45, 46 or 47, wherein said at least one antimicrobial agent is mixed with a carrier.

49. The load bearing structure of claim 43, 44, 45, 46, 47 or 48 further comprising at least two load enclosing structures on top of said load bearing structure to form an enclosed container.

50. The load bearing structure of claim 49, wherein said at least two loading enclosing structures comprise two identical substantially L-shape cross-section halves or two identical clam shell halves.

51. The load bearing structure of claim 43, 44, 45, 46, 47, 48, 49 or 50, wherein said first side comprises pockets for locating a phase change material.

52. A loading bearing structure for loading cargo comprising:
an expanded polymer core with a first side, a second side and a width; and
at least one polymer layer combined with said expanded polymer core on said first side of said expanded polymer core and at least part of said width;
wherein at least part of said second side and part of said width comprises at least one substantially non-leaching antimicrobial agent that is substantially free of environmentally hazardous material.

53. The load bearing structure of claim 52, wherein said polymer core comprises porous surfaces.

54. The loading bearing structure of claim 52 or 53, wherein said substantially non-leaching antimicrobial component has a very low volatility and very low water solubility.

55. The loading bearing structure of claim 52, 53, or 54, wherein said antimicrobial component is active against one or more foreign hosts, selected from the group consisting of bacteria, viruses, fungi, protists, helminths and insect larvae.

56. The load bearing structure of claim 52, 53, 54 or 55, wherein said at least one antimicrobial agent is dispersed in a water based composition comprising at least one polymeric carrier in the form of an emulsion or dispersion.

57. The load bearing structure of claim 52, 53, 54, 55 or 56, wherein a second one polymer layer is combined with said expanded polymer core on said second side of said expanded polymer core and at least part of said width.

58. The load bearing structure of claim 57 wherein said at least part of said second polymer layer is interposed between said at least part of said second side and said antimicrobial agent.

59. A loading bearing structure comprising:

an assembly of a plurality of load bearing structures, each having:

an expanded polymer core with a first side, a second side and a width, said first side, second side and width,
at least one polymer layer combined with said expanded polymer core on said first side, the width and at least part of said second side of said expanded polymer core; and
a water based antimicrobial composition comprising at least one polymeric carrier in the form of an emulsion or dispersion and at least one substantially non-leaching antimicrobial agent is coated on said second side.

60. The load bearing structure of claim 59, wherein at least one of said plurality of load bearing structures comprises pockets on at least one of said sides for locating a phase change material.

61. The loading bearing structure of claim 59 or 60, wherein said load bearing structure is adapted for receiving cargo generated in a clean room to facilitate shipping and minimizing risk of contamination or damage.

62. The loading bearing structure of claim 61, wherein said cargo comprises electronic parts or pharmaceuticals.

63. A system for facilitating security check for air freight cargo comprising:

a light weight load bearing structure for loading perishable cargo, said load bearing structure having a top deck, a bottom deck and a width joining the top and the bottom, said bottom deck having a plurality of legs extending therefrom and said cargo being loaded onto the top deck of the load bearing structure; and

a bag-like enclosure for covering the cargo and at least a portion of the width of the load bearing structure, said bag-like enclosure having an opening with an elastic property about its circumference for stretching over the width of the load bearing structure;

wherein the load bearing structure and bag-like enclosure are both transparent to a magnetic imaging scanner used in security scanning to facilitate the security check of perishable cargo without the need for unloading and reloading of the cargo from the load bearing structure.

64. The system of claim 63, wherein said plurality of legs originating from about a mid-section of the width of the load bearing structure.

65. The system of claim 63 or 64, wherein said load bearing structure comprises a polymeric foam core having at least one polymeric layer surrounding at least the top deck and a portion of the width.

66. The system of claim 63 or 64, wherein said load bearing structure comprises at least one wall extending from the top deck to form a tray-like structure.

67. The system of claim 63, 64, 65 or 66, wherein said enclosure comprises a material having some stretchability to fit tautly over the cargo.

68. The system of claim 63, 64, 65 66 or 67, wherein said enclosure is breathable.

69. The system of claim 63, 64, 65 66 or 67, wherein said enclosure is breathable and biodegradable.

70. A system for facilitating security check for air freight cargo comprising:
a light weight load bearing structure for loading perishable cargo, said load bearing structure having a top deck, a bottom deck and a width joining the top and the bottom, said bottom deck having a plurality of legs extending therefrom and said cargo being loaded onto the top deck of the load bearing structure;
a bag-like enclosure for covering the cargo and at least a portion of the width of the load bearing structure, said bag-like enclosure having an opening with an elastic property about its circumference for stretching over the width of the load bearing structure; and
at least one phase change material present on said load bearing structure;
wherein the load bearing structure and bag-like enclosure are both transparent to a magnetic imaging scanner used in security scanning to facilitate the security check of perishable cargo without the need for unloading and reloading of the cargo from the load bearing structure.

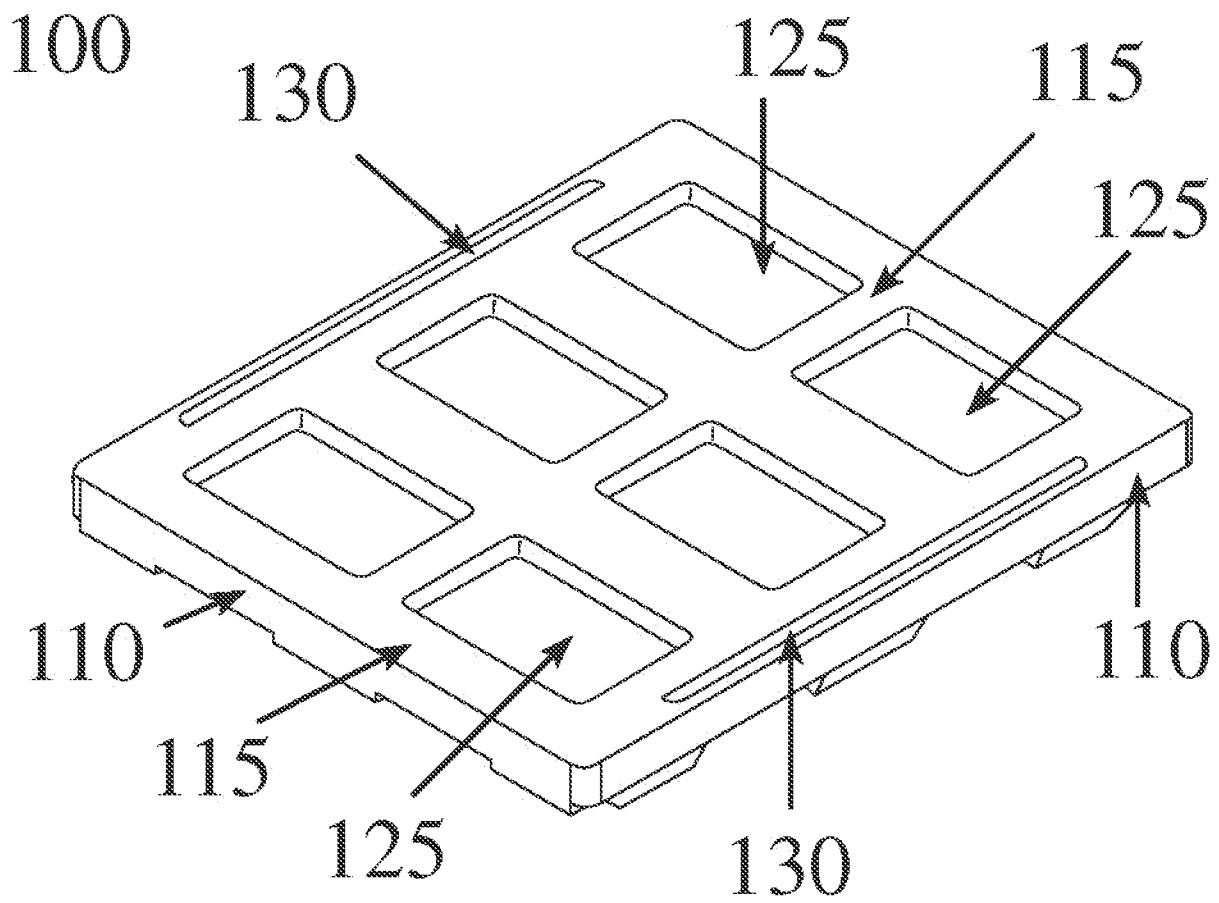
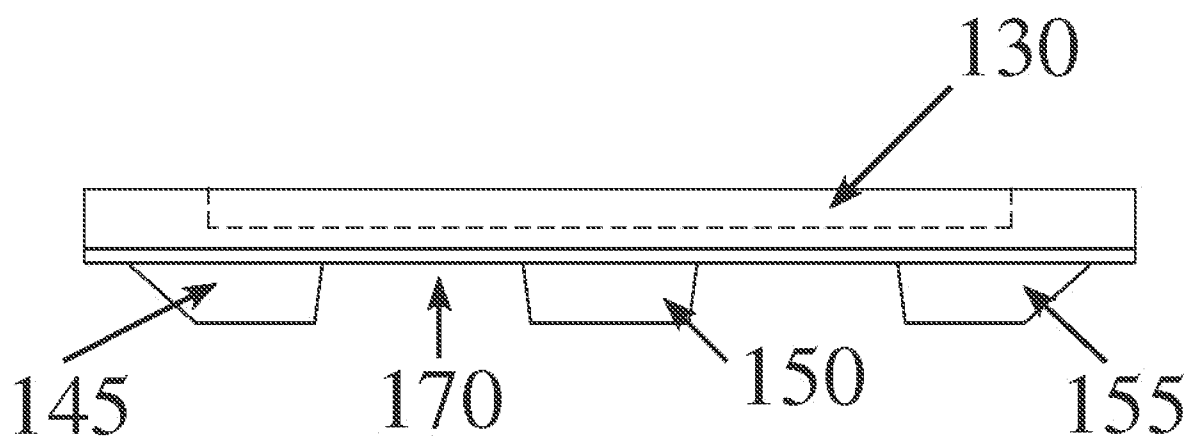
71. The system of claim 70 wherein said phase change material is contained in its own package.

72. The system of claim 71 wherein said phase change material is in close proximity to said cargo.

73. A system for facilitating security check for air freight cargo comprising:
a light weight cargo container for containing perishable cargo, said cargo container having at least one phase change material to insulate the cargo for climate control;
a load bearing structure having a top deck, a bottom deck and a width joining the top and the bottom for loading said cargo container on onto the top deck of the load bearing structure, said bottom deck having a plurality of legs extending therefrom; and
a bag-like enclosure for covering the cargo container, said bag-like enclosure having an opening with an elastic property about its circumference for stretching over the cargo container and the width of the load bearing structure;
wherein the cargo, cargo container, load bearing structure and bag-like enclosure are transparent to a magnetic imaging scanner used in security scanning to facilitate the security check of perishable cargo without the need for unloading and reloading of the cargo from the load bearing structure.

73. The system of claim 72 wherein said phase change material is capable of multiple phase transformations.

74. The system of claim 72 or 73, wherein said cargo container comprises at least two phase change material having different thermal properties.

**FIG. 1A****FIG. 1B**

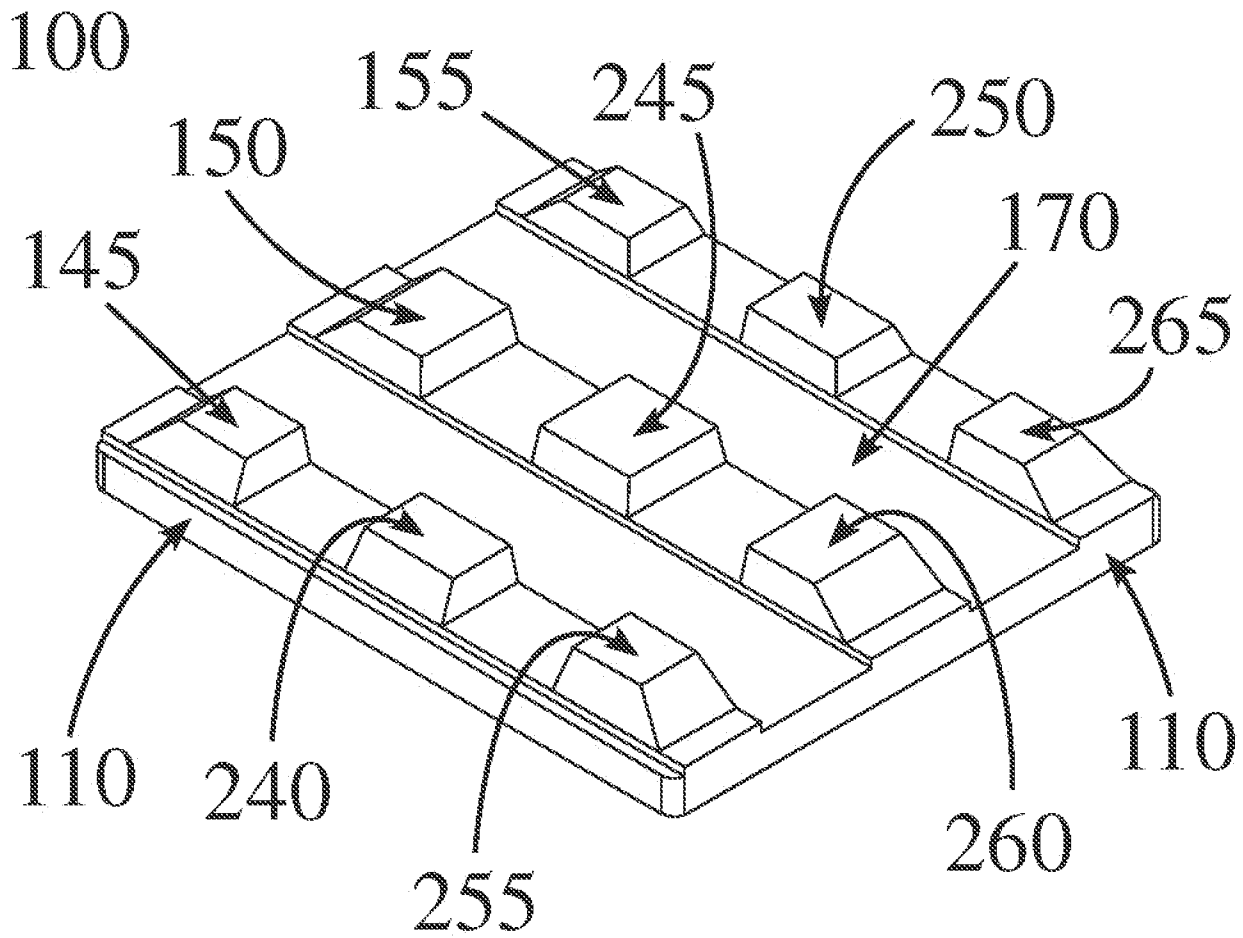


FIG. 2A

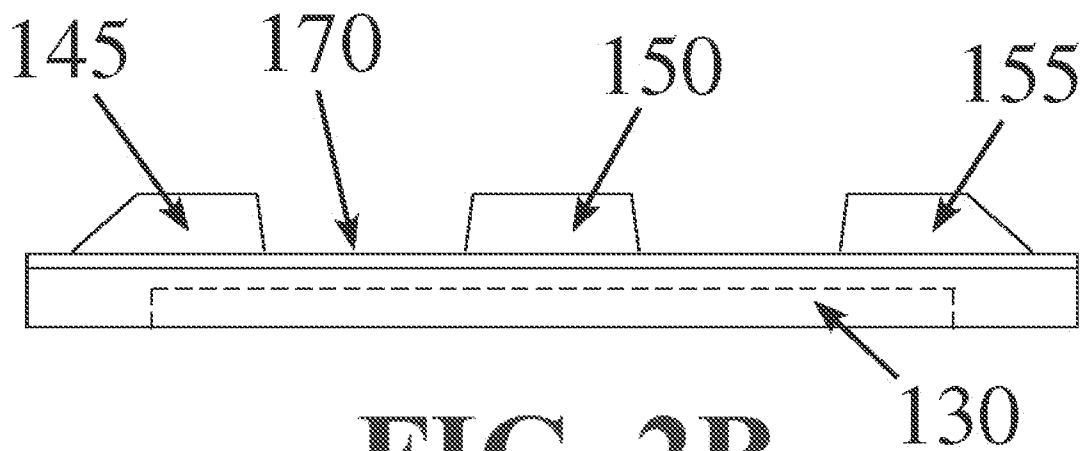


FIG. 2B

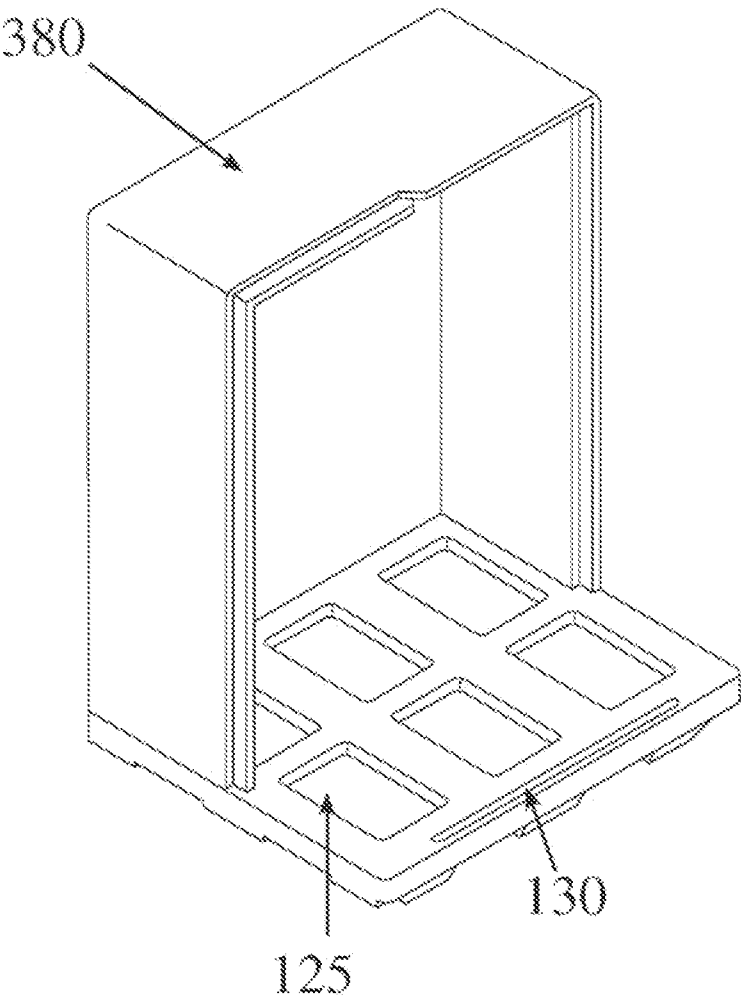


FIG. 3

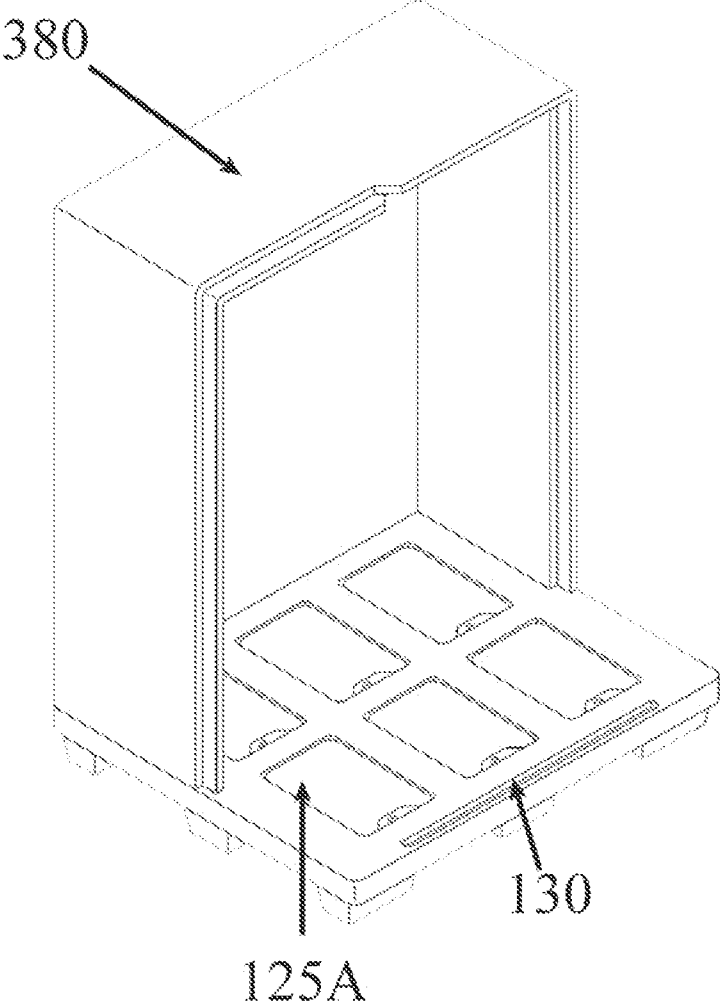


FIG. 3A

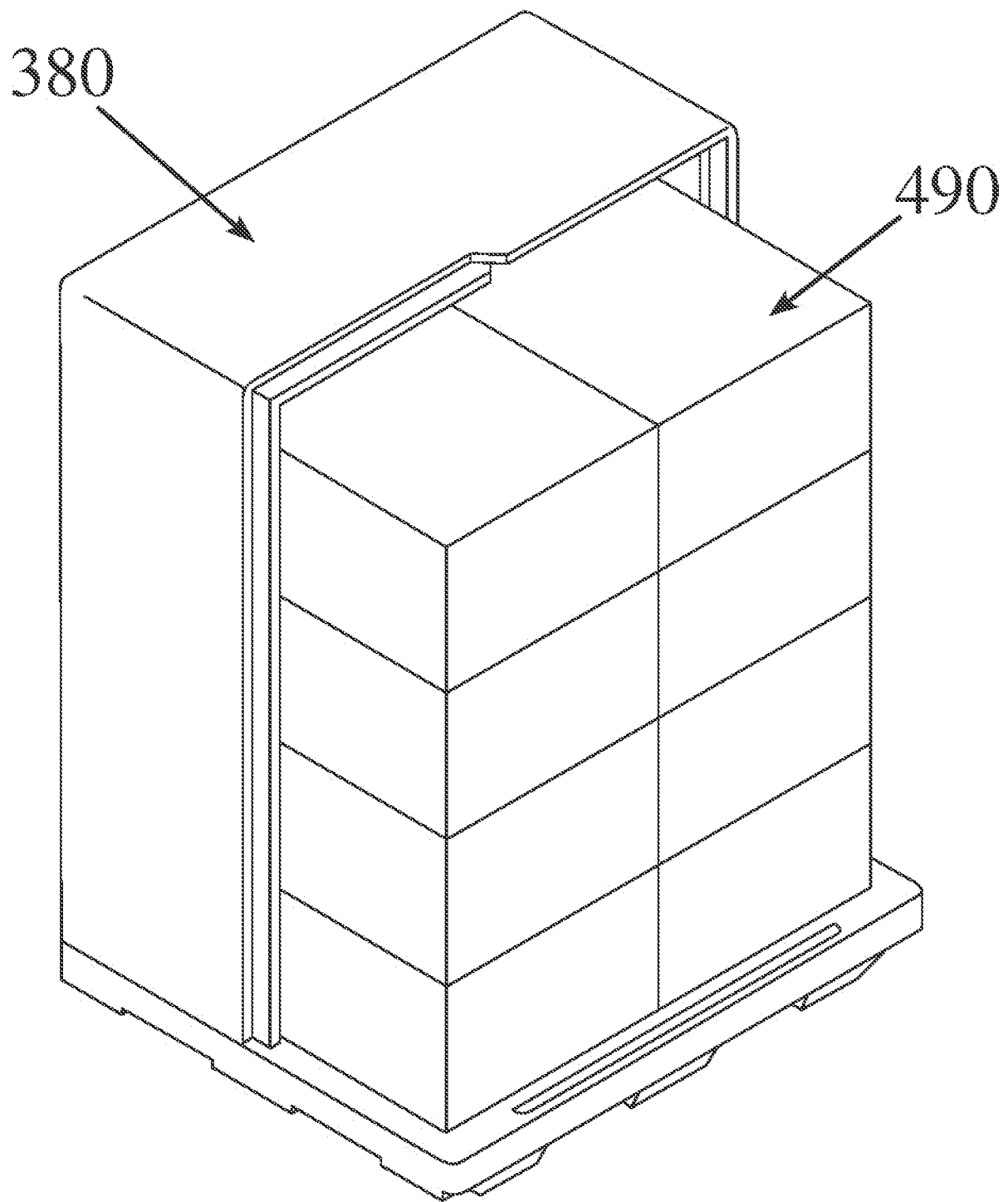
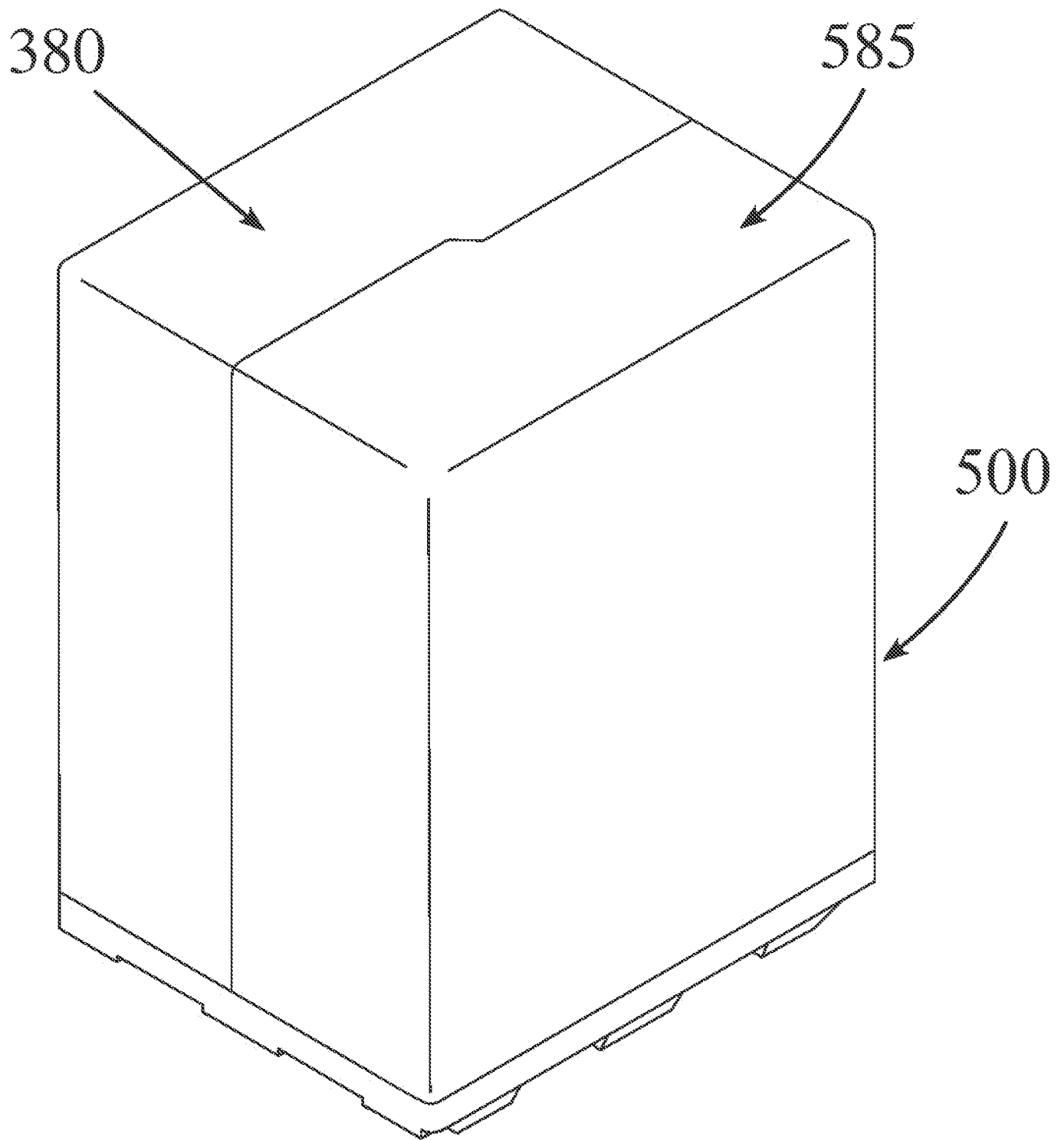


FIG. 4

**FIG. 5A**

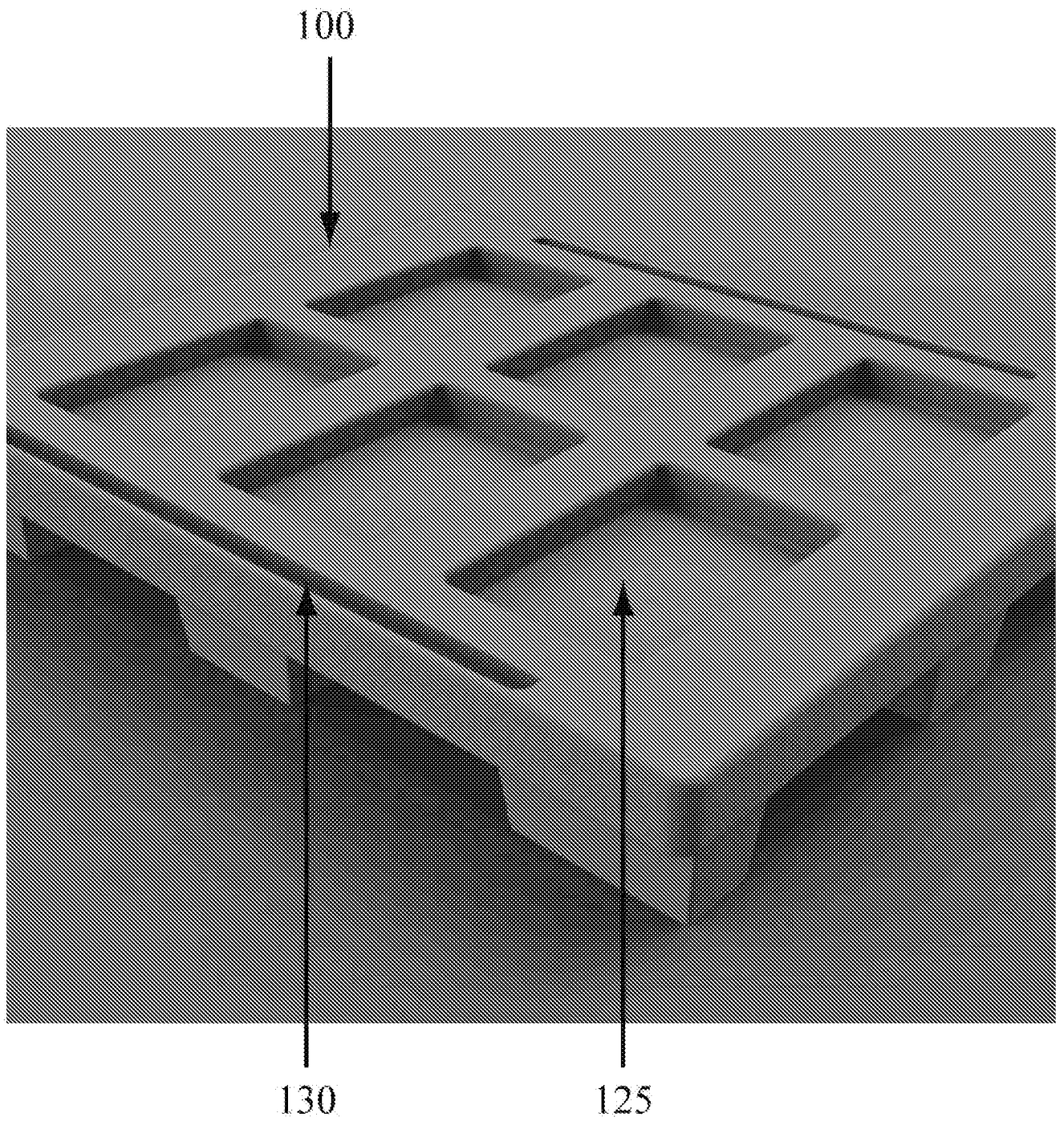


FIG. 1C

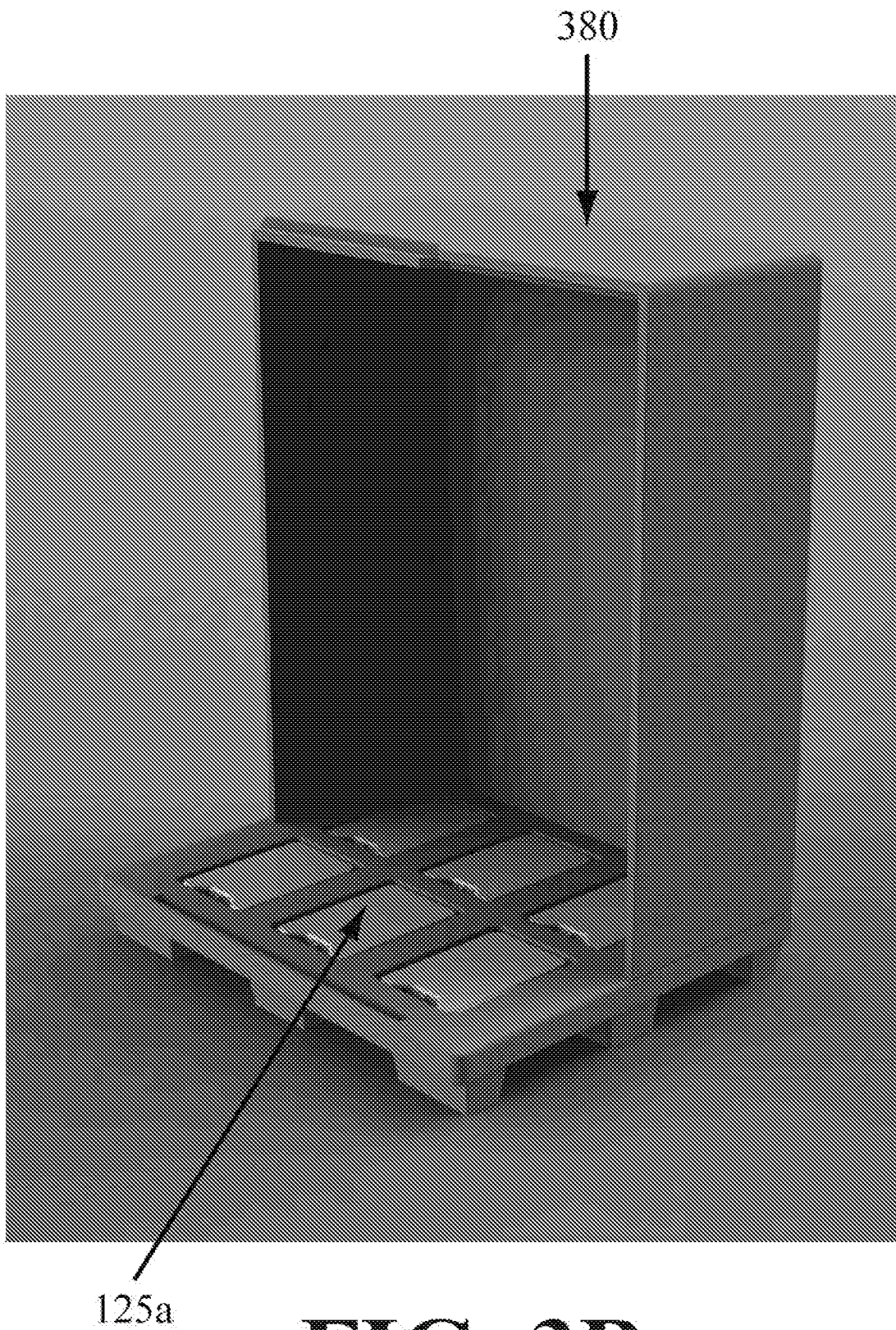


FIG. 3B

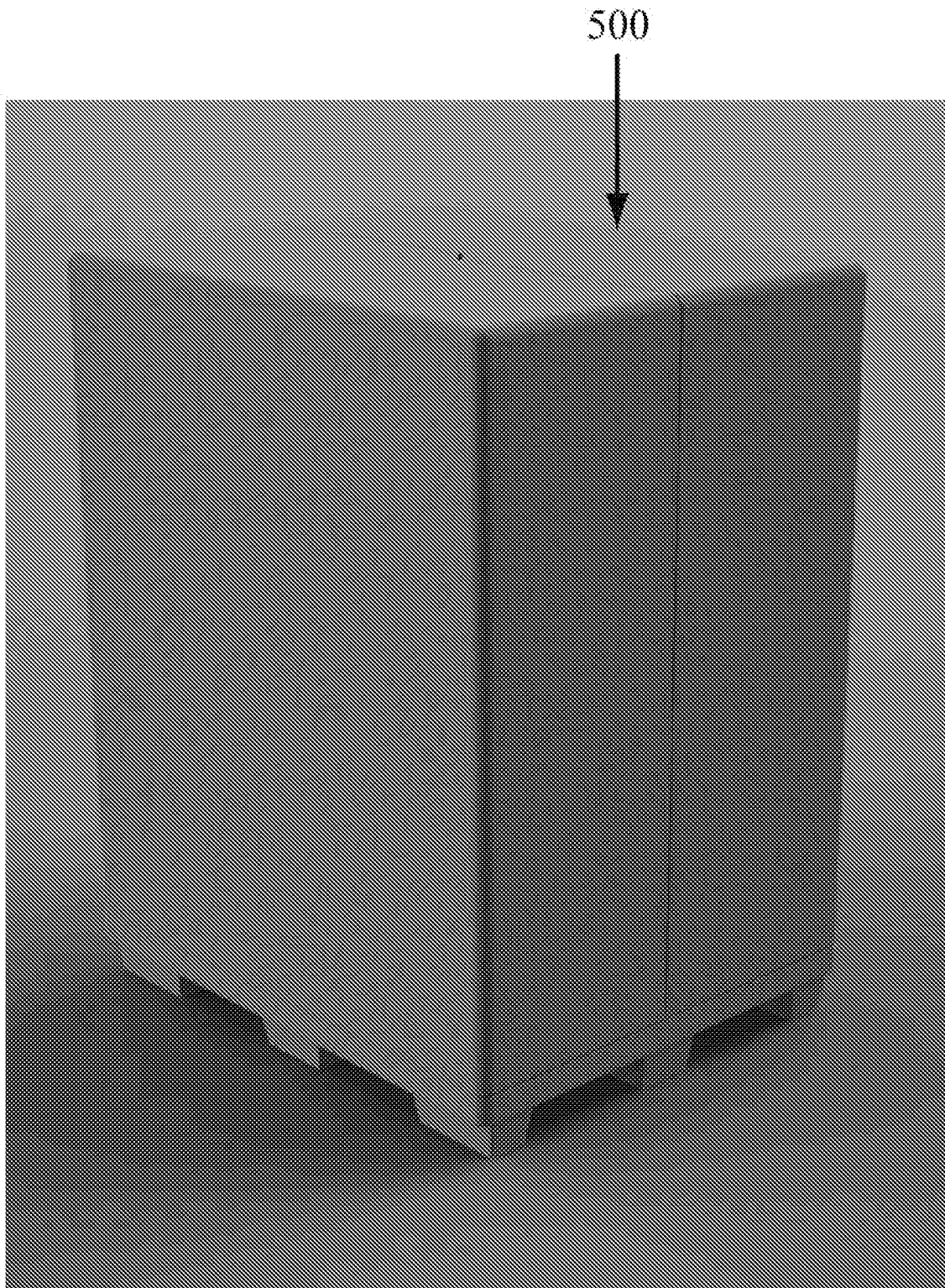


FIG. 5B

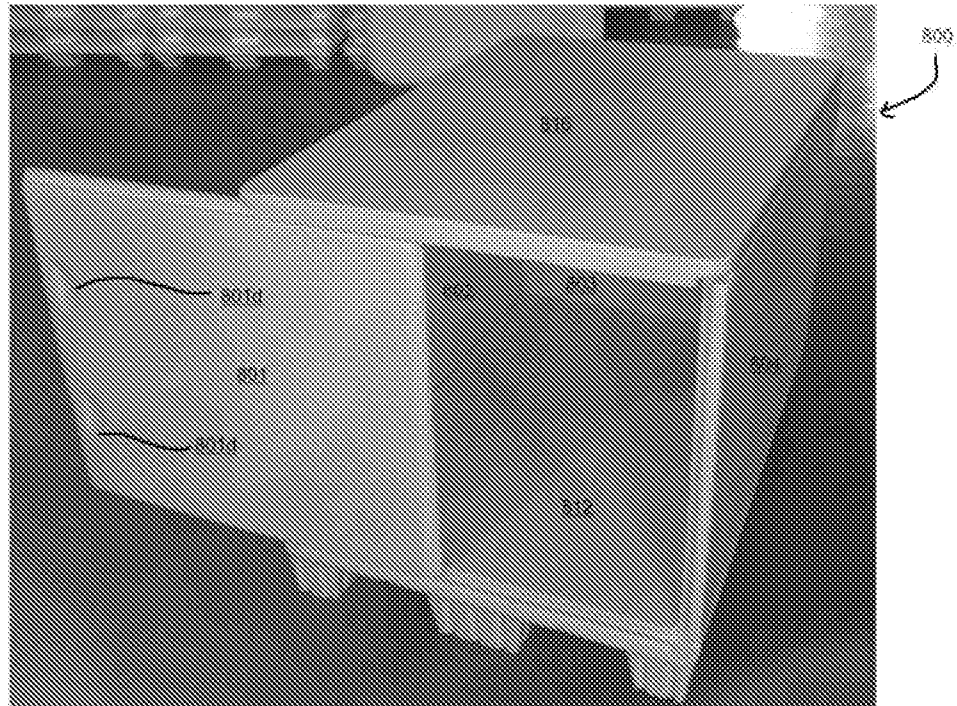


FIG. 8E

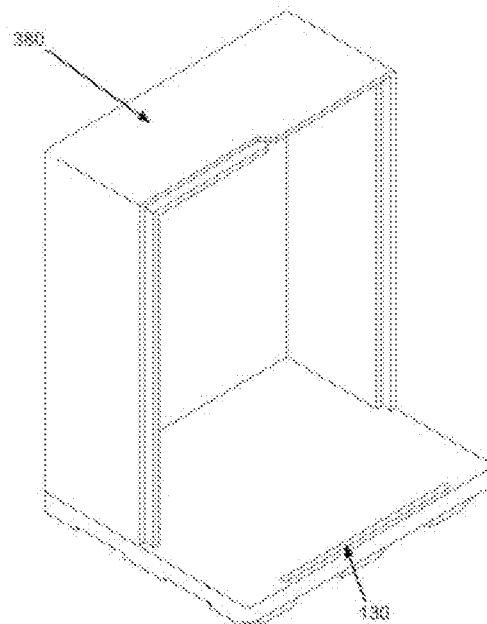


FIG. 9

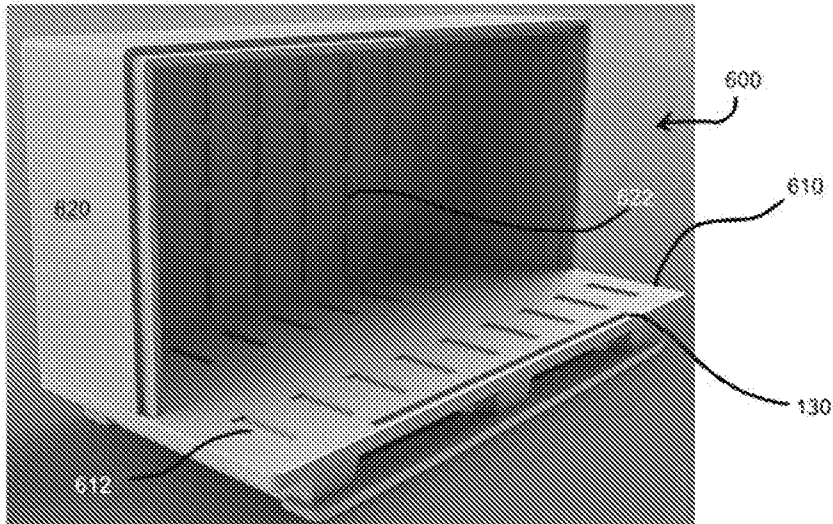


FIG. 6

FIG. 6A

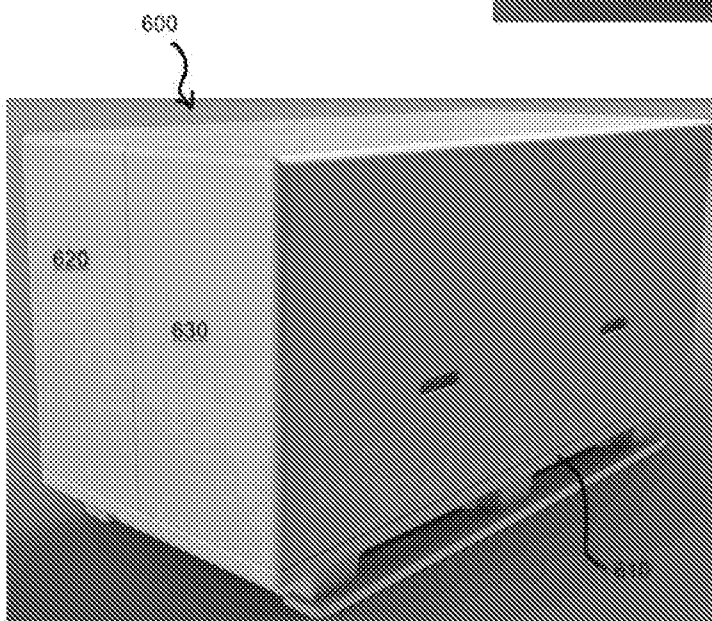
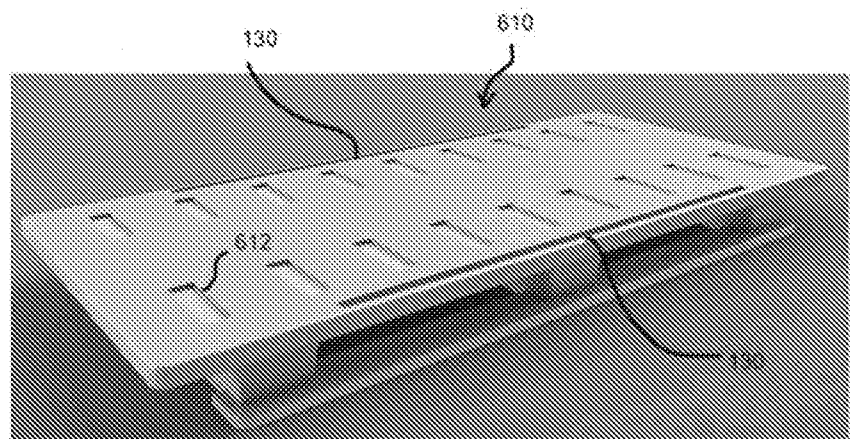


FIG. 7

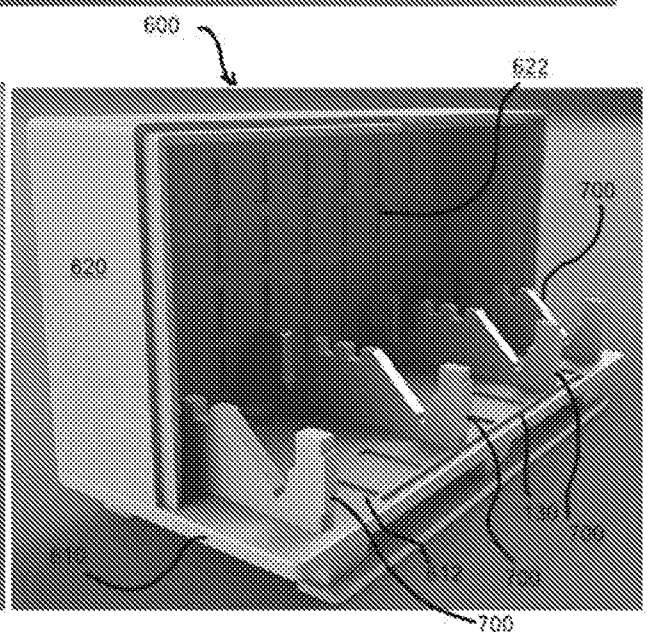


FIG. 7A

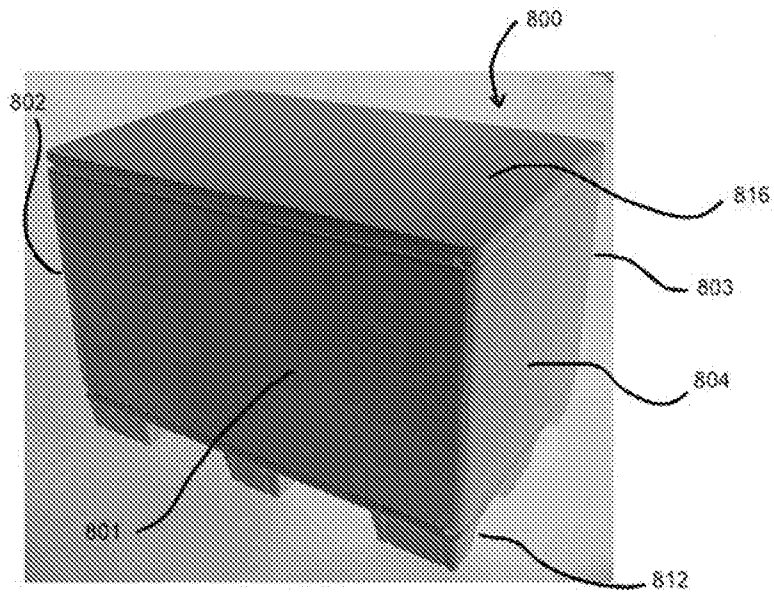


FIG. 8

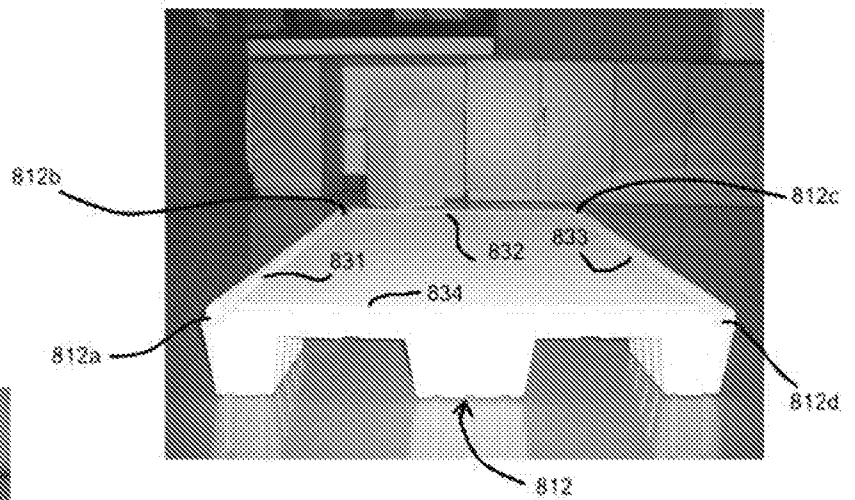


FIG. 8A

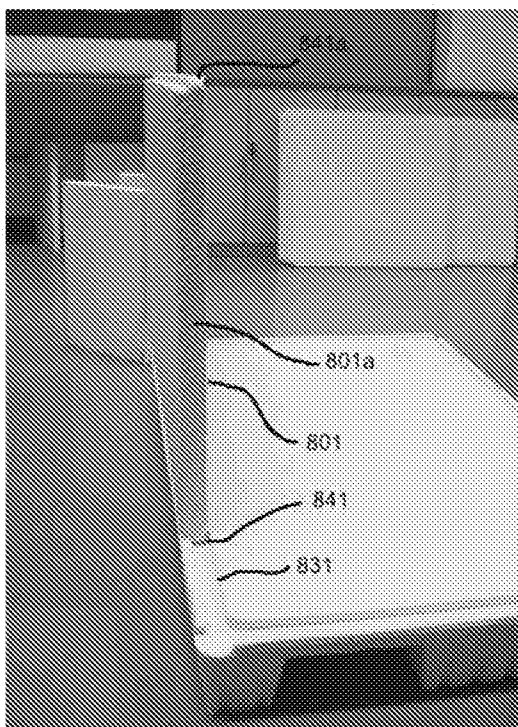


FIG. 8B

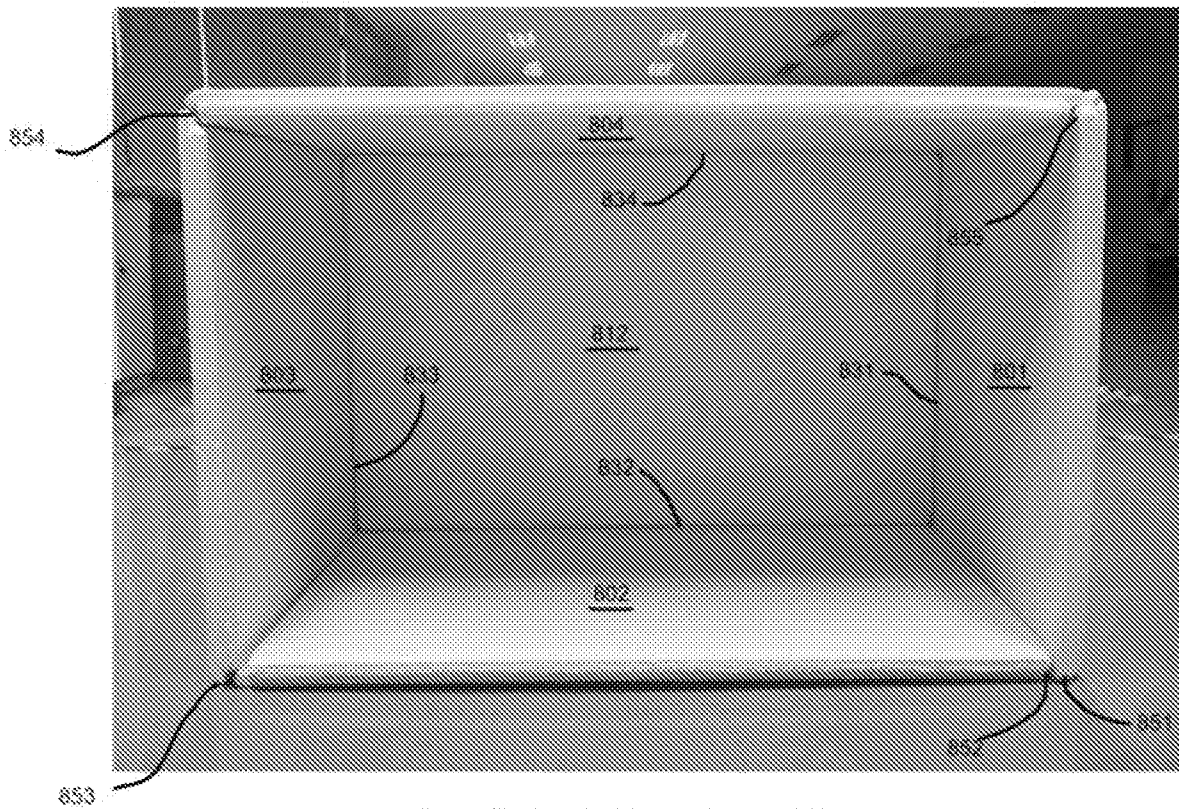
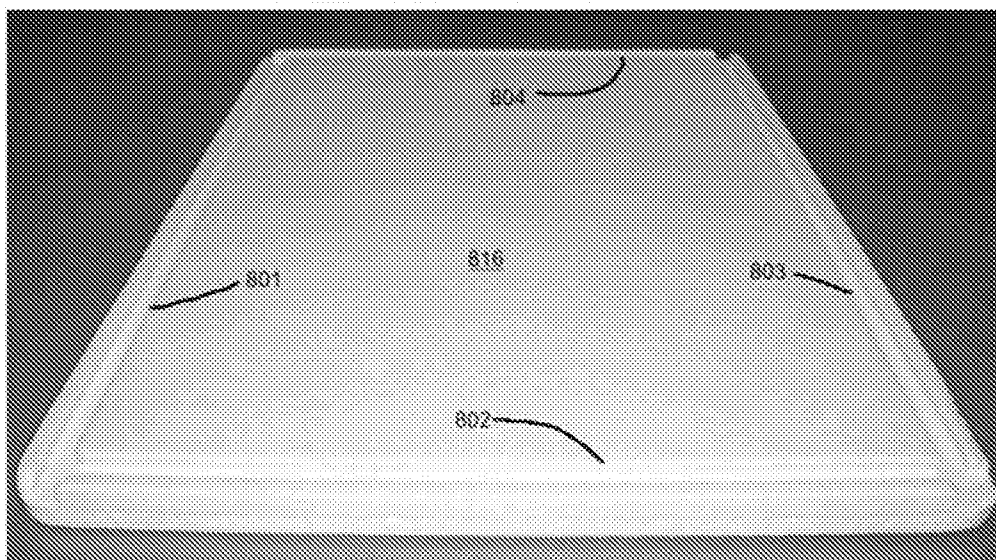
**FIG. 8C****FIG. 8D**



FIG. 10

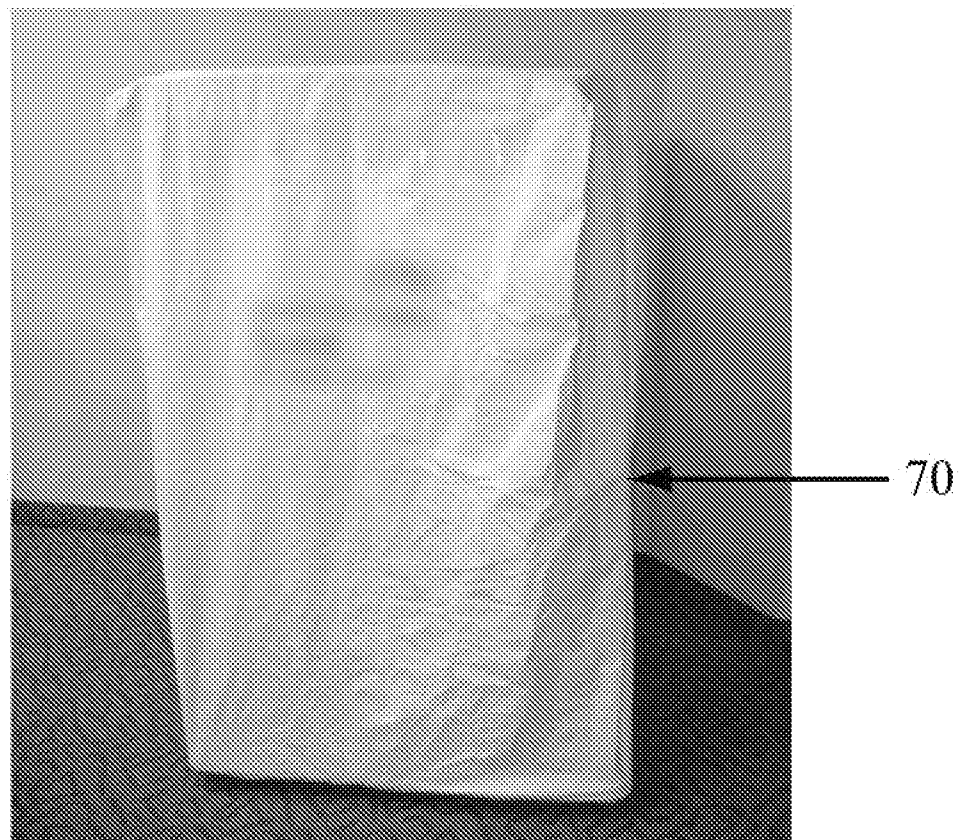


FIG. 10A