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(54) **METHOD OF FABRICATING 3D VACUUM INSULATED REFRIGERATOR STRUCTURE HAVING CORE MATERIAL**

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CPC ***B29C 43/04*** (2013.01); ***F25D 23/062*** (2013.01); ***F25D 23/064*** (2013.01); *B29L 2031/7622* (2013.01); *F25D 2201/122* (2013.01)

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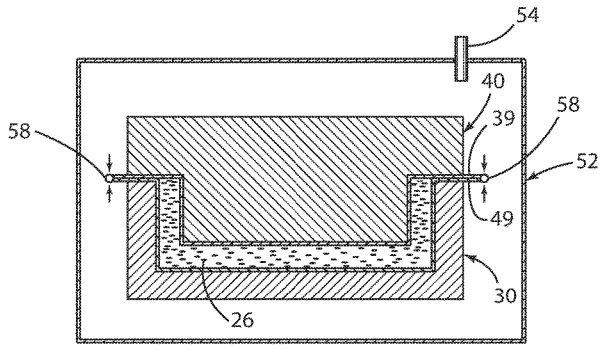
(57) **ABSTRACT**

A method of fabricating a vacuum insulated refrigerator structure includes positioning a first barrier film in a female mold cavity. Porous filler material is positioned on the barrier film, and a second barrier film is positioned over the porous filler material. A male mold is brought into contact with the second barrier film to deform and compress the porous filler material into a 3D shape. A vacuum is formed between the first and second barrier films, and the first and second peripheral edge portions are sealed together to form a vacuum insulated core. The vacuum insulated core may be positioned between a liner and a wrapper to form an insulated refrigerator cabinet, door, or other vacuum insulated component.

17 Claims, 4 Drawing Sheets



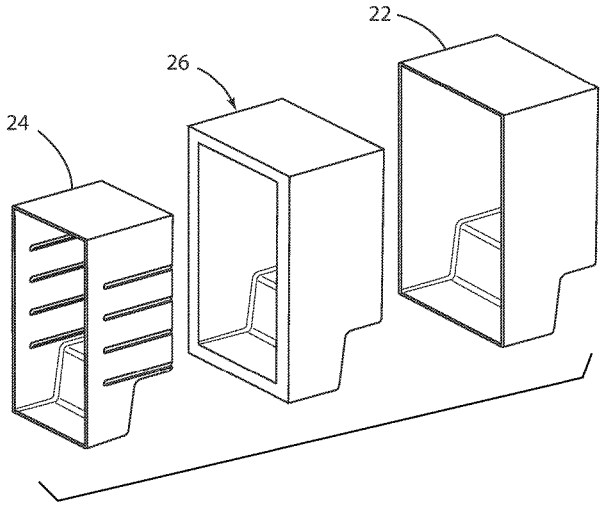


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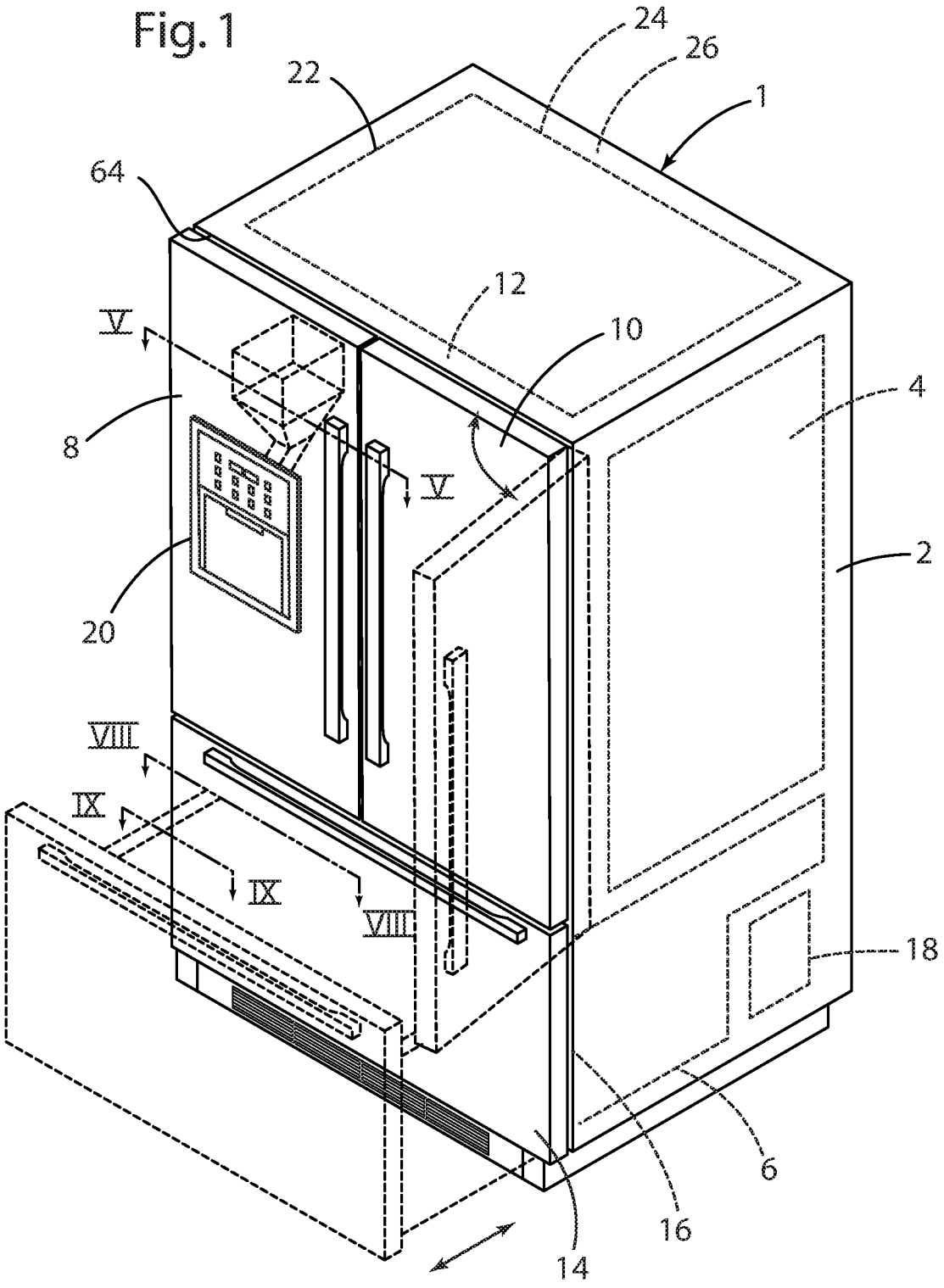
Fig. 1



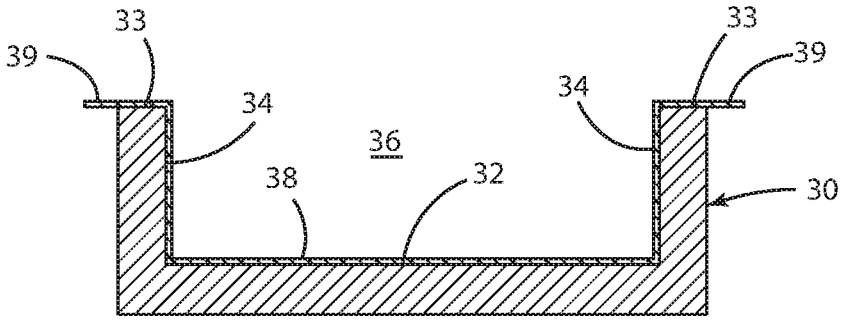


FIG. 2

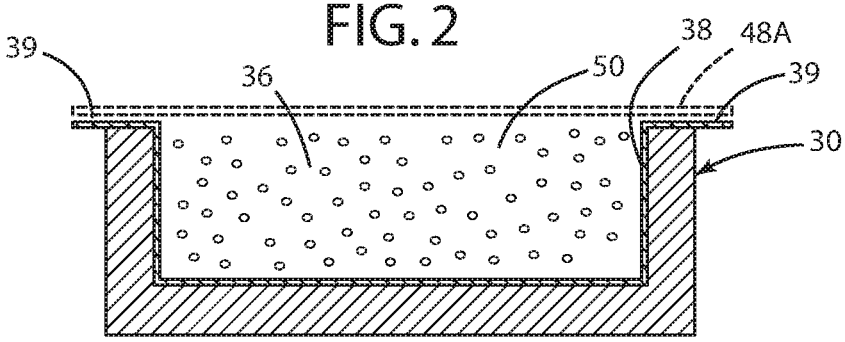


FIG. 3

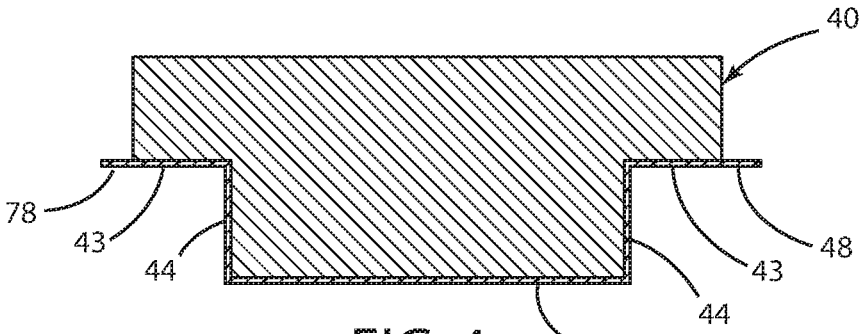


FIG. 4

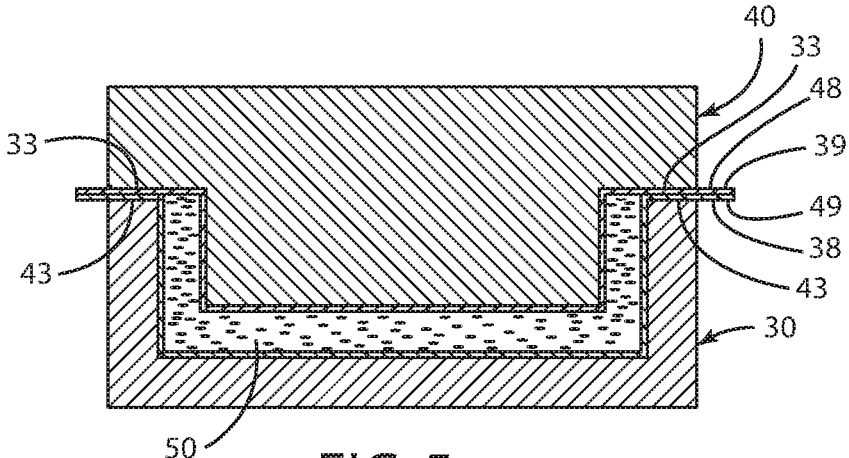


FIG. 5

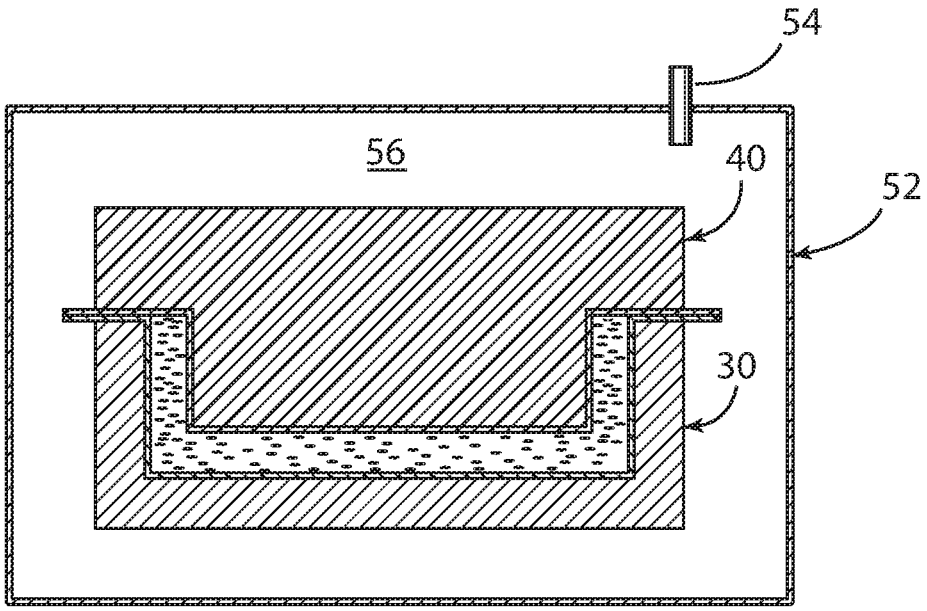


FIG. 6

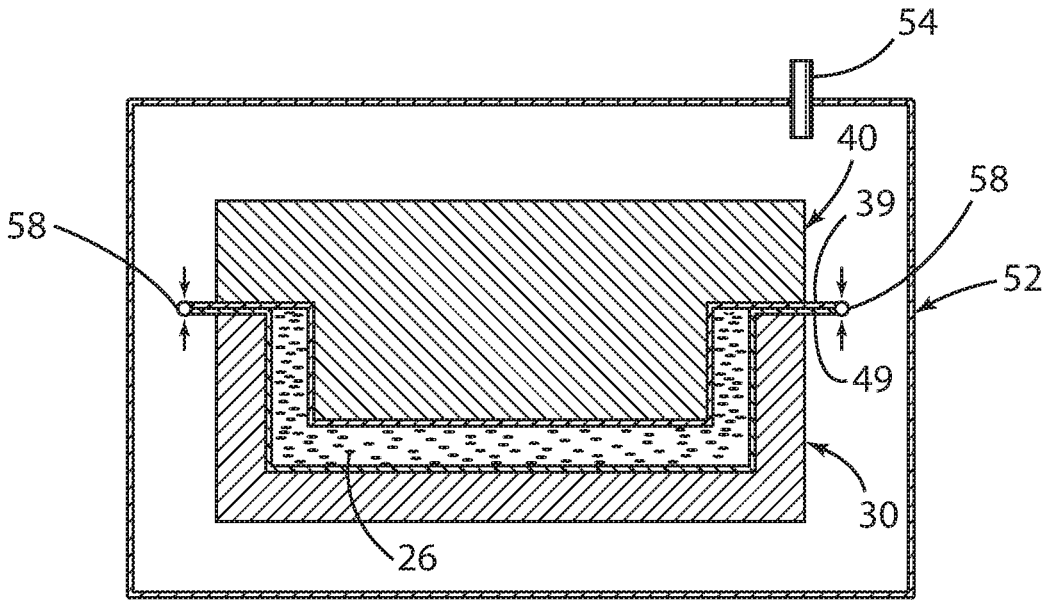


FIG. 7

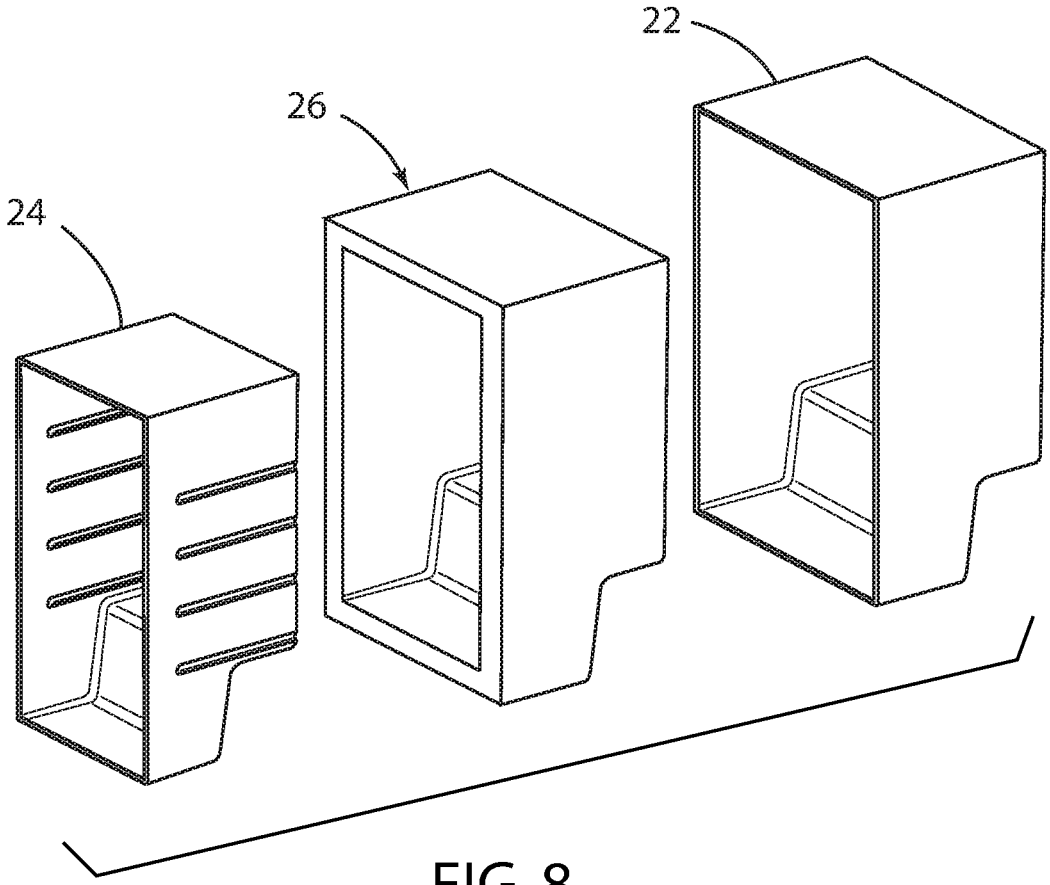


FIG. 8

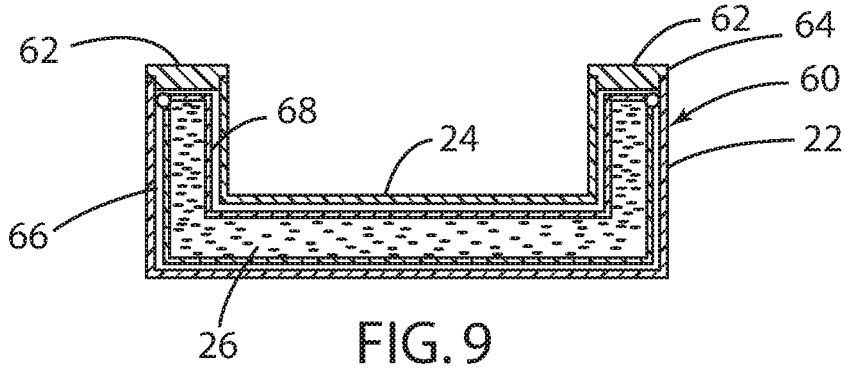


FIG. 9

METHOD OF FABRICATING 3D VACUUM INSULATED REFRIGERATOR STRUCTURE HAVING CORE MATERIAL

BACKGROUND OF THE INVENTION

Various types of vacuum insulated refrigerator cabinets, doors, and other such structures have been developed. However, known methods of forming vacuum insulated structures may suffer from various drawbacks and limitations.

SUMMARY OF THE INVENTION

A method of fabricating a vacuum insulated refrigerator structure includes positioning a first barrier film in a female mold cavity. Porous filler material is positioned on the first barrier film, and a second barrier film is positioned over the porous filler material. The first and second barrier films have first and second peripheral edge portions, respectively. The porous filler material is disposed between the first and second barrier films. A male mold is brought into contact with the second barrier film to thereby cause the porous filler material to deform into a 3D shape including a central portion and at least one sidewall portion that extends transversely from the central portion. A vacuum is formed between the first and second barrier films, and the first and second peripheral edge portions are sealed together to form a vacuum insulated core having porous filler material disposed in a vacuum. The vacuum insulated core may be positioned between a liner and a wrapper to form an insulated refrigerator cabinet, door, or other insulated refrigerator component.

These and other features, advantages, and objects of the present disclosure will be further understood and appreciated by those skilled in the art by reference to the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a refrigerator;

FIG. **2** is a partially schematic view of a female mold part and first barrier film;

FIG. **3** is a partially schematic view showing porous insulation powder disposed over at least a portion of the first barrier film in the female mold part;

FIG. **4** is a partially schematic view of a male mold part having a second barrier film positioned on the male mold part;

FIG. **5** is a partially schematic view showing a core position between male and female mold parts;

FIG. **6** is a partially schematic view showing the mold inside a vacuum chamber;

FIG. **7** is a partially schematic view showing the mold inside a vacuum chamber as the peripheral edge portions of the first and second barrier films are sealed together;

FIG. **8** is a partially schematic cross sectional view of a 3D vacuum insulated core disposed between a liner and wrapper; and

FIG. **9** is a cross sectional view of a vacuum insulated refrigerator structure taken along the line IX-IX; FIG. **1**.

DETAILED DESCRIPTION

For purposes of description herein, the terms "upper," "lower," "right," "left," "rear," "front," "vertical," "horizontal," and derivatives thereof shall relate to the disclosure as oriented in FIG. **2**. However, it is to be understood that the disclosure may assume various alternative orientations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

With reference to FIG. **1**, a refrigerator **1** may include a vacuum insulated cabinet **2** forming a fresh food compartment **4** and a freezer compartment **6**. Doors **8** and **10** are movably mounted to the cabinet **2**, and selectively close off an access opening **12** that provides access to the fresh food compartment **4**. A door or drawer **14** selectively closes off an access opening **16** that provides access to freezer compartment **6**. A cooling system (not shown) including a compressor, condenser, evaporator, and other related components may be positioned in a machine compartment **18** located at a lower rear portion of cabinet **2**. Door **8** may include an ice/water dispenser **20**.

The cabinet **2** may comprise a vacuum insulated structure having an outer wrapper **22**, an inner liner **24** that fits within the outer wrapper **22**, and a vacuum insulated core structure **26** that is disposed between the wrapper **22** and liner **24**. One or more of the doors **8**, **10**, and **14** may also comprise vacuum insulated structures having an outer wrapper or panel, inner liner, and vacuum insulated core disposed between the outer panel and the inner liner.

With reference to FIGS. **2-5**, the cabinet **2** and/or doors **8**, **10**, and **14** may be fabricated utilizing a female mold **30** and a male mold **40**. The female mold **30** may include a generally planar interior surface **32** and one or more inwardly facing side walls or surfaces **34** that together form a mold cavity **36**. In the illustrated example, the female mold **30** includes four generally planar side surfaces **34** that are orthogonal relative to one another such that female mold **30** is generally bathtub-shaped.

A vacuum insulated core component may be fabricated by placing a first barrier film **38** in the mold cavity **36** with the first barrier film **38** positioned closely against surfaces **32** and **34**. The first barrier film **38** includes peripheral edge portions **39** that are positioned directly against edge surfaces **33** of female mold **30**. With further reference to FIG. **3**, porous filler material **50** is then positioned in the female mold cavity **36** over at least a portion of first barrier film **38**. Porous filler material **50** may comprise silica powder, glass fibers, or other suitable material that is capable of being deformed as required for a particular application.

With reference to FIG. **4**, a male mold part **40** includes a generally planar central portion **42**, outwardly-facing side surfaces **44**, and edge surface portions **43**. Male mold part **40** may include four outwardly facing surfaces **44** that are orthogonal relative to one another. A second barrier film **48** is positioned over or on the male mold **40**, and the female and male mold components **30** and **40** are then brought together as shown in FIG. **5** to compress the silica powder **50** between barrier films **38** and **48**. Alternatively, second barrier film **48** may be positioned over female mold **30** as shown by dashed lines **48**A rather than positioning second barrier film **48** on male mold **40**. The peripheral edge portions **39** and **49** of barrier films **38** and **48** overlap one another, and may be pressed together by surfaces **33** and **43** of female and male mold parts **30** and **40**, respectively.

With further reference to FIG. **6**, the female and male mold parts **30** and **40** are then positioned within a vacuum chamber **52**, and air is evacuated from the vacuum chamber **52** through an opening or passageway **54** utilizing a vacuum pump (not shown) or other suitable mechanism to thereby form a vacuum in the space **56** inside vacuum chamber **52**. With further reference to FIG. **7**, the peripheral edge portions **39** and **49** of barrier films **38** and **48**, respectively are then sealed along a seal line **58** utilizing heat sealing, adhesives, or other suitable known processes. The seal line **58** may include **4** substantially straight edge portions if the refrigerator component (e.g. cabinet **2**, or doors **8**, **10**, or **14**) have a rectangular perimeter. Barrier films **38** and **48** may comprise multilayer polymer and/or metal foil that is impervious to oxygen, nitrogen, carbon dioxide water vapor, and other gasses as may be required to maintain a vacuum.

With further reference to FIGS. **8** and **9**, vacuum insulated core **26** is then removed from the vacuum chamber **52**, and the core **26** is positioned between a wrapper **22** and a liner **24** to form a 3D vacuum insulated refrigerator component **60**. The wrapper **22** and liner **24** may be interconnected utilizing known structures and processes. A small gap or space **66** (FIG. **9**) may be formed between vacuum insulated core **26** and outer wrapper **22**. Similarly, a small gap or space **68** may be formed between liner **24** and vacuum insulated core **26**. The gaps **66** and/or **68** may be filled with adhesive and/or polyurethane foam (not shown) to interconnect the vacuum insulated core **26** to the wrapper **22** and liner **24**, and to fill the gaps **66** and **68** to reduce or prevent flexing of wrapper **22** and liner **24**. If the refrigerator component **60** comprises a cabinet **2**, the forward edge **64** of the cabinet **2** may include an edge strip **62** that is sealingly connected to the wrapper **22** and liner **24**.

It will be understood that the 3D vacuum core may have various shapes and sizes as required for a particular application. For example, the 3D vacuum core may be configured to be utilized in a refrigerator cabinet as described above, or it may be configured to be utilized in a refrigerator door or other component.

It is to be understood that variations and modifications can be made on the aforementioned structure without departing from the concepts of the present disclosure, and further it is to be understood that such concepts are intended to be covered by the following claims unless these claims by their language expressly state otherwise.

What is claimed is:

1. A method of fabricating a vacuum insulated refrigerator structure, the method comprising:

providing a female mold having a female mold cavity and a substantially planar central surface portion that is free of protrusions, and a plurality of inwardly facing side wall surface portions facing the female mold cavity, wherein the inwardly facing side wall surface portions are substantially orthogonal to the central surface portion, the female mold further including edge surfaces extending transversely from the inwardly facing side wall surface portions;

providing a male mold having a substantially planar central surface portion that is free of protrusions and a plurality of outwardly facing side wall surface portions that are substantially orthogonal to the central surface portion of the male mold, the male mold further including edge surfaces extending transversely from the outwardly facing side wall surface portions;

positioning the male and female molds in a vacuum chamber;

positioning an impermeable first barrier film having a first peripheral edge portion in the female mold cavity in direct contact with the planar central surface portion and the inwardly facing side wall surface portions;

positioning the first peripheral edge portion of the impermeable first barrier film directly against the edge surfaces of the female mold;

positioning porous powder filler material on the impermeable first barrier film;

positioning an impermeable second barrier film having a second peripheral edge portion over the porous powder filler material whereby the porous powder filler material is disposed between the impermeable first and second barrier films;

causing the male mold to contact the impermeable second barrier film to press the impermeable second barrier film and cause the second barrier film and the porous powder filler material to deform into a shape including a generally planar central portion having a substantially uniform thickness that is free of recesses, the shape including at least one sidewall portion extending transversely from the generally planar central portion;

causing the porous powder filler material to contact the impermeable first and second barrier films;

causing the second peripheral edge portion to overlap the first peripheral edge portion;

pressing the first and second peripheral edge portions together between the edge surfaces of the male and female molds by bringing the male and female molds together to define a closed configuration whereby outer edges of the impermeable first and second barrier films are disposed outside of the male and female molds in the closed configuration;

followed by evacuating air between the impermeable first and second barrier films by forming a vacuum in the vacuum chamber;

followed by sealing the outer edges of the first and second peripheral edge portions together along a seal line while the male and female molds are in the closed configuration in the vacuum chamber to form a vacuum insulated core;

followed by removing the vacuum insulated core from the vacuum chamber;

followed by positioning the vacuum insulated core between a wrapper and a liner; and

followed by connecting the wrapper to the liner to form the vacuum insulated refrigerator structure.

2. The method of claim **1** wherein:

the central surface portion of the female mold and the central surface portion of the male mold are rectangular.

3. The method of claim **1**, wherein:

the impermeable first and second barrier films comprise multilayer films.

4. The method of claim **1**, wherein:

the porous powder filler material comprises silica powder.

5. The method of claim **1**, wherein:

the vacuum insulated refrigerator structure comprises a door.

6. The method of claim **1**, wherein:

the vacuum insulated refrigerator structure comprises a refrigerator cabinet defining an insulated food storage compartment and an access opening that provides access to the insulated food storage compartment.

7. The method of claim **6**, including:

movably mounting an insulated door to the refrigerator cabinet, wherein the door is configured to selectively

close off at least a portion of the access opening when the insulated door is in a closed position.

8. A method of fabricating a vacuum insulated refrigerator structure, the method comprising:

positioning a first barrier film having a first peripheral edge portion in a female mold cavity;

positioning porous powder filler material on the first barrier film;

positioning a second barrier film having a second peripheral edge portion onto a male mold;

moving the male mold and the second barrier film to press the second barrier film into contact with the porous powder filler material to deform the second barrier film and the porous powder filler material into a shape including a generally planar central portion and at least one sidewall portion extending transversely from the generally planar central portion;

forming at least a partial vacuum between the first and second barrier films;

sealing the first and second peripheral edge portions together to form a vacuum insulated core having porous powder filler material disposed in a vacuum;

positioning the vacuum insulated core between a wrapper and a liner; and

connecting the wrapper to the liner to form the vacuum insulated refrigerator structure.

9. The method of claim **8**, wherein:

the female mold includes a substantially planar central surface portion and four inwardly facing side wall surface portions that are substantially orthogonal to the central surface portion.

10. The method of claim **9**, wherein:

the male mold includes a substantially planar central surface portion and four outwardly facing side wall surface portions that are substantially orthogonal to the central surface portion of the male mold.

11. The method of claim **10**, wherein:

the central surface portion of the female mold and the central surface portion of the male mold are rectangular.

12. The method of claim **8**, wherein:

the first and second barrier films comprise multilayer films.

13. The method of claim **8**, including:

causing the first and second peripheral edge portions to overlap prior to sealing the first and second peripheral edge portions together.

14. The method of claim **8**, wherein:

the vacuum insulated refrigerator structure comprises a door.

15. The method of claim **8**, wherein:

the vacuum insulated refrigerator structure comprises a refrigerator cabinet defining an insulated food storage compartment and an access opening that provides access to the insulated food storage compartment.

16. The method of claim **1**, including:

positioning the impermeable first barrier film in the female mold cavity in close contact with the substantially planar surface portion, the inwardly facing side wall surface portions, and the edge surfaces;

followed by positioning the impermeable second barrier film over the porous powder fill material with the impermeable second barrier film being substantially flat prior to being deformed by the male mold.

17. A method of fabricating a vacuum insulated refrigerator structure, the method comprising:

positioning a first barrier film having a first peripheral edge portion in a female mold cavity;

positioning porous powder filler material on the first barrier film;

positioning a second barrier film having a second peripheral edge portion over the porous powder filler material whereby the porous powder filler material is disposed between the first and second barrier films;

utilizing a male mold that is in contact with the second barrier film to press the second barrier film and cause the second barrier film and the porous powder filler material to deform into a shape including a generally planar central portion and at least one sidewall portion extending transversely from the generally planar central portion;

evacuating air between the first and second barrier films;

sealing the first and second peripheral edge portions together to form a vacuum insulated core;

positioning the vacuum insulated core between a wrapper and a liner; and

connecting the wrapper to the liner to form the vacuum insulated refrigerator structure.

* * * * *