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Description

Passive Temperature Controlled Packaging System as a ULD

Technical Field

[0001] The present disclosure relates generally to air freight shipping containers and, more particularly, to a passive temperature controlled packaging system meeting specifications for a unit load device (ULD).

Background

[0002] A unit load device (ULD) is a pallet or container used to load luggage, freight, mail or other types of cargo into wide-body aircraft and into certain narrow-body aircraft. ULDs come in standard sizes that may be compatible with the specific aircraft in which they are loaded, and allow large quantities of cargo to be bundled into a single unit. Consolidation of the cargo into the ULDs leads to fewer individual units to load into the cargo area, thereby saving ground crews time and effort, and helping to keep flights on schedule. Typically, each ULD will have an accompanying packing list or manifest that allows the contents of the ULD to be tracked.

[0003] ULDs typically come in two forms: pallets and containers. ULD pallets are rugged sheets of aluminum with rims designed to lock onto cargo net lugs. The ULD pallets have fork openings for receiving forks of forklifts or other cargo handling equipment to move the ULDs onto and off of the aircraft. ULD containers, which may be referred to as cans and pods, are closed containers typically made of aluminum or a combination of a frame fabricated from aluminum and walls fabricated from Lexan or other appropriate polycarbonate material. Depending on the nature of the goods to be transported, a ULD container may have a built-in refrigeration unit for maintaining a specified temperature within the ULD container.

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[0004] The refrigeration units in presently known ULD containers are active temperature control devices that operate to adjust the temperature inside the ULD container to keep the internal temperature within a specified temperature range. The active temperature control devices are electrical cooling and heating systems that operate in response to internal temperature sensors to regulate the internal temperature. Such active temperature control devices in ULD containers may be expensive and require routine maintenance to manage the mechanical components. Failure of the mechanical components can cause nearly immediate temperature excursions and spoilage of the temperature-reliant cargo stored therein, which can be particularly problematic for life saving pharmaceutical products.

[0005] Passive temperature control solutions, on the other hand, are insulated boxes or containers without any active temperature control. Consequently, passive temperature control packaging does not have systems to make temperature adjustments in response to changes in the internal temperature of the container. Existing passive temperature-controlled packaging solutions are not ULD containers, and typically do not conform to the standard sizes designated for ULD containers. The non-ULD containers are typically loaded onto ULD pallets for consolidation with other packages. Labor is required for the secondary step of positioning the passive temperature-controlled non-ULD containers on the ULD pallets and covering the non-ULD containers with cargo nets. This often leaves open space that is not consumed by cargo but still incurs cargo fees. The nonconformity of the passive temperature-controlled packaging may require additional labor and handling for loading the cargo onto aircraft, which can reduce aircraft loading efficiencies and result in departure delays. Moreover, the non-uniform containers may not have the same tracking capability and customs clearances as the ULD containers, which can further increase processing times through the air freight supply chain.

Summary of the Disclosure

[0006] In one aspect of the present disclosure, a container suitable for use in a shipment of a cargo by air is disclosed. The container may include a container

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body having a top wall, a bottom wall, a front wall, a rear wall and oppositely disposed side walls, wherein the container body defines a cargo space within the container, and a passive temperature control system located within the cargo space. The passive temperature control system may include a plurality of insulation panels, wherein each of the plurality of insulation panels is connected to an inner surface of a corresponding wall of the container body, a rack proximate one of the top wall and one of the oppositely disposed side walls, the rack defining a slot, and a plurality of refrigerant bottles filled with a thermal medium. The plurality of refrigerant bottles and the thermal medium may be one of cooled and heated to a predetermined temperature for the cargo being shipped in the container and inserted into the slot of the rack to passively maintain a cargo space temperature in the cargo space during the shipment of the cargo.

[0007] In another aspect of the present disclosure, a container suitable for use in a shipment of a cargo by air is disclosed. The container may include a container body and a passive temperature control system. The container body may have a top wall, a bottom wall, a front wall, a rear wall and oppositely disposed side walls, wherein the container body defines a cargo space within the container, and wherein the container body may be fabricated as a structure that is a compliant unit load device (ULD) container meeting specified aviation authority structural requirements. The passive temperature control system is located within the cargo space and may have a plurality of insulation panels each connected to an inner surface of a corresponding wall of the container body, at least one rack proximate a corresponding one of the top wall and the oppositely disposed side walls of the container body, and a plurality of refrigerant bottles filled with a thermal medium and received by the at least one rack to passively maintain a cargo space temperature in the cargo space during the shipment of the cargo.

[0008] In a further aspect of the present disclosure, a refrigerant bottle for a container suitable for use in a shipment of a cargo by air is disclosed. The container may have an inner insulation layer and a rack proximate an insulation panel of the inner insulation layer and defining at least one slot. The refrigerant bottle may include a reservoir body that is sized to be inserted into the at least one

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slot of the rack, and a connection mechanism defined in the reservoir body and configured to connect a plurality of refrigerant bottles in series for insertion and removal of multiple refrigerant bottles into and out of the at least one slot together. The refrigerant bottle may be one of cooled and heated to a predetermined temperature for the cargo being shipped in the container and inserted into the slot of the rack to passively maintain a cargo space temperature in a cargo space of the container during the shipment of the cargo.

[0009] Additional aspects are defined by the claims of this patent.

Brief Description of the Drawings

[0010] Fig. 1 is an isometric view of a container meeting ULD specifications and having a passive temperature controlled packaging system in accordance with the present disclosure;

[0011] Fig. 2 is an isometric view of the container of Fig. 1 with a door removed;

[0012] Fig. 3 is an exploded isometric view of a base plate and a bottom insulation panel of the container of Fig. 1;

[0013] Fig. 4 is an exploded isometric view of the base plate of Fig. 3;

[0014] Fig. 5 is a front view of racks and refrigerant bottles of the container of Fig. 1;

[0015] Fig. 6 is an enlarged view of a portion of one of the racks and corresponding refrigerant bottles of Fig. 5;

[0016] Fig. 7 is an isometric view of a refrigerant bottle in accordance with the present disclosure;

[0017] Fig. 8 is an isometric view of two of the refrigerant bottles of Fig. 7 connected to each other;

[0018] Fig. 9 is an isometric view of a thermal break in accordance with the present disclosure; and

[0019] Fig. 10 is an exploded isometric view of a pallet, a bottom insulation panel and thermal breaks of the container of Fig. 1.

Detailed Description

[0020] As shown in Figs. 1 and 2, a passive temperature-controlled container 10 in the form of a ULD-compliant container for shipping cargo by air as well as sea and land is disclosed. The container 10 may be made from composite materials to provide a damage resistant container that is lighter than conventional metal ULDs. The container 10 implements passive temperature control as illustrated and described herein, but may incorporate integrated real-time data capabilities, including internal and ambient temperature tracking and geolocation information as discussed further below. The container 10 may comprise a pallet 12 on which an outer enclosure 14 is mounted. A passive temperature control system 16 (Fig. 2) as illustrated and described more fully below is installed within the outer enclosure 14. The pallet 12 may be a standard ULD pallet meeting the specifications for a particular type of ULD pallet. The pallet 12 may be formed from aluminum or other appropriate material, and may include a plurality of forklift holes 18 into which forks of a forklift or implements of other material handling equipment may be inserted to move the container 10.

[0021] In the illustrated embodiment, the pallet 12, the outer enclosure 14 and a door 20 (i.e., container body) of the container 10 may be cubic and have dimensions that are compliant with particular ULD container specifications. In this embodiment, the container body designed and tested in accordance with specified requirements of the Federal Aviation Administration (FAA) or other appropriate national aviation authority to obtain certification for safe transport of cargo. For example, the container body may be designed and tested by a facility licensed with the aviation authority to meet the requirements of an applicable technical standards order (TSO), such as FAA TSO C90 for cargo pallets, nets and containers which is incorporated by reference herein, and with the test results scrutinized and accepted by the FAA or other aviation authority for issuance of certification indicating that the container body is a compliant ULD container.

[0022] In alternative embodiments, compliant and non-compliant ULD containers in accordance with the present disclosure may have an overall width

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that is larger than a base width depending on the particular ULD container specifications to which the ULD container is being constructed. The outer enclosure 14 as illustrated includes a top wall, a rear wall and oppositely disposed side walls that may be fabricated by thermoforming a plastic sheet using thermoforming techniques known in the art to form the top, rear and side walls as a single unitary component. The outer enclosure 14 may be thermoformed to add stiffness to the edges where the walls intersect so that additional reinforcing framework may be unnecessary. The outer enclosure 14 may be mounted to the pallet 12 and secured by appropriate attachment mechanisms (not show), such as rivets, nuts and bolts, screws and anchors, and the like. The door 20 may constitute a front wall of the outer enclosure 14 and container body, and may be connected to a front edge of one of the side walls by a hinge 22 to rotate between a closed position (Fig. 1) and an open position. The door 20 may have a latch mechanism 24 that secures the door 20 in the closed position. The latch mechanism 24 may include a locking mechanism if necessary to prevent pilferage of the cargo transported in the container 10. An outer face of the door 20 may be formed from same plastic material as the other walls of the outer enclosure 14, or may be formed from other appropriate materials if necessary to meet structural, operational and/or thermodynamic requirements for the container 10. Once assembled, the pallet 12, the outer enclosure 14 and the door 20 define a cargo space 26 (Fig. 2) for holding cargo and the passive temperature control elements of the container 10. The outer enclosure 14 and the door 20 may be configured so that a thermal seal is formed when the door 20 is closed to minimize heat transfer across the interface between the cargo space 26 and the surrounding environment.

[0023] Referring to Fig. 2, the passive temperature control system 16 is disposed within the cargo space 26 and is formed by an insulation layer of insulation panels formed from insulating material and other temperature control elements. In one embodiment, the insulation panels of the passive temperature control system 16 are a composite structure formed of a vacuum insulated panel (VIP) embedded in and surrounded by expanded polypropylene (EPP) foam. The insulation panels correspond to the pallet 12, the walls of the outer enclosure 14 and the door 20.

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Consequently, a bottom insulation panel is attached to the top surface of the pallet 12, top, rear and side insulation panels are mounted on the inner surfaces of the top, bottom and side walls of the outer enclosure 14, respectively, and a door insulation panel is mounted on an inner surface of the door 20. In one embodiment, the top, rear and side panels are integrally formed as a unitary component. The bottom insulation panel may also be included. In other embodiments, the outer enclosure 14 and corresponding panels of the passive temperature control system 16 may have a fully integrated construction where the insulation panels are formed with the walls and then the combined outer enclosure/inner insulation layer is mounted on the pallet 12.

[0024] To provide structural stability and stiffness to the internal structure of the cargo space 26, the container 10 and the passive temperature control system 16 may include a baseplate 30 that will rest on top of a bottom insulation panel 32 as shown in Fig. 3. The baseplate 30 may have a composite structure such as that illustrated in Fig. 4. The baseplate 30 may include an upper metal sheet 34, a lower metal sheet 36 and an internal core 38 sandwiched between the metal sheets 34, 36. The metal sheets 34, 36 may be fabricated from an appropriate metal, such as stainless steel. The internal core 38 may be fabricated from a thermoplastic polymer such as high density polyethylene (HDPE). The baseplate 30 may further include a sealant such as silicone applied to some or all of the edges where the internal core 38 is exposed to retain moisture within the internal core 38. The composite structure of the baseplate 30 is designed to provide structural strength in the cargo space 26 as well as minimizing heat transfer from the exterior of the container 10. When the baseplate 30 is installed on the bottom insulation panel 32, the baseplate 30 provides a durable surface for placement of cargo in the cargo space 26.

[0025] Within the passive temperature control system 16 is a rack system (Figs. 2, 5 and 6) that will hold passive temperature control elements in the form of refrigerant bottles 40 (Figs 2 and 5-8). The rack system may include a top rack 42 proximate the top insulation panel, and side racks 44 proximate corresponding side insulation panels. Each of the racks 42 may have a similar construction. A

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plurality of parallel slats 46 are disposed on either side of the racks 42, 44. Upper U-shaped tracks 48 and lower U-shaped tracks 50 are perpendicular to and separate the slats 46 on either side of the racks 42, 44. The upper tracks 48 are oriented with their channels open downward, and the lower tracks 50 are oriented with their channels facing upward so that the slats 46 and the tracks 48, 50 define a plurality of slots that will receive one or more of the refrigerant bottles 40.

[0026] The refrigerant bottles 40 are illustrated in greater detail in Fig. 7 and 8. Referring to Fig. 7, the refrigerant bottle 40 has a hollow reservoir body 52 that forms a rigid or semi-rigid enclosure for a thermal medium such as water or an appropriate phase change material such as those disclosed in U.S. Patent No. 8,443,623 and 9,376,605. The thermal medium may be added through a fill port that is covered by a removable fill 54. The reservoir body 52 has a width that is less than a width between the slats 46, and a height that is less than a distance spacing the corresponding tracks 48, 50 the form one of the slots. An upper shoulder 56 and a lower shoulder 58 extend from top and bottom edges of the reservoir body 52, respectively, and are dimensioned so that the upper shoulder 56 is received into the channel of the upper track 48 and the lower shoulder 58 is received into the channel of the lower track 50 to guide the refrigerant bottle 40 into the slot.

[0027] The refrigerant bottles 40 may further include features to facilitate loading and unloading multiple bottles 40 in each slot. In the illustrated embodiment, a connection mechanism for adjacent refrigerant bottles 40 is formed by one or more bottle tabs 60 may extend outward at one end of the reservoir body 52, and a corresponding number of bottle sockets 62 may be defined in the opposite end of the reservoir body 52. The bottle tabs 60 and the bottle sockets 62 are configured to interlock as shown in Fig. 8 so that connected refrigerant bottles 40 will move together into an out of the slots. The refrigerant bottles 40 may further be configured with handles 64 defined therein that may be grasped by a cargo handler that is loading or unloading the container 10.

[0028] Returning to Figs. 5 and 6, the racks 42, 44 may be connected to each other to form a unitary structure. Corner rails 70 may be connected to ends of

adjacent racks 42, 44. Base rails 72 may be attached at bottom ends of the side racks 44. Separation of the racks 42, 44 from the pallet 12 may be desirable to minimize heat transfer between the internal and external structures. Such separation may be achieved with thermal breaks 80 as shown in Fig. 9. Each thermal break 80 may have a break body 82 with 3 downward extending break feet 84 and at least one upward extending break shoulder 86. The number of break feet 84 and break shoulders 86 in the illustrated embodiment is exemplary, and the thermal break 80 may be configured as necessary to provide support for the racks 42, 44.

[0029] The bottom insulation panel 32 may include corresponding break holes 88 (Fig. 3 and 10) there through that are sized to receive the thermal breaks 80. The baseplate 30 may also have corresponding break notches 90 through which at least the break shoulders 86 may extend upward. An overall height of the thermal breaks 80 may be greater than a combined thickness of the baseplate 30 and the bottom insulation panel 32 one assembled. With this configuration, the break feet 84 may rest on a top surface 92 of the pallet 12, and extends through the break holes 88 and the break notches 90. The racks 44 may then sit on the break shoulders 86 and be spaced above the baseplate 30 and the bottom insulation panel 32. The thermal breaks 80 may be fabricated from a thermally insulating polymeric to minimize heat transfer there through while simultaneously having sufficient strength to withstand the anticipated loading of the racks 42, 44 and the filled refrigerant bottles 40. The illustrated embodiment includes 4 thermal breaks 80, but fewer or more may be used as necessary to support the racks 42, 44 and the refrigerant bottles 40.

[0030] While temperature control within the container 10 is a passive system, the container 10 may still include active elements for monitoring and tracking of the container 10. Consequently, the container 10 may include an onboard telemetry device (not shown) that provides worldwide communication for location tracking and condition monitoring. Temperature, along with the humidity, pressure, light, shock, tilt, door position, latch status and other parameters may be monitored via appropriate sensors. The information from the telemetry system may provide

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visibility allowing customers to drive risk out of transport of temperature dependent cargo through the air freight supply chain.

Industrial Applicability

[0031] The containers 10 in accordance with the present disclosure may be effective to reliably transport temperature sensitive cargo. At the time of packing, the refrigerant bottles 40 and the thermal medium therein may be cooled or warmed to a desired temperature. The bottle tabs 60 and the bottle sockets 62 of adjacent bottles 40 may be interlocked so that multiple bottles 40 can be inserted into the slots in the racks 42, 44. After the cargo is loaded, the door 20 may be closed to passively yet reliably maintain a necessary temperature within the cargo space 26 during transit. After arrival and unloading of the cargo from the container 10, the front bottles 40 may be grasped by the handles 64 to pull the connected bottles 40 from the slots so they can be heated or cooled to the appropriate temperature for a subsequent shipment.

[0032] The passive temperature-controlled container 10 in the form of a ULD container, in contrast to previously known non-ULD passive temperature-controlled containers, more easily moves through the air freight supply chain, thereby reducing labor and handling requirements, reducing deliver time and flight delays, and increasing aircraft yield. Additionally, the passive temperature-controlled container 10 has many fewer failure paths that can cause changes in temperature within the container 10 that can cause spoilage of temperature-sensitive cargo being transported therein.

[0033] While the preceding text sets forth a detailed description of numerous different embodiments, it should be understood that the legal scope of protection is defined by the words of the claims set forth at the end of this patent. The detailed description is to be construed as exemplary only and does not describe every possible embodiment since describing every possible embodiment would be impractical, if not impossible. Numerous alternative embodiments could be implemented, using either current technology or technology developed after the

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filing date of this patent, which would still fall within the scope of the claims defining the scope of protection.

[0034] It should also be understood that, unless a term was expressly defined herein, there is no intent to limit the meaning of that term, either expressly or by implication, beyond its plain or ordinary meaning, and such term should not be interpreted to be limited in scope based on any statement made in any section of this patent (other than the language of the claims). To the extent that any term recited in the claims at the end of this patent is referred to herein in a manner consistent with a single meaning, that is done for sake of clarity only so as to not confuse the reader, and it is not intended that such claim term be limited, by implication or otherwise, to that single meaning.

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Claims

What is claimed is:

1. A container (10) suitable for use in a shipment of cargo by air, the container (10) comprising:

a container body (12, 14, 20) having a top wall, a bottom wall (12), a front wall (20), a rear wall and oppositely disposed side walls, wherein the container body (12, 14, 20) defines a cargo space (26) within the container (10); and

a passive temperature control system (16) located within the cargo space (26), the passive temperature control system (16) comprising:

a plurality of insulation panels, wherein each of the plurality of insulation panels is connected to an inner surface of a corresponding wall of the container body,

a rack (42, 44) proximate one of the top wall and one of the side walls, the rack (42, 44) defining a slot, and

a plurality of refrigerant bottles (40) filled with a thermal medium, wherein the plurality of refrigerant bottles (40) and the thermal medium are one of cooled and heated to a predetermined temperature for a cargo being shipped in the container (10) and inserted into the slot of the rack (42, 44) to passively maintain a cargo space temperature in the cargo space (26) during shipment of the cargo.

2. The container (10) of claim 1, wherein the container body (12, 14, 20) is fabricated as a structure that is a compliant unit load device (ULD) container meeting specified aviation authority structural requirements.

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3. The container (10) of claim 1, wherein the container body (12, 14, 20) comprises:

a pallet (12) forming the bottom wall;

an outer enclosure (14) forming the top wall, the rear wall and the oppositely disposed side walls, wherein the outer enclosure is mounted on the pallet (12); and

a door (20) forming the front wall, wherein the door is connected to one of the oppositely disposed side walls and rotatable between an open position and a closed position.

4. The container (10) of claim 1, comprising a telemetry system for transmitting data in real time to a remote processor.

5. The container (10) of claim 1, comprising a baseplate (30) having an upper metal sheet (34), a lower metal sheet (36) and an internal core (38) fabricated from a thermoplastic polymer and disposed between the upper metal sheet (34) and the lower metal sheet (36), wherein the baseplate (30) is disposed on top of a bottom insulation panel.

6. The container (10) of claim 5, wherein the thermoplastic polymer of the internal core (38) is high density polyethylene (HDPE).

7. The container (10) of claim 1, wherein a bottom insulation panel (32) has a plurality of break holes (88) extending therethrough, the container (10) comprising a plurality of thermal breaks (80) having a thermal break height that is greater than a bottom insulation panel thickness, wherein each of the plurality of thermal breaks (80) is disposed within a corresponding one of the plurality of break holes (88) such that each of the plurality of thermal breaks (80) engages the top

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surface (92) of the bottom wall (12), extends upward beyond an upper surface of the bottom insulation panel (32), and supports a weight of the rack (42, 44) and the plurality of refrigerant bottles (40).

8. The container (10) of claim 7, comprising a baseplate (30) having an upper metal sheet (34), a lower metal sheet (36) and an internal core (38) fabricated from a thermoplastic polymer and disposed between the upper metal sheet (34) and the lower metal sheet (36), wherein the baseplate (30) is disposed on top of the bottom insulation panel, wherein the baseplate (30) has a plurality of break notches (90) defined therein with each of the plurality of break notches (90) having a position corresponding to one of the plurality of break holes (88) of the bottom insulation panel (32), and wherein each of the plurality of thermal breaks (80) extends upward beyond the upper surface of the baseplate (30).

9. The container (10) of claim 7, wherein each of the plurality of thermal breaks (80) comprises:

a break body (82);

a break foot (84) extending downward from the break body (82) and engaging the top surface (92) of the pallet (12) when the thermal break (80) is disposed within a corresponding one of the plurality of break holes (88); and

a break shoulder (86) extending upward from the break body (82) and extending above the bottom insulation panel (32) and engaging the rack (42, 44) when the thermal break (80) is disposed within the corresponding one of the plurality of break holes (88).

10. The container (10) of claim 1, wherein the rack (42, 44) comprises:

a top rack (42) disposed proximate the top wall;

a first side rack (44) disposed proximate a first one of the side walls; and

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a second side rack (44) disposed proximate a second one of the side walls.

11. The container (10) of claim 1, wherein the rack (42, 44) comprises:

a plurality of parallel slats (46) disposed on either side of the rack (42, 44);

a plurality of upper tracks (48) that are perpendicular to the plurality of parallel slats (46) and are oriented with upper track channels opening downward; and

a plurality of lower tracks (50) that are perpendicular to the plurality of parallel slats (46) and are oriented with lower track channels facing upward, wherein the plurality of upper tracks (48) and the plurality of lower tracks (50) separate the plurality of parallel slats (46) on either side of the rack (42, 44) and are alternated so that each corresponding pair of an upper track (48) and a lower track (50) and corresponding portions of the plurality of parallel slats (46) define one of the slot of the rack (42, 44).

12. The container (10) of claim 1, wherein each of the insulation panels comprises:

a vacuum insulated panel (VIP); and

an outer covering of expanded polypropylene (EPP) foam.

13. A container (10) suitable for use in a shipment of cargo by air, the container (10) comprising:

a container body (12, 14, 20) having a top wall, a bottom wall (12), a front wall (20), a rear wall and oppositely disposed side walls, wherein the container body (12, 14, 20) defines a cargo space (26) within the container (10), and wherein the container body (12, 14, 20) is fabricated as a structure that is a compliant unit

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load device (ULD) container meeting specified aviation authority structural requirements; and

a passive temperature control system (16) located within the cargo space (26) and having a plurality of insulation panels each connected to an inner surface of a corresponding wall of the container body (12, 14, 20), at least one rack (42, 44) proximate a corresponding one of the walls of the container body (12, 14, 20), and a plurality of refrigerant bottles (40) filled with a thermal medium and received by the rack (42, 44) to passively maintain a cargo space temperature in the cargo space (26) during shipment of the cargo.

14. The container (10) of claim 13, wherein the container body (12, 14, 20) comprises:

a pallet (12) forming the bottom wall;

an outer enclosure (14) forming the top wall, the rear wall and the oppositely disposed side walls, wherein the outer enclosure is mounted on the pallet (12); and

a door (20) forming the front wall, wherein the door is connected to one of the side walls and rotatable between an open position and a closed position.

15. The container (10) of claim 13, comprising a telemetry system for transmitting data in real time to a remote processor.

16. A refrigerant bottle (40) for a container (10) suitable for use in a shipment of cargo by air, wherein the container (10) has an inner insulation layer (16) and a rack (42, 44) proximate an insulation panel of the inner insulation layer (16) and defining at least one slot, the refrigerant bottle (40) comprising:

a reservoir body (52) that is sized to be inserted into the at least one slot of the rack (42, 44); and

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a connection mechanism (60, 62) defined in the reservoir body (52) and configured to connect a plurality of refrigerant bottles (40) in series for insertion and removal of multiple refrigerant bottles (40) into and out of the at least one slot together, wherein the refrigerant bottle (40) is one of cooled and heated to a predetermined temperature for a cargo being shipped in the container (10) and inserted into the slot of the rack (42, 44) to passively maintain a cargo space temperature in a cargo space (26) of the container (10) during shipment of the cargo.

17. The refrigerant bottle (40) of claim 16, wherein the refrigerant bottle (40) is filled with a thermal medium.

18. The refrigerant bottle (40) of claim 16, wherein the connection mechanism (60, 62) comprises:

a bottle tab (60) extending outward from a first end of the reservoir body (52); and

a bottle socket (62) defined in the reservoir body (52) at a second end opposite the first end of the reservoir body (52), wherein the bottle tab (60) and the bottle socket (62) are configured to interlock so that a first adjacent refrigerant bottle (40) may be connected to the first end of the reservoir body (52) and a second adjacent refrigerant bottle (40) may be connected to the second end of the reservoir body (52) such that the refrigerant bottle (40), the first adjacent refrigerant bottle (40) and the second adjacent refrigerant bottle (40) move together into and out of the slot of the rack (42, 44).

19. The refrigerant bottle (40) of claim 16, wherein the reservoir body (52) has a handle (64) defined therein.

20. The refrigerant bottle (40) of claim 16, the at least one slot of the rack (42, 44) is defined by an upper track (48) that is oriented with an upper track channel opening facing downward and a lower track (50) that is oriented with lower track channel facing upward, wherein the refrigerant bottle (40) comprises:

an upper shoulder (56) extending upward from an upper edge of the reservoir body (52); and

an lower shoulder (58) extending downward from a lower edge of the reservoir body (52), wherein the upper shoulder (56) is received into the upper track channel of the upper track (48) and the lower shoulder (58) is received into the lower track channel of the lower track (50) when the refrigerant bottle (40) is inserted into the at least one slot of the rack (42, 44) to guide the refrigerant bottle (40) within the at least one slot.