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(54) Passive thermally regulated shipping container employing phase change material panels containing dual immiscible phase change materials

(57) A passive thermally regulated shipping container with at least one removable PCM panel containing dual immiscible phase change materials having different freezing points.

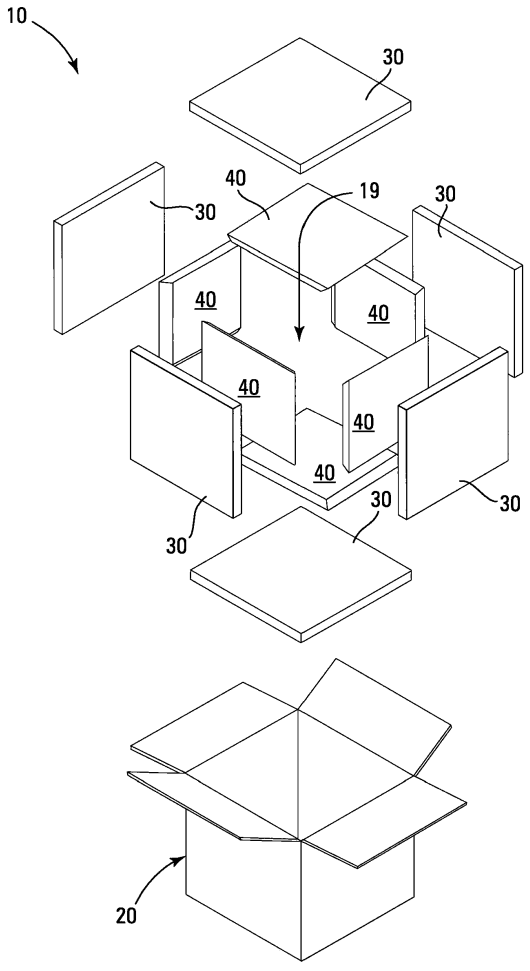

Fig. 1

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Description

BACKGROUND

[0001] Thermally labile goods are frequently transported or shipped in passive thermally regulated shipping containers to prevent spoilage, decomposition, deactivation, transformation, conversion, breakdown, denaturing, etc.

[0002] Transportation of thermally labile goods is particularly challenging when the thermally labile goods must be maintained within a narrow temperature range. Numerous insulated shipping containers have been developed over the years, with those deploying a phase change material (PCM) generally providing superior temperature control over extended periods. A nonexhaustive list of United States Patents and Published Patent Applications disclosing insulated shipping containers employing a PCM include United States Patents 4,145,895; 4,579,170; 4,923,077; 4,931,333; 5,626,936; 5,899,088; 6,209,343 and 6,718,776, and United States Patent Application Publications 2005/0188714; 2004/0079794; 2004/0079793 and 2002/0050147.

[0003] Insulated shipping containers employing a PCM can be deployed for a wide range of thermally labile goods over a wide range of target temperatures by using different PCMs. For example, D_2O melts at +4 °C, H_2O melts at 0 °C, a 20% ethylene glycol solution melts at -8 °C, castor oil melts at -10 °C, neat ethylene glycol melts at -12.9 °C, mineral oil melts at -30 °C, and a 50% ethylene glycol solution melts at -37 °C. This permits use of insulted shipping containers for a broad range of thermally labile goods. However, in order to accommodate the packaging of a wide variety of thermally labile goods, the shipper needs to purchase and inventory a sufficient number of PCM panels containing each of the different PCMs to meet the highest possible demand for that type of PCM panel. For example, assume that a shipper typically has between about 800 and 1,200 passive thermally regulated shipping containers in transport on any given day, each of which employ six PCM panels and all of which could require one of two different PCM panels containing different PCM. This shipper would need to purchase, inventory, track and maintain 14,400 PCM panels ((1,200 containers)(6 PCM panels/container)(2 PCM panel types)). The need to purchase, track and maintain such a large number of PCM panels can become cost prohibitive.

[0004] Accordingly, a substantial need exists for a system of packaging thermally labile goods that reduces the total number of PCM panels that need to be purchased, tracked and maintained by a shipper.

SUMMARY OF THE INVENTION

[0005] The invention is a passive thermally regulated shipping container. The container has an outer shell, a layer of thermal insulation, and a phase change material panel (PCM panel). The outer shell defines a retention chamber. The layer of thermal insulation lines the retention chamber so as to define an insulated retention chamber. The PCM panel is removably positioned within the insulated retention chamber, and contains dual immiscible phase change materials having different freezing points.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Figure 1 is an exploded isometric view of one embodiment of the invention.

[0007] Figure 2A is a cross-sectional view of the fully assembled container depicted in FIG. 1 employing phase change panels that have been thermally conditioned in a horizontal position below the freezing point of both phase change materials.

[0008] Figure 2B is a cross-sectional view of the fully assembled container depicted in FIG. 1 employing phase change panels that have been thermally conditioned in a vertical position below the freezing point of both phase change materials.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Definitions

[0009] As utilized herein, including the claims, the term "***removable***" means capable of being inserted and removed without application of violent force and without damage or destruction.

[0010] As utilized herein, including the claims, the term *"immiscible"* means insoluble such that the liquids form separate layers, each of which have a separate and independent melting point such that one layer can be frozen into a solid while the other layer remains a liquid.

Nomenclature

[0011]

10 Passive Thermally Regulated Shipping Container
19 Payload Retention Chamber
20 Outer Structural Shell
30 Thermal Insulation
40 Phase Change Material Panels (PCM Panel)
51 Higher Density First Phase Change Material
52 Lower Density Second Phase Change Material

Construction

[0012] Referring generally to FIGs 1, 2A and 2B, the invention is a passive thermally regulated shipping container **10**. The container **10** has an outer shell **20**, a layer of thermal insulation **30**, and at least one phase change material panel (PCM panel) **40**.

[0013] The outer shell **20** defines a retention chamber. The outer shell **20** may be made from any material possessing sufficient structural integrity, including specifically but not exclusively, cellulosic materials such as paperboard and cardboard, engineered wood products such as laminated and unlaminated fiberboard and plywood, wood, plastics such as polyethylene, polypropylene, polyethylene terephthalate, nylon polycarbonates and phenolic resins, wood-plastic composites, metals such as aluminum, copper, brass and steel, glass, ceramics, combinations thereof, and the like.

[0014] The layer of thermal insulation **30** lines the retention chamber **19** so as to define an insulated retention chamber (not separately numbered). The layer of thermal insulation **30** may be formed as a single unitary piece with a removable cover (not shown) or as separate panels such as shown in FIGs 1, 2A and 2B. The thermal insulation may be constructed from any material having good thermal insulating qualities, (*i.e.*, having a high thermal resistance "R"), such as Styrofoam, vacuum insulated panels, or the like.

[0015] The PCM panel **40** is removably positioned within the insulated retention chamber, and contains dual immiscible phase change materials (**51** and **52**) having different freezing points.

[0016] The container **10** includes at least one phase change material panel (PCM panel) **40** and preferably includes a plurality of planar PCM panels **40** configured and arranged for lining the insulated retention chamber.

[0017] By filling each PCM panel **40** with dual immiscible phase change materials (**51** and 52) having different freezing points, a single PCM panel **40** can be used for shipping thermally labile goods at two different target temperatures by thermally conditioning the PCM panels **40** at the desired target temperature. For example, PCM panels containing 50% v/v water (0°C melting point) and 50% v/v castor oil (-10 °C melting point). Such PCM panels **40** thermally conditioned at a temperature below the melting point of the water but above the melting point of the castor oil allows the thermally conditioned PCM panels to regulate the temperature of a insulated retention chamber **19** at a temperature of 0°C, while such PCM panels **40** thermally conditioned at a temperature below the melting point of the castor oil allows the thermally conditioned PCM panels to regulate the temperature of a insulated retention chamber **19** at a temperature of -10°C. This avoids the need to purchase, inventory and track separate PCM panels.

[0018] The phase change materials (PCMs) need to be immiscible as soluble or miscible PCMs do not retain their individual melting points. For example water and ethylene glycol are miscible and produce a mixture which has a single melting point (e.g., a 20% ethylene glycol solution melts at -8 °C).

[0019] Exemplary combinations of immiscible PCMs are provided in TABLE ONE.

TABLE ONE

[0020]

EXAMPLE	HYDROPHILIC PCM	HYDROPHOBIC PCM
A	Water	n-Octadecane
B	Salt Water	n-Octadecane
C	Water	n-Tetradecane
D	Salt Water	n-Tetradecane
E	Water	n-Heptadecane
F	Ethylene Glycol and Water	n-Octadecane
G	Ethylene Glycol and Water	n-Tetradecane

Claims

1. A passive thermally regulated shipping container, comprising:

    a. an outer shell defining a retention chamber,
    b. a layer of thermal insulation lining the retention chamber so as to define an insulated retention chamber, and
    c. a removable phase change material panel positioned within the insulated retention chamber, wherein the phase change material panel contains dual immiscible phase change materials having different freezing points.

2. The passive thermally regulated shipping container of claim 1, wherein the thermal insulation is vacuum insulated panels.

3. The passive thermally regulated shipping container of claim 1 or 2, comprising a plurality of the removable phase change material panels lining the insulated retention chamber.

4. The passive thermally regulated shipping container of any of claims 1 to 3, wherein one of the immiscible phase change materials is water.

5. The passive thermally regulated shipping container of any of claims 1 to 4, wherein one of the immiscible phase change materials is ethylene glycol.

6. A passive thermally regulated shipping container of any of claims 1 to 5, wherein one of the immiscible phase change materials is a paraffin which is liquid at room temperature.

7. A passive thermally regulated shipping container of any of claims 1 to 5, wherein one of the immiscible phase change materials is a paraffin which is solid at room temperature.

8. The passive thermally regulated shipping container of any of claims 1 to 7, wherein one of the immiscible phase change materials is salt water.

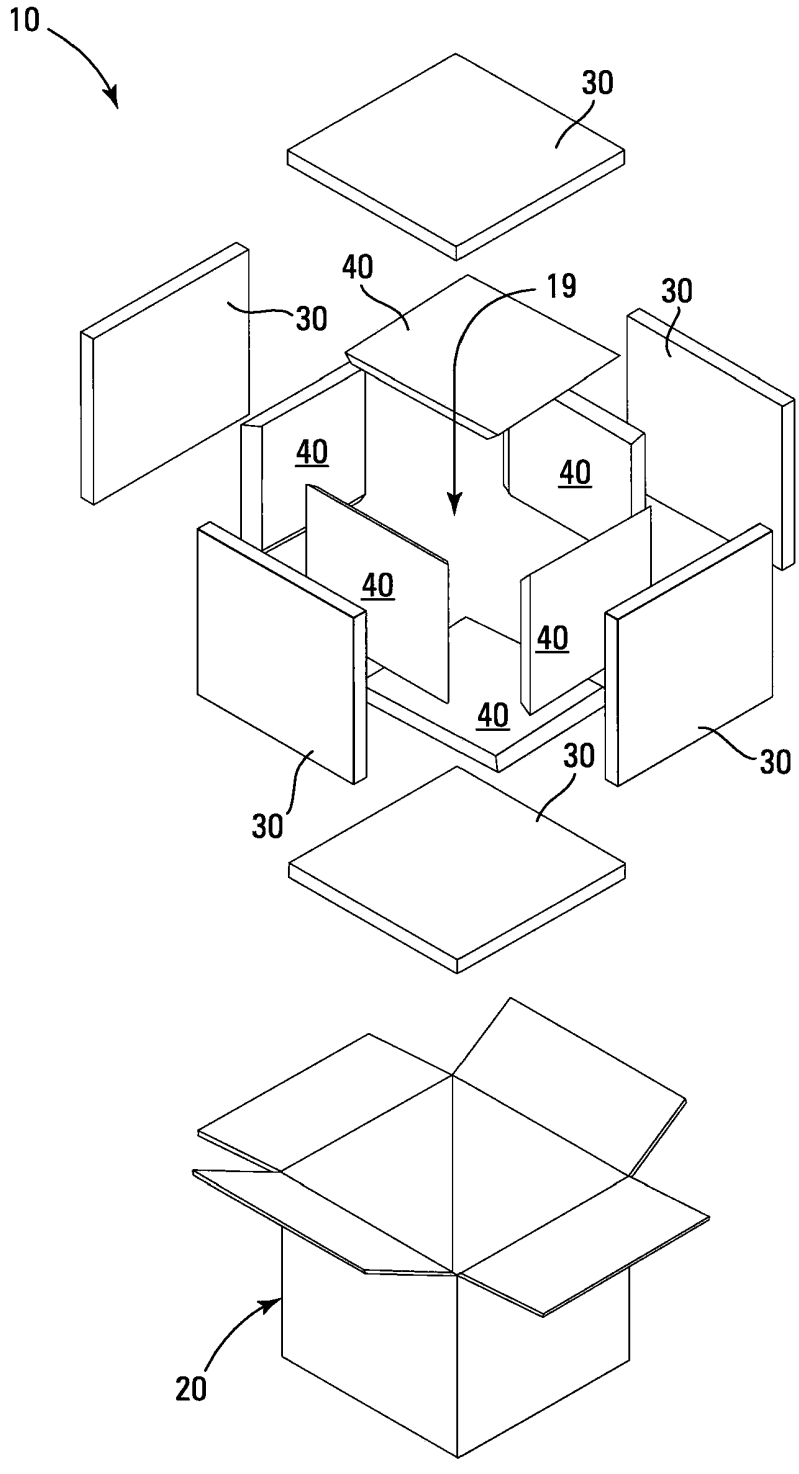

Fig. 1

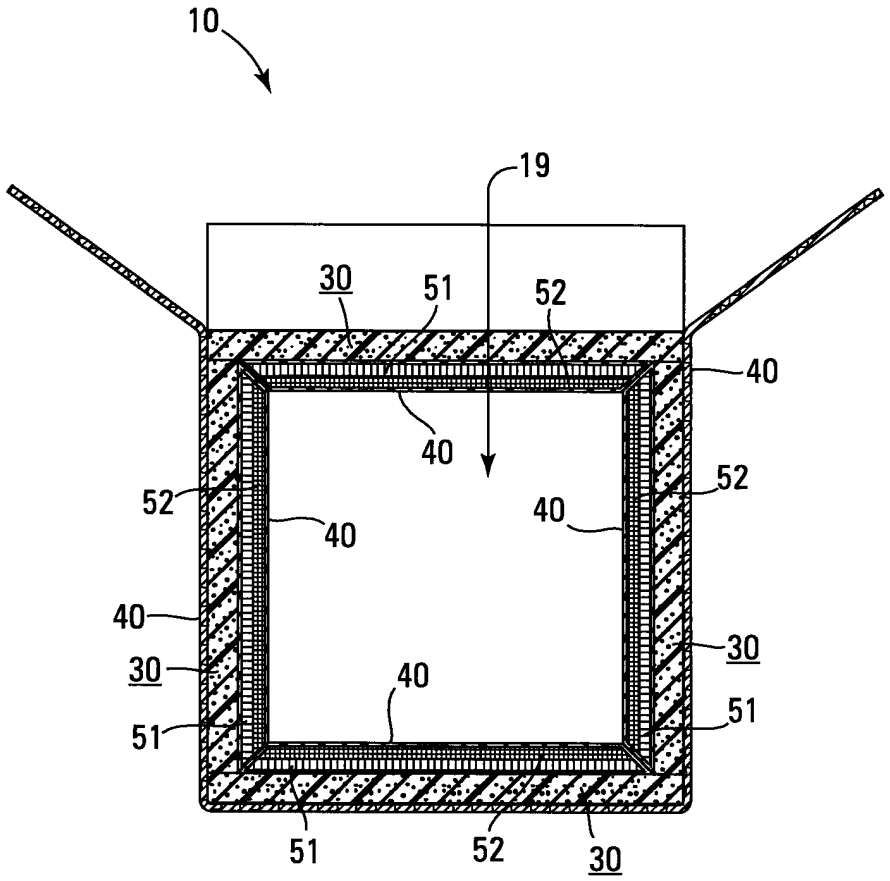

Fig. 2A

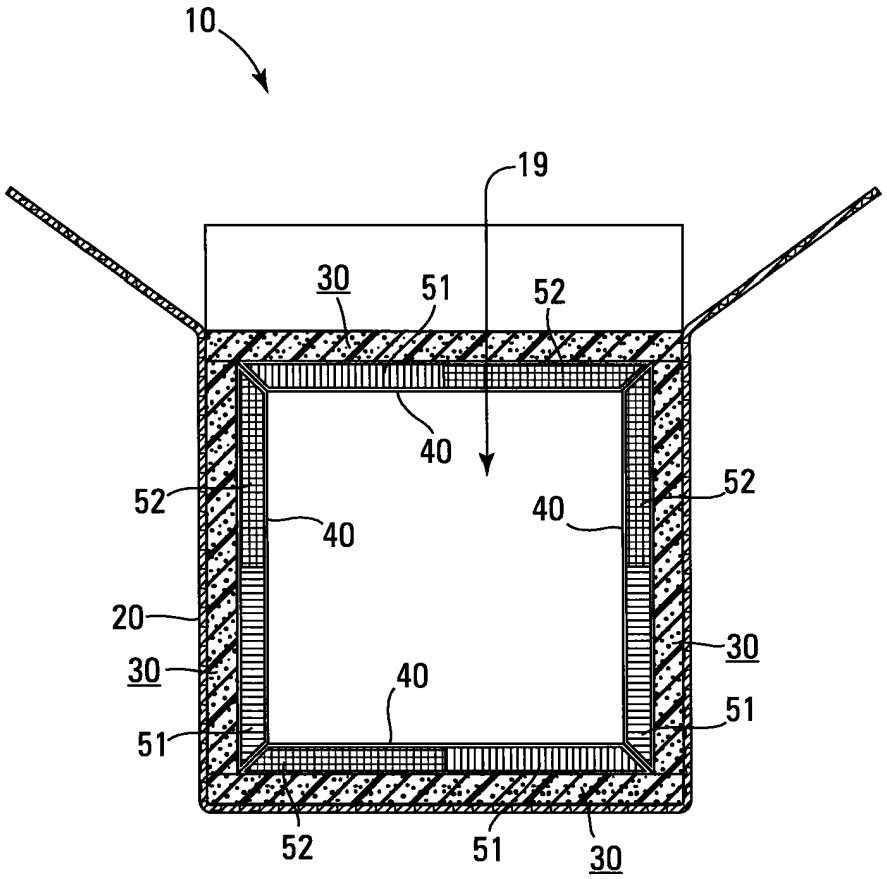

Fig. 2B

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4145895 A **[0002]**
- US 4579170 A **[0002]**
- US 4923077 A **[0002]**
- US 4931333 A **[0002]**
- US 5626936 A **[0002]**
- US 5899088 A **[0002]**
- US 6209343 B **[0002]**
- US 6718776 B **[0002]**
- US 20050188714 A **[0002]**
- US 20040079794 A **[0002]**
- US 20040079793 A **[0002]**
- US 20020050147 A **[0002]**