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(54) Title: THERMALLY INSULATED MACHINE

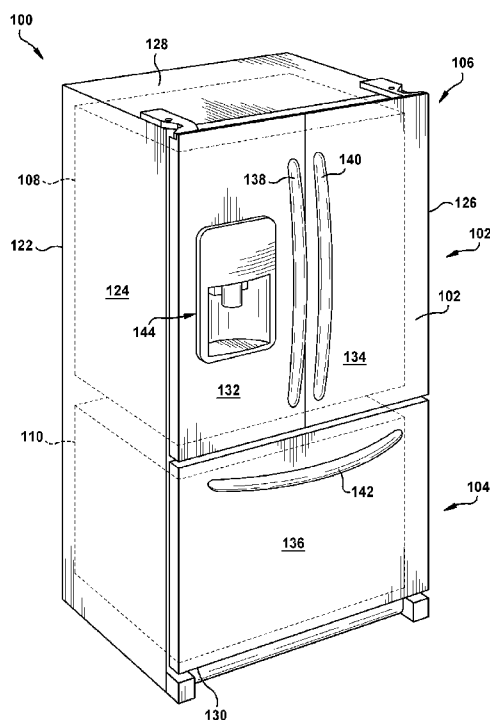


Fig. 1

(57) Abstract: A thermally insulated machine (100) having a housing (106), a refrigerating compartment (108) positioned within the housing (106) and a wall (120, 122, 124, 126, 128, 130) between the refrigerating compartment (108) and an area exterior to the compartment. The wall including a first insulation layer (306) and a second insulation layer (308), wherein the first insulation layer (306) has a higher thermal resistance than the second insulation layer (308), and wherein the first insulation layer (306) is positioned closer to the refrigerating compartment (108) than the second insulation layer (308).



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THERMALLY INSULATED MACHINE

RELATED APPLICATIONS

[0001] This application claims priority to and all benefit of U.S. Provisional Patent Application Serial No. 62/251,918, filed on November 6, 2015, for THERMALLY INSULATED MACHINE, the entire disclosure of which is fully incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present application relates generally to thermally insulated machines, and more particularly to thermally insulated machines having a refrigerated compartment and thermal insulation selectively arranged around the machine.

BACKGROUND OF THE INVENTION

[0003] A refrigerator is a common household appliance that consists of a food storage compartment, such as a refrigerating compartment, and a system that transfers heat from the inside of the compartment to an external environment so that the compartment is cooled to a temperature below the ambient temperature of the room. Most common household refrigerators utilize a vapor-compression refrigeration cycle to cool the compartment.

[0004] In a vapor compression cycle of a refrigerator, a circulating refrigerant enters a compressor as low-pressure vapor. The vapor is compressed and exits the compressor as high-pressure superheated vapor. The superheated vapor travels under pressure through condenser coils mounted on an exterior portion of the refrigerator, such as underneath the refrigerator. The condenser coils act as a heat exchanger in which the air in the room cools the vapor, which liquefies. The pressurized liquid refrigerant then flows through an expansion valve and evaporator coils. A fan blows air from the food storage compartment across the evaporator coils or tubes. The rapid expansion

and flow through the evaporator coils draws heat from the air and vaporizes the refrigerant. The cooled air is returned to the food storage compartment to cool the compartment. The refrigerant leaves the evaporator, now fully vaporized and slightly heated, and returns to the compressor inlet to repeat the cycle. The compressor and condenser coils are heat sources that can negatively impact the thermal efficiency of the refrigerator.

[0005] Many modern refrigerators also include an ice maker and an ice dispenser. For convenience, the ice dispenser is often located in the door to the food storage compartment which may result in the need to locate the ice maker in the refrigeration portion, rather than the freezer portion, of the refrigerator. The location of the ice dispenser in the door and the location of the ice maker in the refrigerator portion can negatively impact the thermal efficiency of the refrigerator.

SUMMARY

[0006] A thermally insulated machine is disclosed. In one embodiment, the thermally insulated machine includes a housing, a refrigerating compartment positioned within the housing, and a wall between the refrigerating compartment and an area exterior to the compartment. The wall includes a first insulation layer and a second insulation layer, where the first insulation layer has a higher thermal resistance than the second insulation layer in the temperature range of zero degrees Fahrenheit to 37 degrees Fahrenheit, and where the first insulation layer is positioned closer to the refrigerating compartment than the second insulation layer.

[0007] In another embodiment, the thermally insulated machine includes a housing, a refrigerating compartment positioned within the housing, and an icemaker positioned within the refrigerating compartment. The icemaker including at least one wall having an insulating layer covering the wall.

[0008] Various objects and advantages will become apparent to those skilled in the art from the following detailed description of the invention, when read in light of the accompanying drawings. It is to be expressly understood, however, that the drawings are for illustrative purposes and are not to be construed as defining the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings are incorporated in and form a part of this specification, illustrate several aspects of the present invention, and together with the description serve to explain certain principles of the invention. In the drawings:

[0010] FIG. 1 is a perspective view of an exemplary embodiment of a refrigerator;

[0011] FIG. 2 is a graph of the thermal resistance per inch vs. temperature for various insulations;

[0012] FIG. 3 is a partial sectional view of an exemplary embodiment of a door for the refrigerator of FIG. 1;

[0013] FIG. 4 is a graph of the temperature at different locations through the thickness of the door of FIG. 3;

[0014] FIG. 5 is a partial sectional view of an exemplary embodiment of a door for the refrigerator of FIG. 1;

[0015] FIG. 6 is a perspective view of an exemplary embodiment of a refrigerator including an icemaker;

[0016] FIG. 7 is a schematic view of an exemplary embodiment of the icemaker for the refrigerator of FIG. 6;

[0017] FIG. 8A is a partial sectional view of an exemplary embodiment of a wall for the icemaker of FIG. 7;

[0018] FIG. 8B is a partial sectional view of an exemplary embodiment of a wall for the icemaker of FIG. 7;

[0019] FIG. 9A is a perspective view of an exemplary embodiment of a refrigerator including an lower, rear insulation member;

[0020] FIG. 9B is a perspective view of an exemplary embodiment of a refrigerator including a pair of lower, side insulation members;

[0021] FIG. 10A is a schematic illustration of a front partial sectional view of the refrigerator of FIG. 9A;

[0022] FIG. 10B is a schematic illustration of a side partial sectional view of the refrigerator of FIG. 10A;

[0023] FIG. 10C is a schematic illustration of a front partial sectional view of another embodiment of the refrigerator of FIG. 9A;

[0024] FIG. 10D is a schematic illustration of a side partial sectional view of the refrigerator of FIG. 10C;

[0025] FIG. 11A is a partial side sectional view of the front door of a prior art refrigerator with an ice dispenser mounted in the front door; and

[0026] FIG. 11B is a partial side sectional view of the front door of a prior art refrigerator with an ice dispenser mounted in the front door.

DETAILED DESCRIPTION OF THE INVENTION

[0027] The embodiments disclosed herein will now be described by reference to some more detailed embodiments, in view of the accompanying drawings. These embodiments may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the inventions to those skilled in the art.

[0028] As described herein, when one or more components are described as being connected, joined, affixed, coupled, attached, or otherwise interconnected, such interconnection may be direct as between the components or may be indirect such as through the use of one or more intermediary components. Also as described herein, reference to a “member,” “component,” or “portion” shall not be limited to a single structural member, component, or element but can include an assembly of components, members or elements.

[0029] The present application discloses exemplary embodiments of thermally insulated machines. The thermally insulated machine may take a wide variety of different forms. For example, the thermally insulated machine may be a household machine or appliance with one or more refrigerated compartments, such as for example, a refrigerator, a freezer, or combination thereof. The thermally insulated machines may also be or any other household machine or appliance that may utilize thermal insulation.

[0030] Referring to FIG. 1, an exemplary embodiment of the thermally insulated machine is illustrated as a refrigerator 100. The refrigerator 100 may be configured in variety of ways. For example, the refrigerator 100 may include both a refrigerating compartment and a freezing compartment arranged side-by-side or one over top of the other. Any suitable arrangement may be used. In the illustrated embodiment, the refrigerator 100 includes a refrigeration portion 102 positioned over top of a freezer portion 104.

[0031] The refrigerator 100 can include a generally box-shaped housing 106 surrounding and defining a refrigerating compartment 108 in the refrigeration portion 102 and a freezing compartment 110 in the freezer portion 104. In other embodiments, however, the housing 106 may be any suitable shape. The housing 106 can include a front wall 120, a rear wall 122 spaced apart from and generally parallel to the front wall, a first side wall 124 extending between the front wall and the rear wall, a second side wall 126 spaced apart from first side wall and extending between the front wall and the rear wall, a top wall 128 generally perpendicular to the first and second side walls and extending between the front wall and the rear wall, and a bottom wall 130 spaced apart from the top wall and extending between the front wall and the rear wall. The front wall 120 includes a first door 132, a second door 134 laterally adjacent first door, and a third door 136 positioned below the first and second doors 132, 134. The first door 132 includes a first handle 138 and second door 134 includes a second handle 140. The first door 132 and the second door 134 are movable relative to the remainder of the housing 106 to provide access to the refrigerating compartment 108. The third door 136 includes a third handle 142 and is movable relative to the remainder of the housing 106 to provide access to the freezing

compartment 110. In the illustrated embodiment, the first door 130 includes a built-in ice dispenser 144.

[0032] Referring to FIG. 2, the effectiveness of thermal insulation is commonly evaluated by its R-value, a measure of thermal resistance for a particular material. FIG. 2 is a graph showing the thermal resistance per inch (R/inch) vs. temperature of three different insulation materials: expanded polystyrene foam 200, extruded polystyrene foam 202, a needled glass fiber blanket 204, and modified polyisocyanurate foam 206. As shown in the graph, the thermal resistance per inch of expanded polystyrene foam 200 at zero degrees F is less than the thermal resistance per inch at 70 degrees F while the thermal resistance per inch of both extruded polystyrene foam 202 and the needled glass fiber blanket 204 is greater at zero degrees F than at 70 degrees F. The thermal resistance per inch of modified polyisocyanurate foam 206 is approximately the same at zero degrees F as it is at 70 degrees F. While expanded polystyrene foam 200 has a lower thermal resistance per inch than extruded polystyrene foam 202 and a needled glass fiber blanket 204 at all temperatures in the range of zero degrees F to 70 degrees F, modified polyisocyanurate foam 206 has a higher thermal resistance per inch at 70 degrees F and a lower thermal resistance per inch below approximately 37 degrees F.

[0033] FIG. 3 illustrates a partial cross-section of an exemplary embodiment of a wall 300 for the refrigerator 100. For example, the wall 300 may be any of the walls of the refrigerator 100, or any combination thereof, including the front wall 120, the rear wall 122, the first side wall 124, the second side wall 126 the top wall 128, the bottom wall 130, and the first door 132, the second door 134 laterally adjacent first door, and a third door 136 of the front wall 120 (see FIG. 1). In the exemplary embodiment, the wall 300 separates the refrigerating compartment 108 or the freezer compartment 110 from an area external to the refrigerator 100.

[0034] The wall 300 can be configured in a variety of ways. In the illustrated embodiment, the wall 300 includes a rigid inner layer 302, and a rigid outer layer 304 spaced apart from and generally parallel to the inner layer 302. Sandwiched between the inner layer 302 and the outer layer 304 are a first insulation layer 306 adjacent the inner layer and a second insulation layer 308 adjacent the outer layer. The wall 300

has a total thickness T_t , the first insulation layer 306 has a thickness T_1 and the second insulation layer has a thickness T_2 . In one exemplary embodiment, the thickness T_1 of the first insulation layer 306 is less than the thickness T_2 of the second insulation layer 308. In other embodiments, however, the thickness T_1 of the first insulation layer 306 may be equal to or greater than the thickness T_2 of the second insulation layer 308.

[0035] The rigid inner layer 302 and the rigid outer layer 308 may be configured in a variety of ways. For example, the rigid inner layer 302 and the rigid outer layer 308 may be single layers or each may include multiple layers. The inner layer 302 and the outer layer 308 may be made from any suitable material or materials. For example, in one exemplary embodiment, the outer layer 308 may be made from aluminum, stainless steel, or steel sheet metal. In some embodiments, the outer layer 308 may be painted or include tempered glass layer. The inner layer 302 made of steel sheet metal, like the outer layer, or of plastic, such as a synthetic resin.

[0036] In the exemplary embodiment, the first insulation layer 306 has a higher thermal resistance than the second insulation layer 308 in the temperature range of zero degrees F to 37 degrees F. In some embodiments, the first insulation layer 306 has a higher thermal resistance than the second insulation layer 308 in the temperature range of zero degrees to 35 degrees F, zero degrees to 30 degrees F, zero degrees to 25 degrees F, zero degrees to 20 degrees F, or zero degrees to 15 degrees F.

[0037] The first insulation layer 306 and the second insulation layer 308 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials may differ in different embodiments. Any configuration, arrangement and materials suitable for use with a machine having a refrigerating or freezing compartment and where the first insulation layer 306 has a higher thermal resistance than the second insulation layer 308 may be used. In the exemplary embodiment, the first insulation layer 306 can include, but not be limited to, extruded polystyrene foam, a needled glass fiber blanket, aerogels, or a combination thereof. The second insulation layer 308 can include polyisocyanurate foam.

[0038] The graph of FIG. 4 shows that relative temperature at different locations along the thickness T_t of the wall 300. Since the thermal resistance of extruded

polystyrene foam and a needled glass fiber blanket is greater than the thermal resistance of modified polyisocyanurate foam in the temperature range of zero degrees F to 37 degrees F, the change in temperature through the first insulation layer 306 when moving from the refrigerating compartment 108 or freezer compartment 110 outward to an area external to the refrigerator 100, is greater than the change in temperature through the second insulation layer 308. Thus, the first insulation layer 306 provides improved insulating performance than the second insulation layer 308.

[0039] FIG. 5 illustrates a partial cross-section of an exemplary embodiment of a wall 500 for the refrigerator 100. The wall 500 is similar to the wall 300 of FIG. 300 in that the wall 500 includes a rigid inner layer 502, and a rigid outer layer 504 spaced apart from and generally parallel to the inner layer 502. Sandwiched between the inner layer 502 and the outer layer 504 are a first insulation layer 506 adjacent the inner layer and a second insulation layer 508 adjacent the outer layer. The wall 500 has a total thickness T_t , the first insulation layer 506 has a thickness T_1 and the second insulation layer has a thickness T_2 .

[0040] Similar to the wall 300, the wall 500 may be any of walls of the refrigerator 100, or any combination thereof, the rigid inner layer 502 and the rigid outer layer 508 may be configured in a variety of ways and be any suitable materials, and the first insulation layer 306 and the second insulation layer 308 may be configured in a variety of ways, such as for example, a variety of thickness, shape, density, and insulation materials may be used.

[0041] The wall 500, however, differs from the wall 300 in that the wall 500 includes a barrier layer 510 between the first insulation layer 506 and the second insulation layer 508. The barrier layer 510 may be configured in a variety of ways. For example, polyisocyanurate foam is typically applied “wet”; thus, the barrier layer 510 may be any material that can prevent or impede the polyisocyanurate foam from penetrating the first insulation layer 506. In one exemplary embodiment, the barrier layer 510 may be a impermeable layer, such as a plastic sheet or foil. In other embodiments, however, the barrier layer 510 can be permeable.

[0042] Referring to FIG. 6, an exemplary embodiment of the thermally insulated machine is illustrated as a refrigerator 600. The refrigerator 600 is similar to the

refrigerator 100 of FIG. 100. The refrigerator 600 may be configured in variety of ways. For example, the refrigerator 600 may include both a refrigerating compartment and a freezing compartment arranged side-by-side or one over top of the other. Any suitable arrangement may be used. In the illustrated embodiment, the refrigerator 600 includes a refrigeration portion 602 positioned over top of a freezer portion 604.

[0043] The refrigerator 600 can include a generally box-shaped housing 606 surrounding and defining a refrigerating compartment 608 in the refrigeration portion 602 and a freezing compartment 610 in the freezer portion 604. In other embodiments, however, the housing 606 may be any suitable shape. The housing 606 can include a front wall 620, a rear wall 622 spaced apart from and generally parallel to the front wall, a first side wall 624 extending between the front wall and the rear wall, a second side wall 626 spaced apart from first side wall and extending between the front wall and the rear wall, a top wall 628 generally perpendicular to the first and second side walls and extending between the front wall and the rear wall, and a bottom wall 630 spaced apart from the top wall and extending between the front wall and the rear wall. The front wall 620 includes a first door 632, a second door 634 laterally adjacent first door, and a third door 636 positioned below the first and second doors 632, 634. The first door 632 includes a first handle 638 and second door 634 includes a second handle 640. The first door 632 and the second door 634 are movable relative to the remainder of the housing 606 to provide access to the refrigerating compartment 608. The third door 636 includes a third handle 642 and is movable relative to the remainder of the housing 606 to provide access to the freezing compartment 610.

[0044] In the illustrated embodiment, the first door 630 includes a built-in ice dispenser 644. The ice dispenser 644 is operatively coupled to an icemaker 646 such that ice from the icemaker can be dispensed through the ice dispenser. The icemaker 646 can be configured and arranged in a variety of ways. For example, any suitable shape, size and location may be used. The icemaker 646 can be a conventional refrigerator icemaker as is known in the art. In the illustrated embodiment, the icemaker 646 positioned within the refrigerating compartment 608.

[0045] Referring to FIG. 7, in the illustrated embodiment, the icemaker 646 schematically represented as having a box-like housing 710 surrounding and defining a freezing compartment 712. The housing 710 includes a front wall 720, a rear wall 722 spaced apart from and generally parallel to the front wall, a first side wall 724 extending between the front wall and the rear wall, a second side wall 726 spaced apart from first side wall and extending between the front wall and the rear wall, a top wall 728 generally perpendicular to the first and second side walls and extending between the front wall and the rear wall, and a bottom wall 730 spaced apart from the top wall and extending between the front wall and the rear wall.

[0046] When the icemaker 646 is operating and positioned within the refrigerating compartment 608, the temperature in the refrigerating compartment 608 of the refrigerator 600 is greater than the temperature in the freezing compartment 712 of the icemaker 646. Thus, as shown by the arrows in FIG. 7, the walls of the icemaker 646 and the freezing compartment 712 may be warmed (as illustrated by arrows in FIG. 7) by the refrigerating compartment 608. In the illustrated embodiment, the icemaker 646 is mounted such that the top wall 728 and the rear wall 722 of the icemaker 646 abut the inner side of the top wall 628 and rear wall 622 of the refrigerator 600, respectively. Thus, the top wall 728 and the rear wall 722 abut insulated walls and are not warmed by the refrigerating compartment 608 to the same degree as the front wall 720, the first side wall 724, the second side wall 726 and the bottom wall 730 (as shown by no arrows pointing at the top wall 728 and the rear wall 722 in FIG. 7).

[0047] To improve the thermal efficiency of the icemaker 646, one or more walls of the icemaker can be insulated. In some embodiments, all of the walls of the icemaker 646 are insulated. In other embodiments, less than all of the walls of the icemaker 646 may be insulated. For example, if the icemaker 646 is mounted such that the top wall 728 and the rear wall 722 of the icemaker 646 abut the inner side of the top wall 628 and rear wall 622 of the refrigerator 600, respectively, then the top wall 728 and the rear wall 722, in some embodiments, are not insulated since they abut the insulated walls of the refrigerator. One or more the other walls (*i.e.* the front wall 720, the first side wall 724, the second side wall 726, and the bottom wall 730), however, may be insulated.

[0048] FIG. 8A illustrates a partial cross-section of an exemplary embodiment of a wall 800 of the icemaker 646. The wall 800 can be configured in a variety of ways. In the illustrated embodiment, the wall 800 includes a rigid inner layer 802 and an outer insulation layer 806 adjacent the inner. In other embodiments, the wall may include a rigid outer layer and an inner insulation layer or may include an insulation layer sandwiched between inner and outer rigid layers. The wall 800 has a total thickness T_t , and the insulation layer 806 has a thickness T_1 .

[0049] The rigid inner layer 802 may be configured in a variety of ways. For example, the rigid inner layer 802 may be a single layer or include multiple layers. The inner layer 802 may be made from any suitable material or materials. For example, in one exemplary embodiment, the inner layer 802 may be made from aluminum, stainless steel, or steel sheet metal.

[0050] The insulation layer 806 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials used may differ in different embodiments. The insulation layer 806 can be a single layer or include multiple layers. Any configuration, arrangement and materials suitable for use on an icemaker may be used. In the exemplary embodiment, the insulation layer 806 can include extruded polystyrene foam, polyisocyanurate foam, or a combination thereof. In one exemplary embodiment, the insulation layer includes a VersaMat® polyester insulation layer.

[0051] FIG. 8b illustrates a partial cross-section of an exemplary embodiment of a wall 850 of the icemaker 646. The wall 850 can be similar to the wall 800. The wall 850 includes a rigid inner layer 852 and an insulation layer 856 adjacent the inner. The wall 800 has a total thickness T_t , and the insulation layer 856 has a thickness T_1 . The wall 850, however, can also include an rigid outer layer 858 that is spaced apart from and is substantially perpendicular to the rigid inner layer 852 such that the insulation layer 856 is sandwiched between the rigid inner layer 852 and the rigid outer layer 858.

[0052] The rigid outer layer 858 may be configured in a variety of ways. For example, the rigid outer layer 858 may be single layer or include multiple layers. The outer layer 858 may be made from any suitable material or materials. For example,

the outer layer 858 may be made of the same or similar materials to the inner layer 852 or may include a different material or materials.

[0053] Referring to FIG. 9A, an exemplary embodiment of the thermally insulated machine is illustrated as a refrigerator 900. The refrigerator 900 is similar to the refrigerator 100 of FIG. 100. The refrigerator 900 may be configured in variety of ways. For example, the refrigerator 900 may include both a refrigerating compartment and a freezing compartment arranged side-by-side or one over top of the other. Any suitable arrangement may be used. In the illustrated embodiment, the refrigerator 900 includes a refrigeration portion 902 positioned over top of a freezer portion 904.

[0054] The refrigerator 900 can include a generally box-shaped housing 906 surrounding and defining a refrigerating compartment (not shown but similarly arranged as refrigerating compartment 608 of FIG. 6) in the refrigeration portion 902 and a freezing compartment 910 (see FIGS. 10A-D) in the freezer portion 904. In other embodiments, however, the housing 906 may be any suitable shape. The housing 906 can include a front wall 920, a rear wall 922 spaced apart from and generally parallel to the front wall, a first side wall 924 extending between the front wall and the rear wall, a second side wall 926 spaced apart from first side wall and extending between the front wall and the rear wall, a top wall 928 generally perpendicular to the first and second side walls and extending between the front wall and the rear wall, and a bottom wall 930 spaced apart from the top wall and extending between the front wall and the rear wall.

[0055] The front wall 920 includes a first door 932, a second door 934 laterally adjacent first door, and a third door 936 positioned below the first and second doors 932, 934. The first door 932 includes a first handle 938 and second door 934 includes a second handle 940. The first door 932 and the second door 934 are movable relative to the remainder of the housing 906 to provide access to the refrigerating compartment 908. The third door 936 includes a third handle 942 and is movable relative to the remainder of the housing 906 to provide access to the freezing compartment 910. In the illustrated embodiment, the first door 930 includes a built-in ice dispenser 944.

[0056] The refrigerator 900 includes a rear mounted insulation member 946 at the intersection between the rear wall 922 and the bottom wall 930. The insulation member 946 is positioned, at least partially, between the freezer compartment 910 and one or more working components of the refrigerator 900, such as a refrigerator compressor 948 and condenser coils 950 (see FIG. 10B). In one embodiment, the insulation member 946 at least partially supports the freezer compartment 910 over the one or more of the working components, 948, 950.

[0057] The insulation layer 946 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials used may differ in different embodiments. The insulation layer 946 can be a single layer or include multiple layers and may be a single piece or include multiple pieces. Any configuration, arrangement and materials suitable for use in the refrigerator and able to be positioned, at least partially, between the freezer compartment 910 and the one or more working components of the refrigerator 900 may be used.

[0058] In the exemplary embodiment, the insulation member 946 is generally L-shaped including a first portion 952 extending upward along the rear wall 922 of the refrigerator 900 and a second portion 954 extending generally perpendicular to the first portion and along the bottom wall 930 of the refrigerator 900. In one exemplary embodiment, the insulation member 946 includes at least one of extruded polystyrene foam, a needled glass fiber blanket, and polyisocyanurate foam, or a combination thereof.

[0059] Referring to FIG. 9B, an exemplary embodiment of the thermally insulated machine is illustrated as a refrigerator 960. The refrigerator 960 is similar to the refrigerator 900 of FIG. 9A. The refrigerator 960 may be configured in variety of ways. For example, the refrigerator 960 may include both a refrigerating compartment and a freezing compartment arranged side-by-side or one over top of the other. Any suitable arrangement may be used. In the illustrated embodiment, the refrigerator 960 includes a refrigeration portion 962 positioned over top of a freezer portion 964.

[0060] The refrigerator 960 can include a generally box-shaped housing 966 surrounding and defining a refrigerating compartment (not shown but similarly

arranged as refrigerating compartment 608 of FIG. 6) in the refrigeration portion 962 and a freezing compartment (not shown but similar to the freezing compartment 910 of FIGS. 10A-D) in the freezer portion 964. In other embodiments, however, the housing 966 may be any suitable shape. The housing 966 can include a front wall 970, a rear wall 972 spaced apart from and generally parallel to the front wall, a first side wall 974 extending between the front wall and the rear wall, a second side wall 976 spaced apart from first side wall and extending between the front wall and the rear wall, a top wall 978 generally perpendicular to the first and second side walls and extending between the front wall and the rear wall, and a bottom wall 980 spaced apart from the top wall and extending between the front wall and the rear wall.

[0061] The front wall 970 includes a first door 982, a second door 984 laterally adjacent first door, and a third door 936 positioned below the first and second doors 982, 984. The first door 982 includes a first handle 988 and second door 984 includes a second handle 990. The first door 982 and the second door 984 are movable relative to the remainder of the housing 966 to provide access to the refrigerating compartment 968. The third door 986 includes a third handle 992 and is movable relative to the remainder of the housing 966 to provide access to the freezing compartment 970. In the illustrated embodiment, the first door 982 includes a built-in ice dispenser 994.

[0062] The refrigerator 960 includes a pair of side mounted insulation member 996. The insulation members 996 are positioned, at least partially, between the freezer compartment 970 and one or more working components of the refrigerator 960, such as a refrigerator compressor and condenser coils (not shown but similar to the compressor 948 and condenser coils 950 of FIGS. 10A-D). In one embodiment, the insulation members 996 at least partially support the freezer compartment 970 over the working components.

[0063] The insulation members 996 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials used may differ in different embodiments. Each of the insulation member 996 can be a single layer or include multiple layers and may be a single piece or include multiple pieces. Any configuration, arrangement and materials suitable for use in the refrigerator and

capable of being positioned, at least partially, between the freezer compartment 970 and one or more working components of the refrigerator 960 may be used.

[0064] In the exemplary embodiment, each of the insulation members 996 are generally L-shaped including a first portion 1002 extending upward along the first and second sidewalls 974, 976 of the refrigerator 960, respectively, and a second portion 1004 extending generally perpendicular to the first portion and along the bottom wall 980 of the refrigerator 960. In one exemplary embodiment, the insulation member 946 includes at least one of extruded polystyrene foam, a needled glass fiber blanket, and polyisocyanurate foam, or a combination thereof.

[0065] Referring to FIG. 10A and 10B, the refrigerator 900 includes a plurality of legs 1010 and/or wheels that support the housing 906. While FIGS. 10A-10D illustrate refrigerator 900, the description applies equally to refrigerator 960 or any of the other refrigerators described herein. At least some of the working components, such as the compressor 948 and condenser coils 950 are provided in a cavity 1012 between the legs 1010 and below the bottom wall 930 of the housing 906 or behind the rear wall 922. In the illustrated embodiment, the condenser coils 950 are illustrated within the cavity 1012 and the compressor 948 is behind the rear wall 922. In other embodiments, however, the working components may be positioned differently.

[0066] The bottom wall 930 and rear wall 922 of the housing 906 are insulated to provide a thermal barrier between the freezer compartment 910 and the compressor 948 and the condenser coils 950. The insulation member 946 is positioned at the intersection between the bottom wall 930 and rear wall 922. In the exemplary embodiment, the insulation member 946 extends from the first side wall 924 to the second sidewall 926.

[0067] The bottom wall 930 and rear wall 922 may be configured in a variety of ways. In the illustrated embodiment, at the intersection between the rear wall 922 and the bottom wall 930, the rear wall 922 and the bottom wall 930 may include a rigid inner layer 1014 and a rigid outer layer 1016 spaced apart from and generally parallel to the inner layer. The insulation member 946 is sandwiched between the inner layer 1014 and the outer layer 1016. In the illustrated embodiment, the insulation member

946 includes a first insulation portion 1020, a second insulation portion 1022, and a third insulation portion 1024 (FIG. 10A). The first insulation portion 1020 extends from the rigid inner layer 1014 and the rigid outer layer 1016. In the illustrated embodiment, the first insulation portion 1020 does not extend from the first sidewall 924 to the second sidewall 926. Instead, the first insulation portion 1020 is sandwiched between the second insulation portion 1022 and the third insulation portion 1024. The second insulation portion 1022 is positioned adjacent the first sidewall 924 and the third insulation portion 1024 is positioned adjacent the second sidewall 926. The second insulation portion 1022 and the third insulation portion 1024 may extend from the rigid inner layer 1014 and the rigid outer layer 1016.

[0068] The wall 300 has a total width W_t . The first insulation portion has width W_1 , the second insulation portion has a width W_2 , and the third insulation portion has a width W_3 . In one exemplary embodiment, the width W_1 of the first insulation portion is greater than the width W_2 of the second insulation portion or the width W_3 of the third insulation portion. In some embodiments, the width W_2 of the second insulation portion is the same, or approximately the same, as the width W_3 of the third insulation portion. In other embodiments, however, the width W_2 of the second insulation portion may differ from the width W_3 of the third insulation portion.

[0069] The rigid inner layer 1014 and the rigid outer layer 1016 may be configured in a variety of ways. For example, the rigid inner layer 1014 and the rigid outer layer 1016 may be single layers or each may include multiple layers. The inner layer 1014 and the outer layer 1016 may be made from any suitable material or materials. For example, in one exemplary embodiment, the outer layer 1016 may be made from aluminum, stainless steel, or steel sheet metal. The inner layer 1014 may be made of steel sheet metal, like the outer layer 1016, or of plastic, such as a synthetic resin.

[0070] In the exemplary embodiment, the first insulation portion 1020 has a lower thermal resistance than the second and third insulation portions 1022, 1024. The first, second and third insulation portions 1022, 1024 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials may differ in different embodiments. Any configuration, arrangement and materials suitable for use with the refrigerator 900 and where the first insulation portion 1020 has a lower

thermal resistance than the second and third insulation portions 1022, 1024 may be used. In the exemplary embodiment, the second and third insulation portions 1022, 1024 can include extruded polystyrene foam, a needled glass fiber blanket, aerogels, or a combination thereof. The first insulation portion 1020 can include polyisocyanurate foam. In other embodiments, the entire insulation member 946 may have the same thermal resistance.

[0071] The rear wall 922 and the bottom wall 930, in locations other than where the insulation member 946 is positioned, may be configured in any suitable manner. For example, in the illustrated embodiment of FIGS. 10A and 10B, the rear wall 922 and the bottom wall 930 are insulation with the same or similar material as the first insulation portion 1020 (*e.g.*, polyisocyanurate foam). In other embodiments, the rear wall 922 and the bottom wall 930, in locations other than where the insulation member 946 is positioned, may be configured similar to the wall 300 of FIG. 3.

[0072] Referring to FIG. 10C and 10D, the illustrated exemplary embodiment of the refrigerator 900 is the same as illustrated in FIG. 10A except the first insulation portion 1020 of the insulation member 946 includes a first insulation layer 1030 and a second insulation 1032 and at least some of the walls, in locations other than where the insulation member 946 is positioned, are configured similar to the wall 300 of FIG. 3.

[0073] The refrigerator 900 includes a plurality of legs 1010 and/or wheels that support the housing 906. At least some of the working components, such as the compressor 948 and condenser coils 950 are provided in a cavity 1012 between the legs 1010 and below the bottom wall 930 of the housing 906 or behind the rear wall 922. In the illustrated embodiment, the condenser coils 950 are illustrated within the cavity 1012 and the compressor 948 is behind the rear wall 922. In other embodiments, however, the working components may be positioned differently.

[0074] The bottom wall 930 and rear wall 922 of the housing 906 are insulated to provide a thermal barrier between the freezer compartment 910 and the compressor 948 and the condenser coils 950. The insulation member 946 is positioned at the intersection between the bottom wall 930 and rear wall 922. In the exemplary

embodiment, the insulation member 946 extends from the first side wall 924 to the second sidewall 926.

[0075] The bottom wall 930 and rear wall 922 may be configured in a variety of ways. In the illustrated embodiment, at the intersection between the rear wall 922 and the bottom wall 930, the rear wall 922 and the bottom wall 930 may include a rigid inner layer 1014 and a rigid outer layer 1016 spaced apart from and generally parallel to the inner layer. The insulation member 946 is sandwiched between the inner layer 1014 and the outer layer 1016. In the illustrated embodiment, the insulation member 946 includes a first insulation portion 1020, a second insulation portion 1022, and a third insulation portion 1024 (FIG. 10A). The first insulation portion 1020 extends from the rigid inner layer 1014 and the rigid outer layer 1016.

[0076] The first insulation portion 946 includes the first insulation layer 1030 adjacent the inner layer 1014 and the second insulation layer 1032 adjacent the outer layer 1016. The wall 930 has a total thickness T_t , the first insulation layer 1030 has a thickness T_1 and the second insulation layer 1032 has a thickness T_2 .

[0077] In the exemplary embodiment, the first insulation layer 1030 has a higher thermal resistance than the second insulation layer 1032. The first insulation layer 1030 and the second insulation layer 1032 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials may differ in different embodiments. Any configuration, arrangement and materials suitable for use with a machine having a refrigerating or freezing compartment and where the first insulation layer 1030 has a higher thermal resistance than the second insulation layer 1032 may be used. In the exemplary embodiment, the first insulation layer 1030 can include extruded polystyrene foam, a needled glass fiber blanket, or a combination thereof. The second insulation layer 1032 can include polyisocyanurate foam.

[0078] In the illustrated embodiment, the first insulation portion 1020 does not extend from the first sidewall 924 to the second sidewall 926. Instead, the first insulation portion 1020 is sandwiched between the second insulation portion 1022 and the third insulation portion 1024. The second insulation portion 1022 is positioned adjacent the first sidewall 924 and the third insulation portion 1024 is positioned adjacent the second sidewall 926. The second insulation portion 1022 and the third insulation

portion 1024 may extend from the rigid inner layer 1014 and the rigid outer layer 1016.

[0079] The wall 300 has a total width W_t . The first insulation portion has width W_1 , the second insulation portion has a width W_2 , and the third insulation portion has a width W_3 . In one exemplary embodiment, the width W_1 of the first insulation portion is greater than the width W_2 of the second insulation portion or the width W_3 of the third insulation portion. In some embodiments, the width W_2 of the second insulation portion is the same, or approximately the same, as the width W_3 of the third insulation portion. In other embodiments, however, the width W_2 of the second insulation portion may differ from the width W_3 of the third insulation portion.

[0080] The rigid inner layer 1014 and the rigid outer layer 1016 may be configured in a variety of ways. For example, the rigid inner layer 1014 and the rigid outer layer 1016 may be single layers or each may include multiple layers. The inner layer 1014 and the outer layer 1016 may be made from any suitable material or materials. For example, in one exemplary embodiment, the outer layer 1016 may be made from aluminum, stainless steel, or steel sheet metal. The inner layer 1014 may be made of steel sheet metal, like the outer layer 1016, or of plastic, such as a synthetic resin.

[0081] In the exemplary embodiment, the first insulation portion 1020 has a lower thermal resistance than the second and third insulation portions 1022, 1024. The first, second and third insulation portions 1022, 1024 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials may differ in different embodiments. Any configuration, arrangement and materials suitable for use with the refrigerator 900 and where the first insulation portion 1020 has a lower thermal resistance than the second and third insulation portions 1022, 1024 may be used. In the exemplary embodiment, the second and third insulation portions 1022, 1024 can include extruded polystyrene foam, a needled glass fiber blanket, or a combination thereof. The first insulation portion 1020 can include polyisocyanurate foam.

[0082] The rear wall 922, the bottom wall 930, in locations other than where the insulation member 946 is positioned, and any of the other walls of the refrigerator 900 may be configured in any suitable manner. For example, in the illustrated

embodiment of FIGS. 10A and 10B, the rear wall 922, the bottom wall 930, in locations other than where the insulation member 946 is positioned, and the front wall 920 are configured similar to the wall 300 of FIG. 3.

[0083] In particular, the walls 920, 922, and 930 include the rigid inner layer 1014, the rigid outer layer 1016, and, sandwiched between the inner layer and the outer layer, a first insulation layer 1040 adjacent the inner layer and a second insulation layer 1042 adjacent the outer layer. As with the wall 300 of FIG. 3, for the walls 920, 922, and 930 the thickness of the first insulation layer 1040 can be less than the thickness of the second insulation layer 1042. In other embodiments, however, the thickness of the first insulation layer 1040 may be equal to or greater than the thickness of the second insulation layer 1042.

[0084] In the exemplary embodiment, the first insulation layer 1040 has a higher thermal resistance than the second insulation layer 1042. The first insulation layer 1040 and the second insulation layer 1042 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials may differ in different embodiments. Any configuration, arrangement and materials suitable for use with a machine having a refrigerating or freezing compartment and where the first insulation layer 1040 has a higher thermal resistance than the second insulation layer 1042 may be used. In the exemplary embodiment, the first insulation layer 1040 can include extruded polystyrene foam, a needled glass fiber blanket, or a combination thereof. The second insulation layer 1042 can include polyisocyanurate foam.

[0085] FIG. 11A illustrates an exemplary embodiment of a refrigerator 1100 having a door 1102 with a built-in ice dispenser 1104. The door 1102, as with door 632 of the refrigerator 600 of FIG. 6, covers a refrigerating compartment 1106. The ice dispenser 1104 may be configured in a variety of ways. For example, the ice dispenser 1104 may be a conventional ice dispenser as is known in the art. In the exemplary embodiment, the ice dispenser 1104 includes an icemaker 1108 capable of making ice, such as for example, ice cubes 1110. The icemaker 1108 drops the ice cubes 1110 into a chute 1112. The chute 1112 directs the ice cubes 1110 to an outlet opening 1114. The outlet opening 1114 is positioned above a platform or shelf 1116 capable of supporting a receptacle (not shown), such as a glass, for receiving the ice

cubes 1110. An interface 1118 for activating the ice dispenser 1104 to dispense the ice cubes 1110 may be provided. In the illustrated embodiment, the interface 1118 is formed as a paddle or pad disposed adjacent the platform 1116 such that the receptacle, when placed on the platform, can activate the interface.

[0086] The door 1102 may be configured in a variety of ways. In the exemplary embodiment, the door 1102 can be configured similarly to the door 632 of the refrigerator 600 of FIG. 6. Thus, the door 1102 can include rigid inner layer 1120, and a rigid outer layer 1122 spaced apart from and generally parallel to the inner layer. The door 1102 includes an inward facing recess 1124 in which the chute 1112 is positioned. The inward facing recess 1124 is positioned above the outlet opening 1114. The door 1102 also includes an outward facing recess 1126 defining or housing the platform or shelf 1116. The outward facing recess 1126 is positioned under the outlet opening 1114.

[0087] The door 1102 includes a rigid divider 1128 outward facing recess 1126 and platform 1116 from the refrigerating compartment 1106. The rigid divider 1128 may be configured in a variety of ways. In the illustrated embodiment, the rigid divider 1128 is made of plastic or other like material. In other portions of the door 1102, including the area between the inward facing recess and the rigid outer layer 1122, an insulation layer 1130 is sandwiched between the rigid inner layer 1120 and a rigid outer layer 1122. The insulation layer 1130 may include polyisocyanurate foam.

[0088] FIG. 11B illustrates an exemplary embodiment of a refrigerator 1150 having a door 1152 with a built-in ice dispenser 1154. The door 1152 as with the door 632 of the refrigerator 600 of FIG. 6, covers a refrigerating compartment 1156. The ice dispenser 1154 may be configured in a variety of ways. For example, the ice dispenser 1154 may be a conventional ice dispenser as is known in the art. In the exemplary embodiment, the ice dispenser 1154 includes an icemaker 1158 capable of making ice, such as for example, ice cubes 1160. The icemaker 1158 drops the ice cubes 1160 into a chute 1162. The chute 1162 directs the ice cubes 1160 to an outlet opening 1164. The outlet opening 1164 is positioned above a platform or shelf 1166 capable of supporting a receptacle (not shown), such as a glass, for receiving the ice cubes 1160. An interface 1168 for activating the ice dispenser 1154 to dispense the

ice cubes may be provided. In the illustrated embodiment, the interface 1168 is formed as a paddle or pad disposed adjacent the platform or shelf such that the receptacle when placed on the platform can activate the interface.

[0089] The door 1152 may be configured in a variety of ways. In the exemplary embodiment, the door 1152 can be configured similarly to the door 632 of the refrigerator 600 of FIG. 6. Thus, the door 1152 can include rigid inner layer 1170, and a rigid outer layer 1172 spaced apart from and generally parallel to the inner layer. The door 1152 includes an inward facing recess 1174 in which the chute 1162 is positioned. The inward facing recess 1174 is positioned above the outlet opening 1164. The door 1152 also includes an outward facing recess 1176 defining or housing the platform or shelf 1166. The outward facing recess 1166 is positioned under the outlet opening 1164.

[0090] The door 1152 includes a first wall portion 1178 separating the outward facing recess 1176 and platform 1166 from the refrigerating compartment 1156. The first wall portion 1178 may be configured in a variety of ways. In the illustrated embodiment, the first wall portion 1178 includes the rigid inner layer 1170 and an insulation layer 1180. The insulation layer 1180 may be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials used may differ in different embodiments. The insulation layer 1180 may be a single layer or multiple layers, may be a single piece or multiple pieces, and may be a single material or multiple materials. Any configuration, arrangement and materials suitable for use with the ice dispenser 1154 may be used. In one exemplary embodiment, insulation layer 1180 includes extruded polystyrene foam, a needled glass fiber blanket, or a combination thereof.

[0091] The door 1152 includes a second wall portion 1182 separating the inward facing recess 1174 and from exterior to the refrigerator 1150. The second wall portion 1182 may be configured in a variety of ways. In the illustrated embodiment, the second wall portion 1182 includes the rigid outer layer 1172, a first insulation layer 1184, and a second insulation layer 1186. In the exemplary embodiment, the first insulation layer 1184 has a higher thermal resistance than the second insulation layer 1186. The first insulation layer 1184 and the second insulation layer 1186 may

be configured in a variety of ways. For example, the thickness, shape, density, and insulation materials may differ in different embodiments. The insulation layers 1184, 1186 may be a single layer or multiple layers, may be a single piece or multiple pieces, and may be a single material or multiple materials. Any configuration, arrangement and materials suitable for use with a machine having a refrigerating or freezing compartment and where the first insulation layer 1184 has a higher thermal resistance than the second insulation layer 1186 may be used. In the exemplary embodiment, the first insulation layer 1184 can include extruded polystyrene foam, a needled glass fiber blanket, or a combination thereof. The second insulation layer 1186 can include polyisocyanurate foam.

[0092] The rigid inner layer 1170 and the rigid outer layer 1172 may be configured in a variety of ways. For example, the rigid inner layer 1170 and the rigid outer layer 1172 may be single layers or each may include multiple layers. The inner layer 1170 and the outer layer 1172 may be made from any suitable material or materials. For example, in one exemplary embodiment, the outer layer 1172 may be made from aluminum, stainless steel, or steel sheet metal. In some embodiments, the outer layer 1172 may be painted or include tempered glass layer. The inner layer 1170 made of steel sheet metal, like the outer layer, or of plastic, such as a synthetic resin.

[0093] While various inventive aspects, concepts and features of the inventions may be described and illustrated herein as embodied in combination in the exemplary embodiments, these various aspects, concepts and features may be used in many alternative embodiments, either individually or in various combinations and sub-combinations thereof. Unless expressly excluded herein all such combinations and sub-combinations are intended to be within the scope of the present inventions. Still further, while various alternative embodiments as to the various aspects, concepts and features of the inventions--such as alternative materials, structures, configurations, methods, devices and components, alternatives as to form, fit and function, and so on--may be described herein, such descriptions are not intended to be a complete or exhaustive list of available alternative embodiments, whether presently known or later developed. Those skilled in the art may readily adopt one or more of the inventive aspects, concepts or features into additional embodiments and uses within the scope of the present inventions even if such embodiments are not expressly disclosed herein.

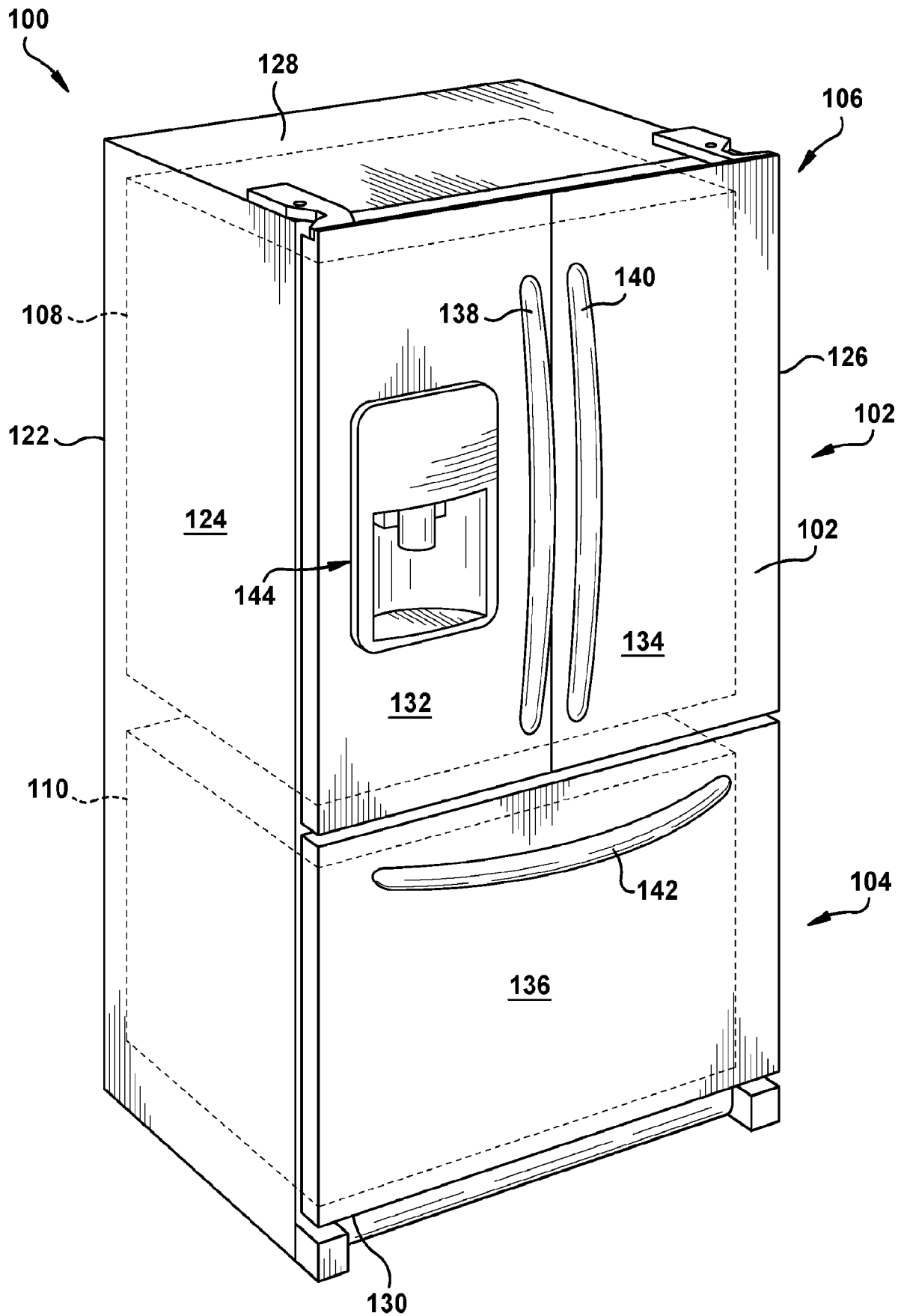
Additionally, even though some features, concepts or aspects of the inventions may be described herein as being a preferred arrangement or method, such description is not intended to suggest that such feature is required or necessary unless expressly so stated. Still further, exemplary or representative values and ranges may be included to assist in understanding the present disclosure, however, such values and ranges are not to be construed in a limiting sense and are intended to be critical values or ranges only if so expressly stated. Moreover, while various aspects, features and concepts may be expressly identified herein as being inventive or aiming part of an invention, such identification is not intended to be exclusive, but rather there may be inventive aspects, concepts and features that are fully described herein without being expressly identified as such or as part of a specific invention, the inventions instead being set forth in the appended claims. Descriptions of exemplary methods or processes are not limited to inclusion of all steps as being required in all cases, nor is the order that the steps are presented to be construed as required or necessary unless expressly so stated.

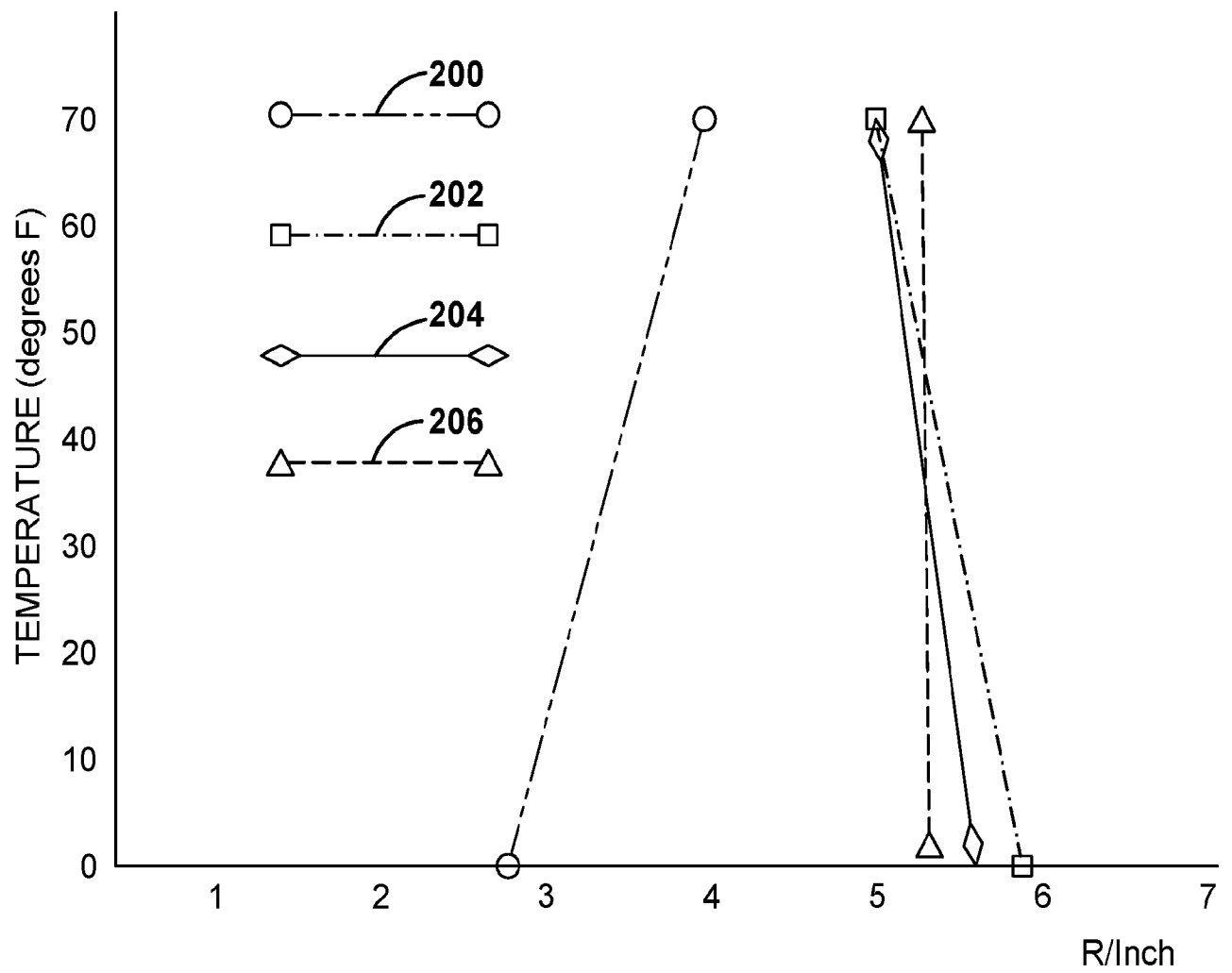
Claims

1. A thermally insulated machine, comprising:
a housing;
a refrigerating compartment positioned within the housing;
a wall between the refrigerating compartment and an area exterior to the compartment, the wall including a first insulation layer and a second insulation layer, wherein the first insulation layer has a higher thermal resistance than the second insulation layer in the temperature range of zero degrees Fahrenheit to 37 degrees Fahrenheit, and wherein the first insulation layer is positioned closer to the refrigerating compartment than the second insulation layer.
2. The thermally insulated machine of claim 1 wherein the wall is an exterior wall or door of the housing.
3. The thermally insulated machine of claim 1 wherein the refrigerating compartment is a compartment of an icemaker and the area exterior to the compartment includes a compartment within a refrigerator.
4. The thermally insulated machine of claim 1 wherein the refrigerating compartment is a freezer compartment.
5. The thermally insulated machine of claim 4 wherein the area exterior to the compartment is the underside of the machine which houses at least one working component of the thermally insulated machine.
6. The thermally insulated machine of claim 1 wherein the second insulation layer includes polyisocyanurate foam.
7. The thermally insulated machine of claim 6 wherein the first insulation layer includes extruded polystyrene foam.

8. The thermally insulated machine of claim 6 wherein the first insulation layer includes a needled, glass fiber layer.
9. The thermally insulated machine of claim 6 wherein an impermeable barrier layer is sandwiched between the first insulation layer and the second insulation layer.
10. The thermally insulated machine of claim 1 wherein the first insulation layer has a first thickness and the second insulation layer has a second thickness that is greater than the first thickness.
11. A thermally insulated machine, comprising:
 - a housing;
 - a refrigerating compartment positioned within the housing;
 - an icemaker positioned within the refrigerating compartment;
 - wherein the icemaker includes at least one wall having a thermal insulation layer.
12. The thermally insulated machine of claim 11 further comprising a door that provides access to the refrigerating compartment, the door including an outward facing recess that receives ice from the ice maker, and a first wall portion positioned between the recess and the refrigerating compartment, the wall including at least one layer of thermal insulation.
13. The thermally insulated machine of claim 11 wherein the door includes a second wall portion between the refrigerating compartment and an area exterior to the machine, the wall including a first insulation layer and a second insulation layer, wherein the first insulation layer has a higher thermal resistance than the second insulation layer, and wherein the first insulation layer is positioned closer to the refrigerating compartment than the second insulation layer.
14. The thermally insulated machine of claim 13 wherein the second insulation layer includes polyisocyanurate foam.

15. The thermally insulated machine of claim 14 wherein the first insulation layer includes at least one of extruded polystyrene foam and a needled, glass fiber layer.
16. A thermally insulated machine, comprising:
- a housing having a bottom wall and a rear wall;
 - a refrigerating compartment positioned within the housing;
 - one or more working components positioned adjacent one or more of the bottom wall and rear wall;
 - an extruded polystyrene insulation member positioned such that a first portion of the insulation member extends along a portion of the rear wall and a second portion of the insulation member extends along a portion of the bottom wall.
17. A method for thermally insulating a refrigerating compartment of a refrigerator, the method comprising:
- positioning a first insulation layer having a first thermal resistance between the refrigerating compartment and an area exterior to the refrigerating compartment;
 - positioning a second insulation layer having a second thermal resistance between the first insulation layer and the area exterior to the refrigerating compartment;
 - wherein the first thermal resistance is greater than the second thermal resistance and wherein the first insulation layer is positioned closer to the refrigerating compartment than the second insulation layer.
18. The method of claim 17 further comprising wherein the second insulation layer includes polyisocyanurate foam.
19. The method of claim 18 wherein the first insulation layer includes at least one of extruded polystyrene foam, an aerogel, and a needled, glass fiber layer.

**Fig. 1**

**Fig. 2**

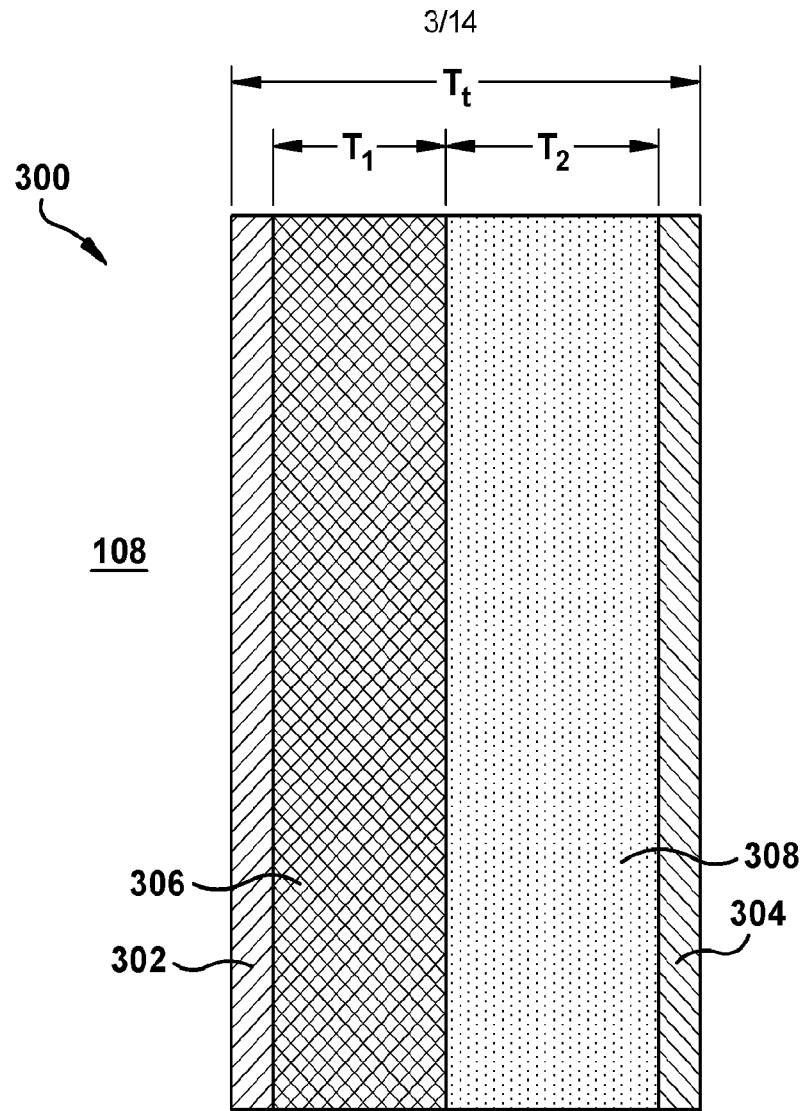


Fig. 3

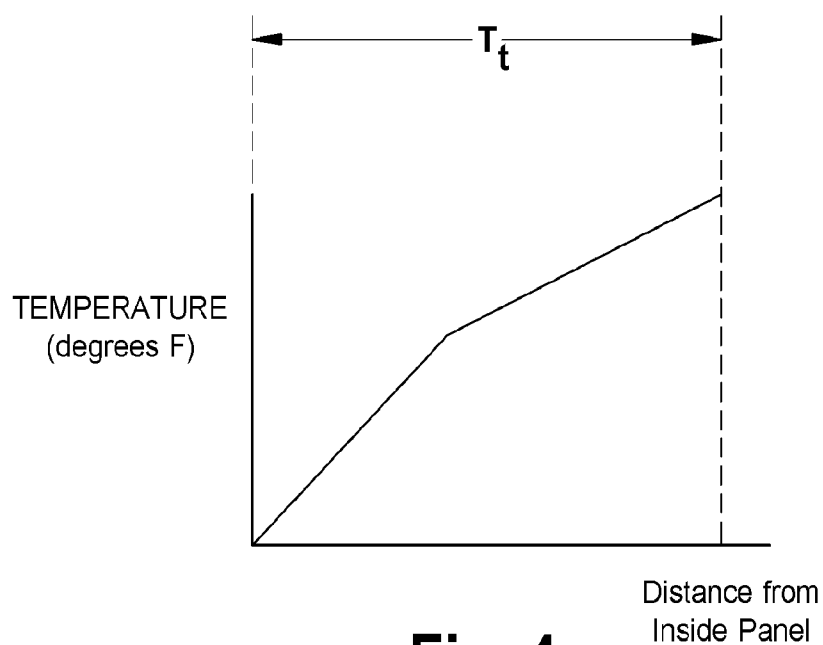
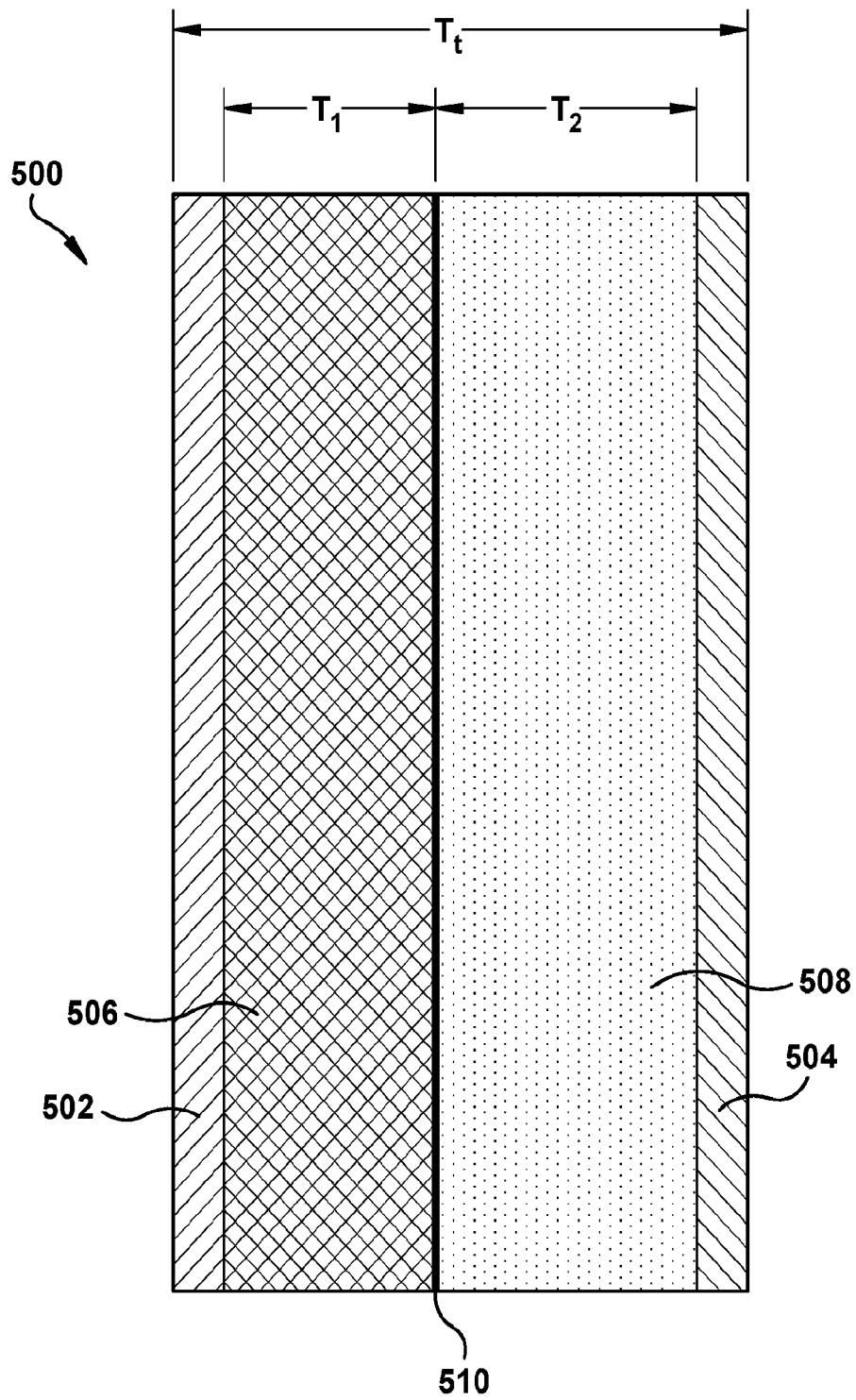
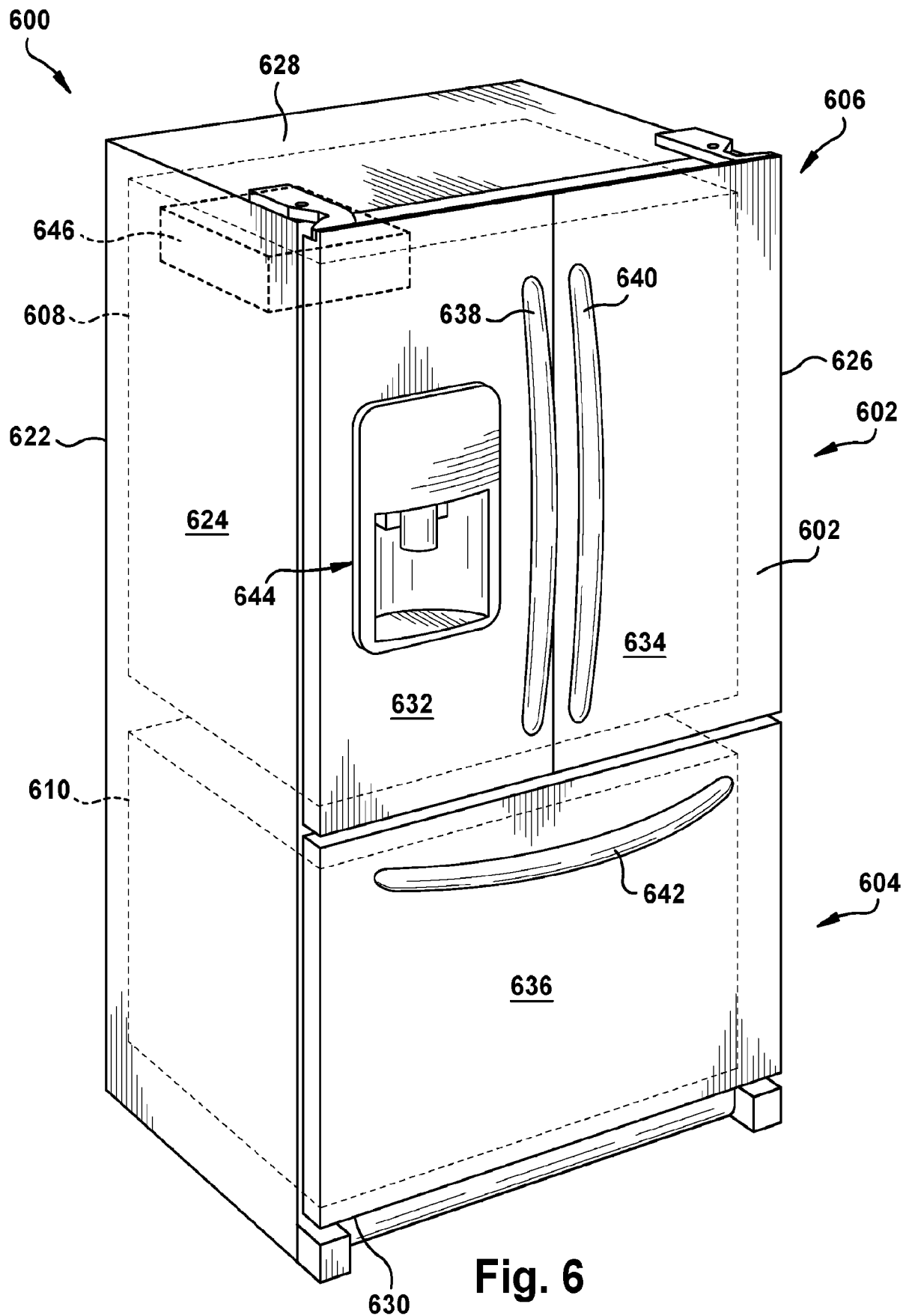
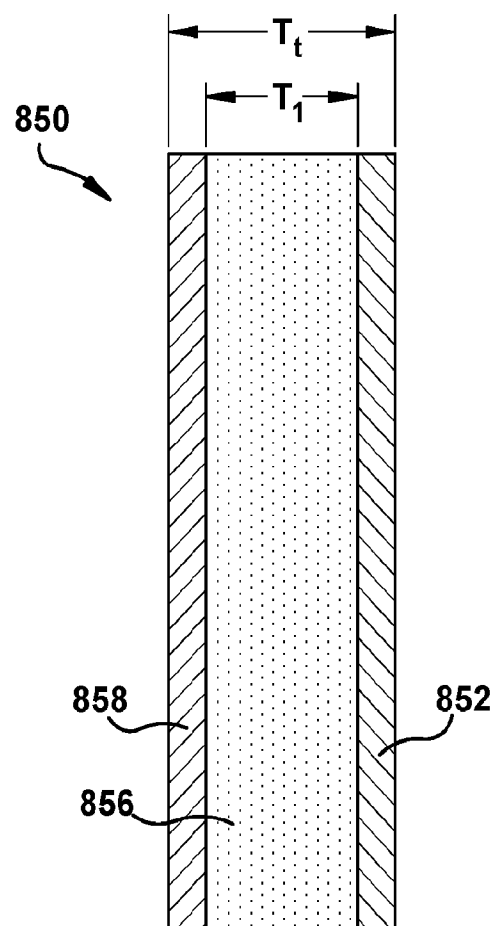
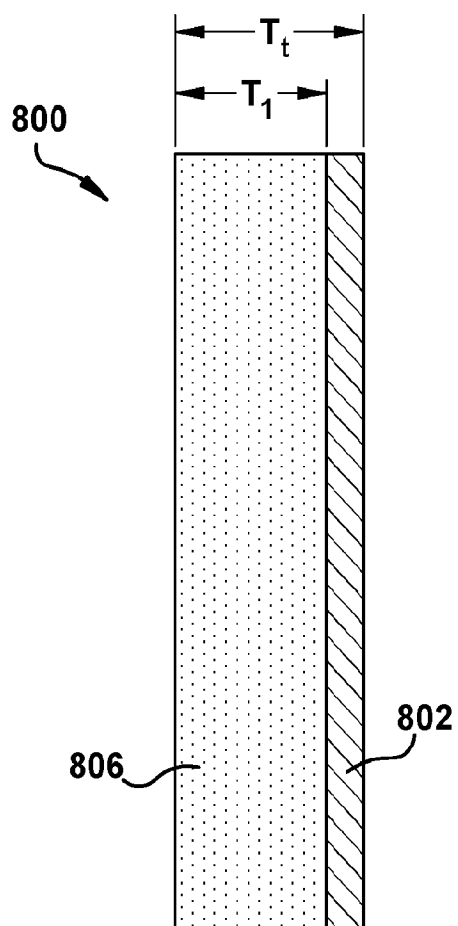
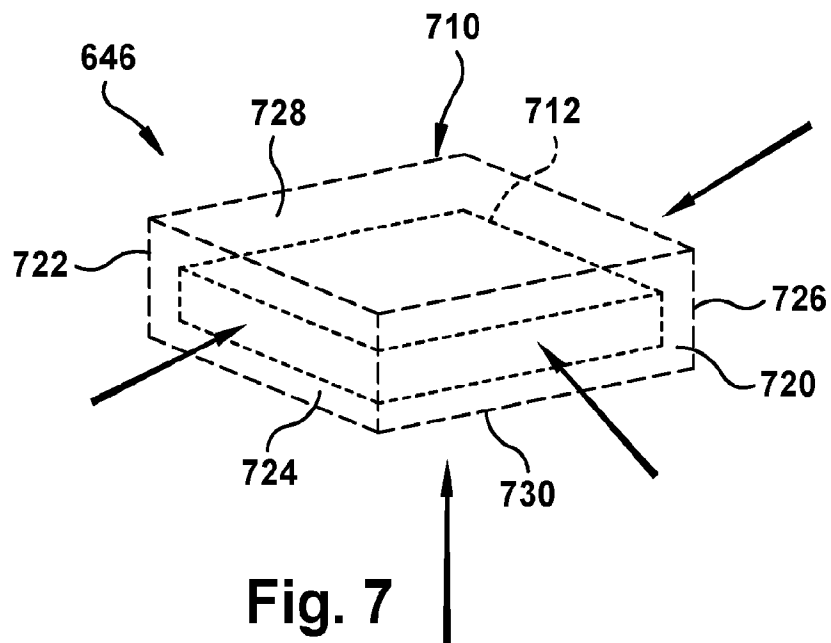
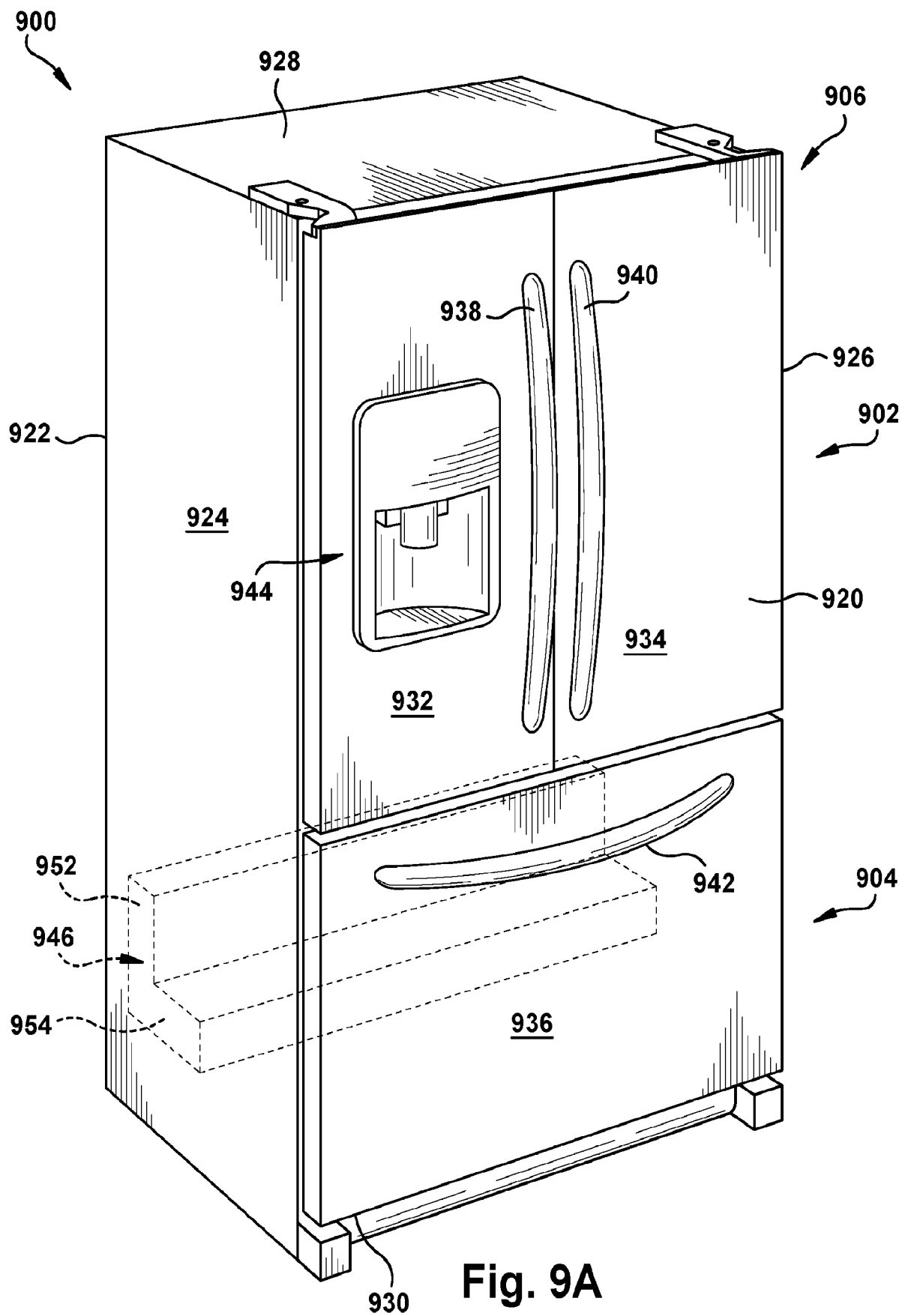


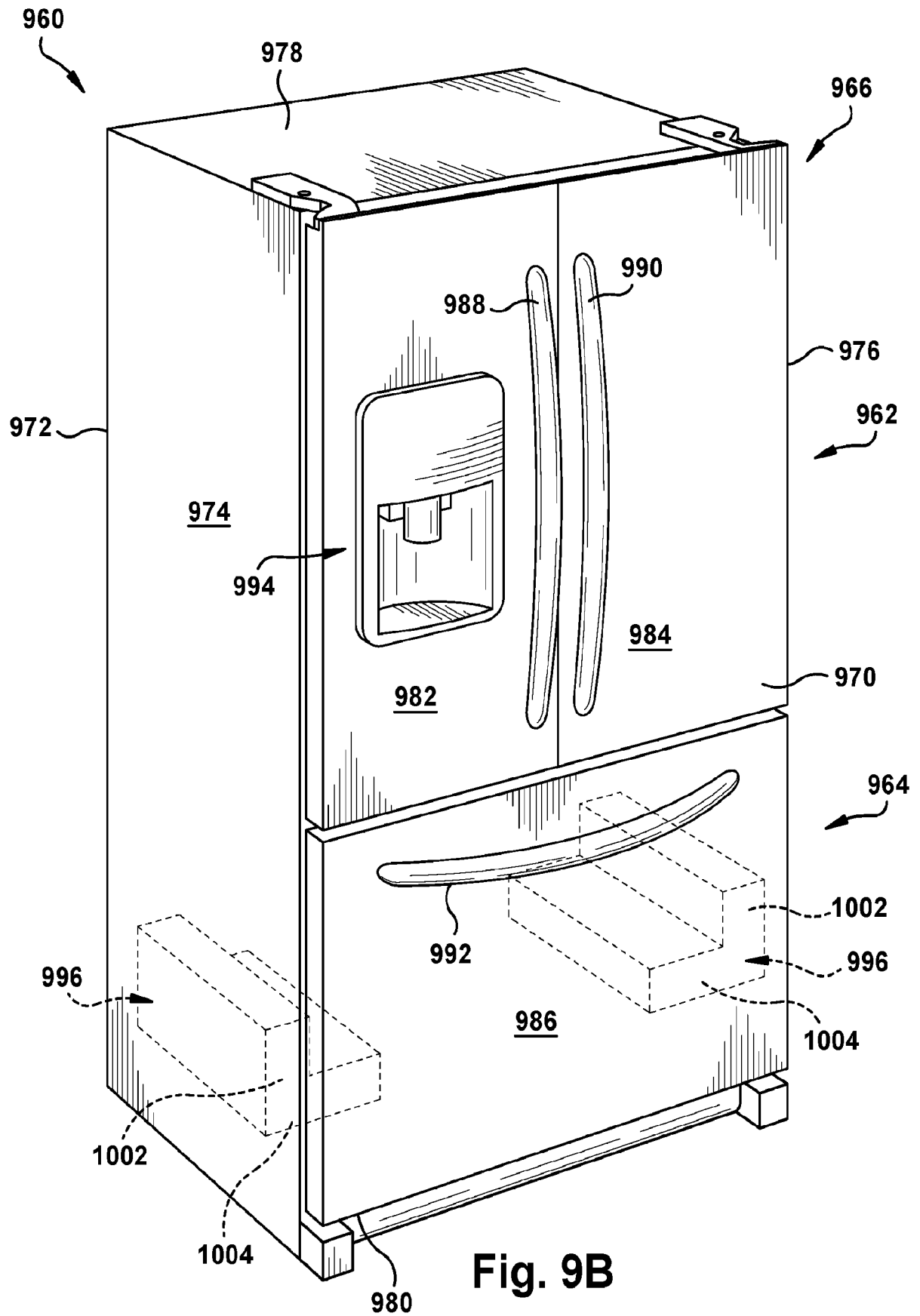
Fig. 4

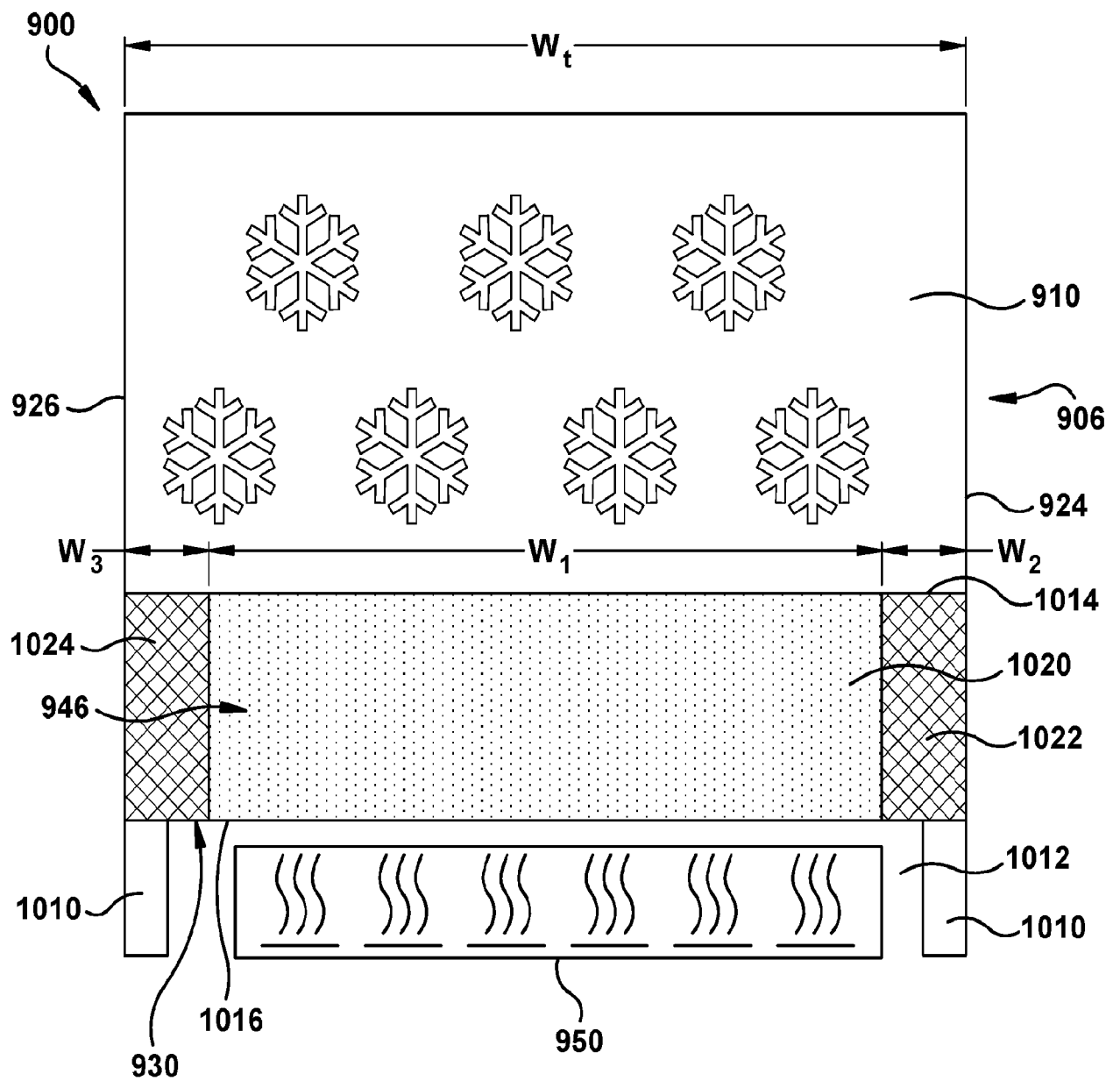
**Fig. 5**







**Fig. 9B**

**Fig. 10A**

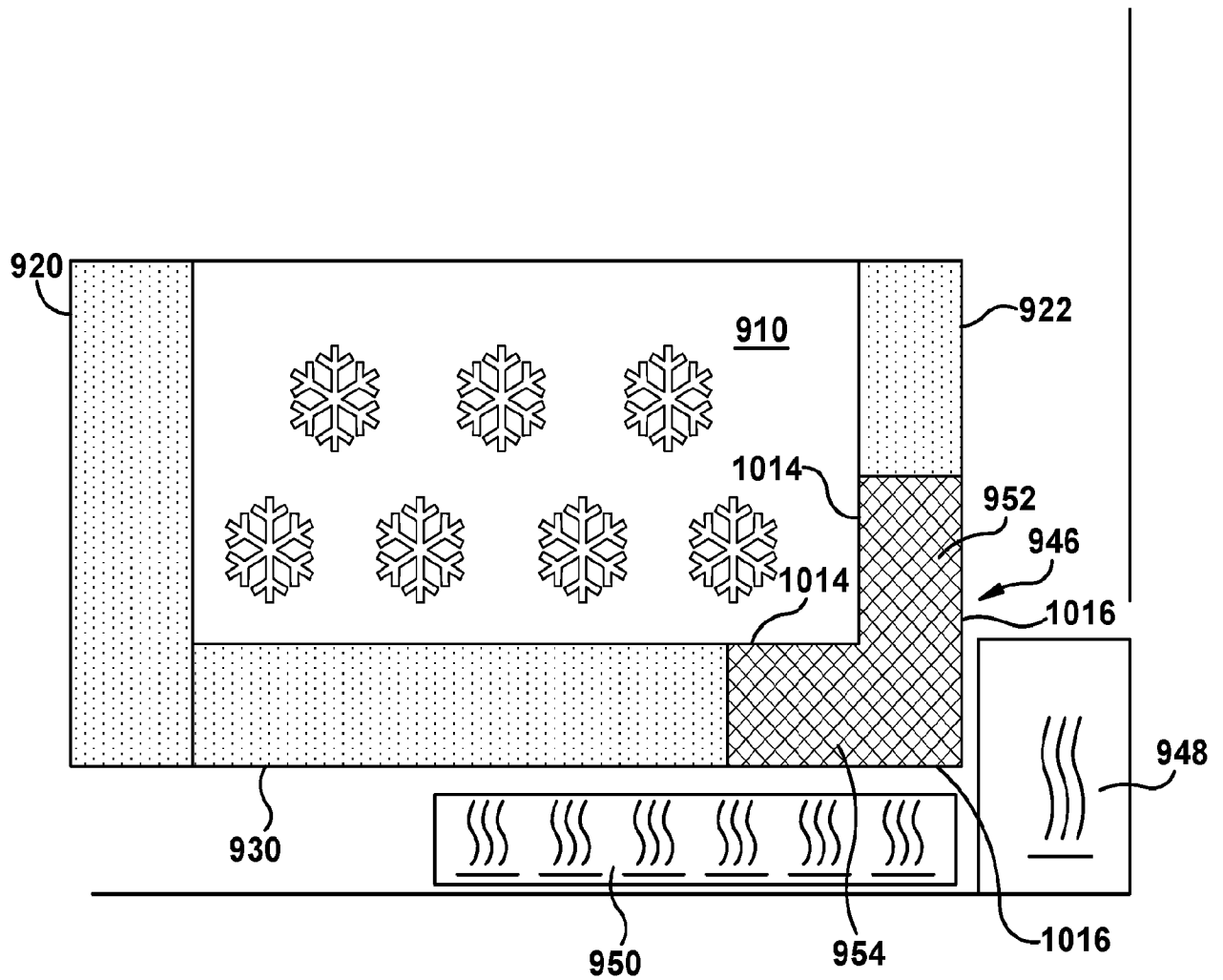
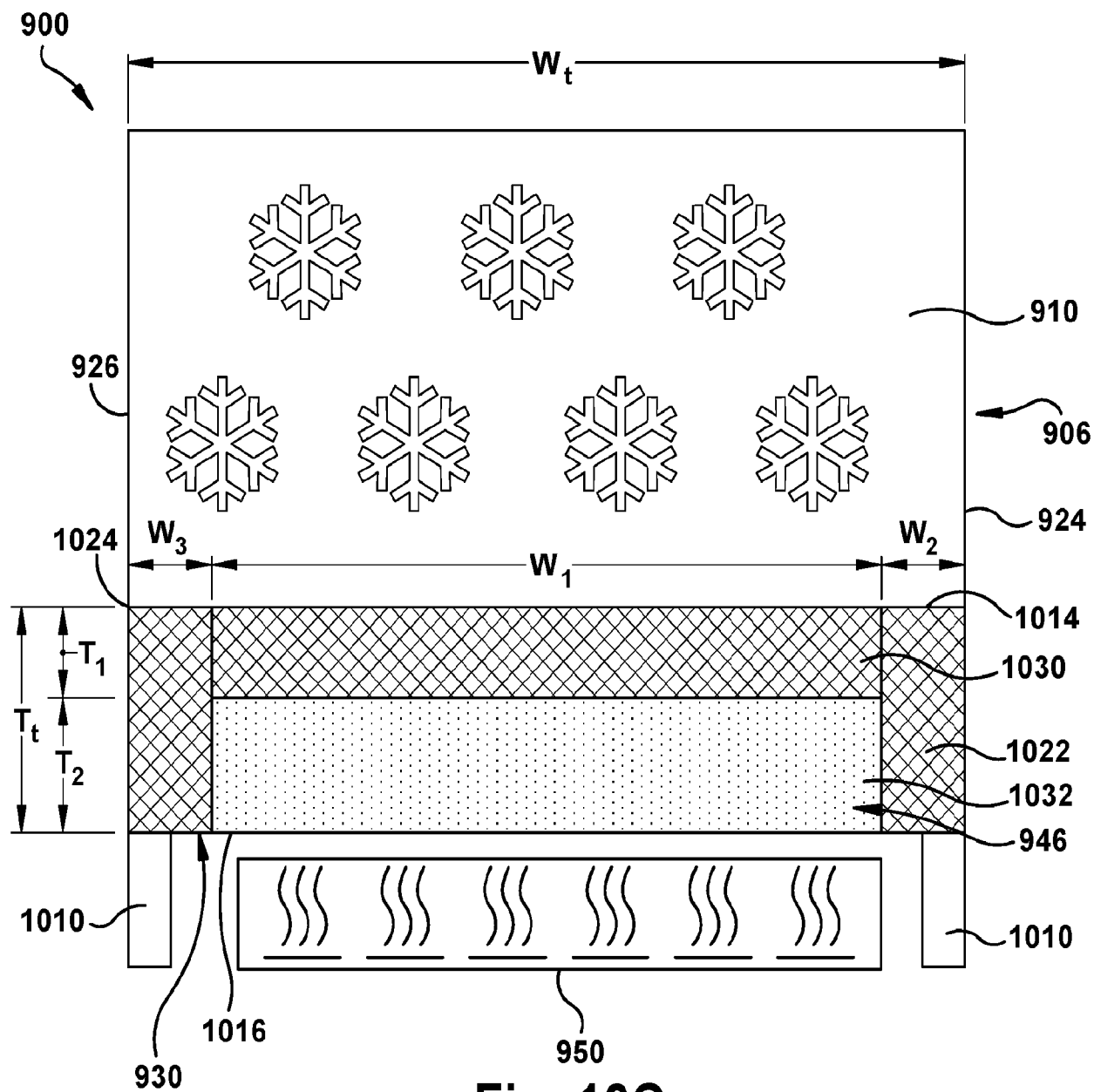


Fig. 10B

**Fig. 10C**

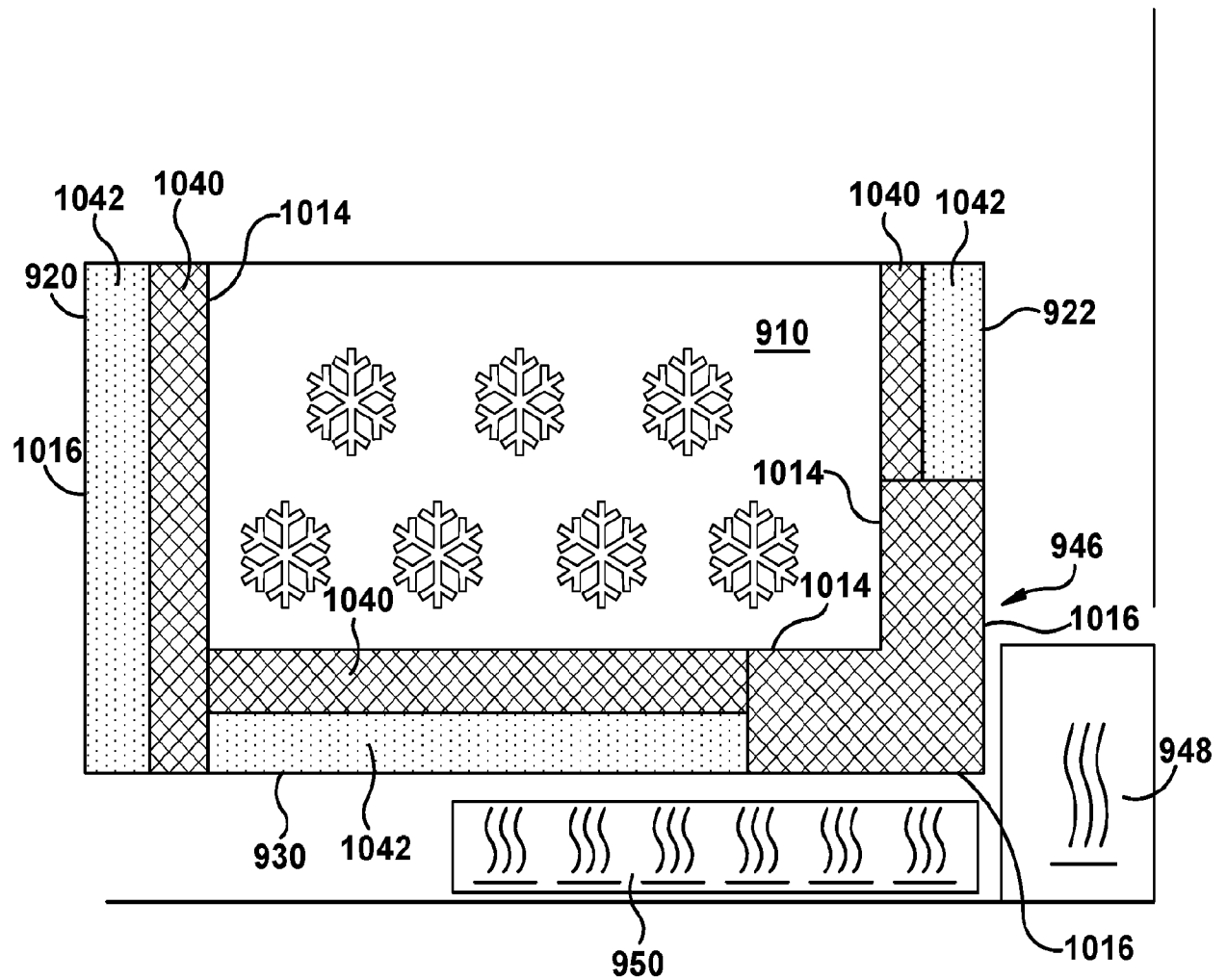


Fig. 10D

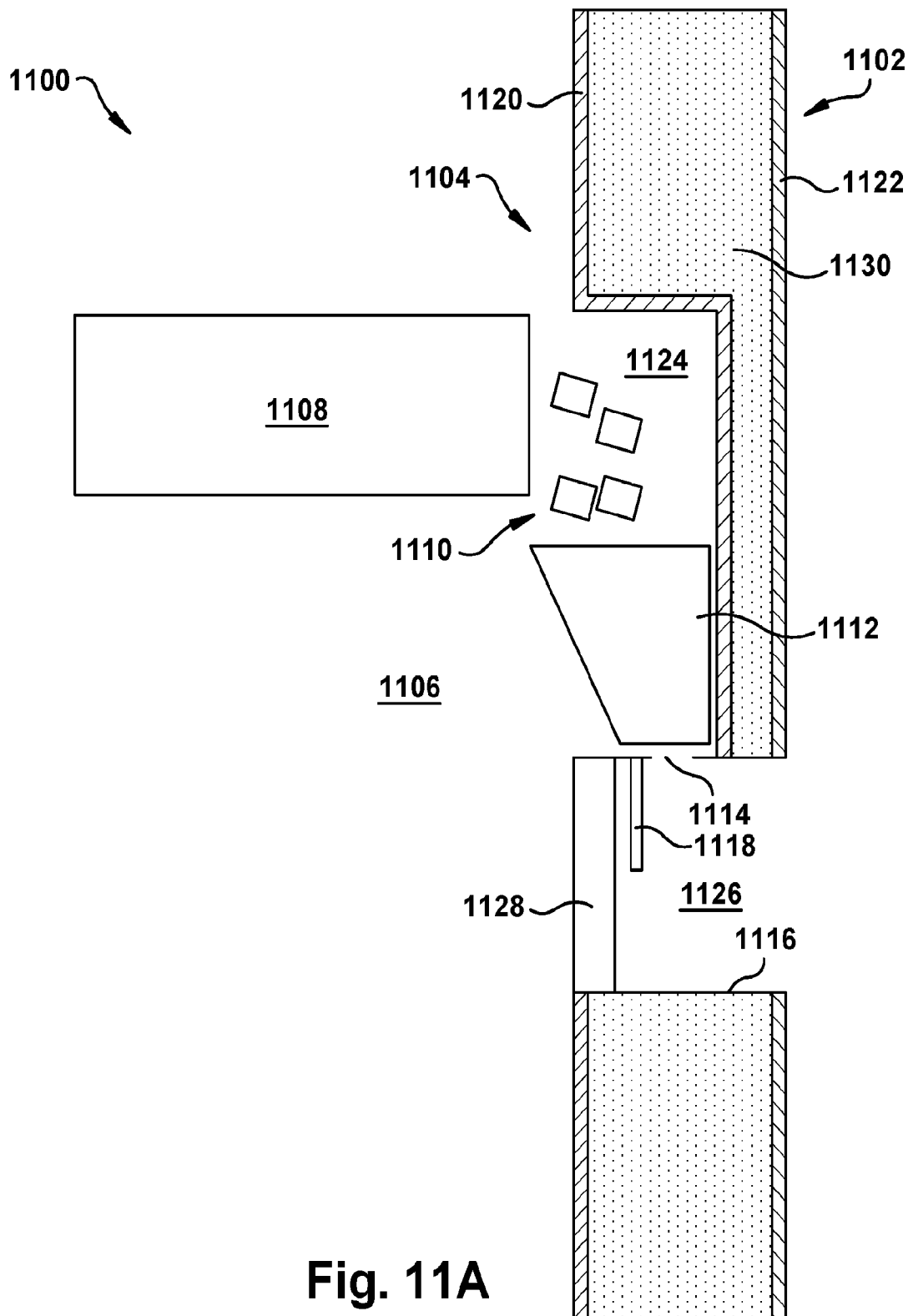
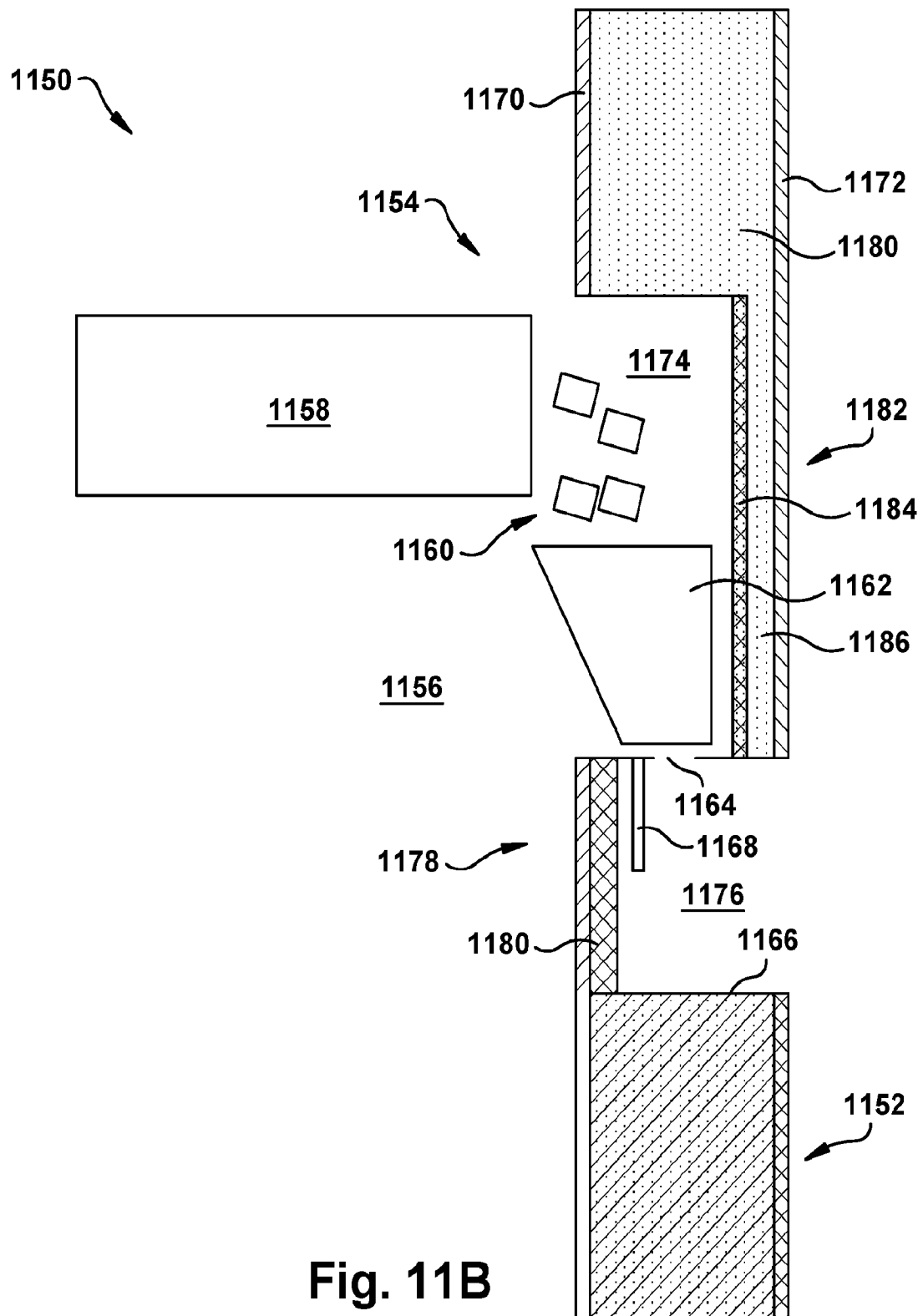


Fig. 11A



INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/060442

A. CLASSIFICATION OF SUBJECT MATTER
 INV. F25D23/06
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 F25D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 066 437 A (BARITO ROBERT W [US] ET AL) 19 November 1991 (1991-11-19)	1,2,17
Y	column 1, line 11 - column 2, line 52; figures; tables 1,2	3-10,14,15,18,19
Y	----- IE 20 120 162 A1 (KINGSPAN RES & DEV LTD [IE]) 9 October 2013 (2013-10-09) page 3, lines 20-29; figures 1-3 page 4, lines 25-29	6-10,14,15,18,19
X	----- US 2008/134708 A1 (LEE JONG DAL [KR] ET AL) 12 June 2008 (2008-06-12)	11-13
Y	abstract; figure 3	3-5
X	----- TW 201 437 579 A (HSIEH CHI-SHENG [TW]) 1 October 2014 (2014-10-01) the whole document	16
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

7 February 2017

Date of mailing of the international search report

15/02/2017

Name and mailing address of the ISA/

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 NL - 2280 HV Rijswijk
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 Fax: (+31-70) 340-3016

Authorized officer

Vigilante, Marco

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/060442

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP S53 113360 A (MATSUSHITA REFRIGERATION) 3 October 1978 (1978-10-03) abstract; figures -----	1-19
A	CN 101 846 431 A (TOSHIBA CONSUMER ELECT HOLDING; TOSHIBA HOME APPLIANCES CORP; TOSHIBA) 29 September 2010 (2010-09-29) the whole document -----	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/060442

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5066437	A	19-11-1991	NONE
IE 20120162	A1	09-10-2013	NONE
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