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(71) Applicant: **WHIRLPOOL CORPORATION**
Benton Harbor Michigan 49022 (US)

(72) Inventors:
- **Grittner Gunter, Whirlpool Europe S.r.l.**
  21025 Comerio (IT)
- **Molteni, Paolo, Whirlpool Europe S.r.l.**
  21025 Comerio (IT)
- **Casoli, Fiorenzo, Whirlpool Europe S.r.l.**
  21025 Comerio (IT)

(74) Representative: **Guerci, Alessandro**
Whirlpool Europe S.r.l.
Patent Department
Viale G. Borghi 27
21025 Comerio (VA) (IT)

(54) Vacuum-insulated refrigerator with modular frame-and-sheet structure

(57) A refrigerator cabinet has an inner box-shaped liner and an outer liner which together define a double-walled vacuum-insulating structure. In such structure it is embedded a modular frame (10) whose elements (B, C) are sealed to the outer liner (14).

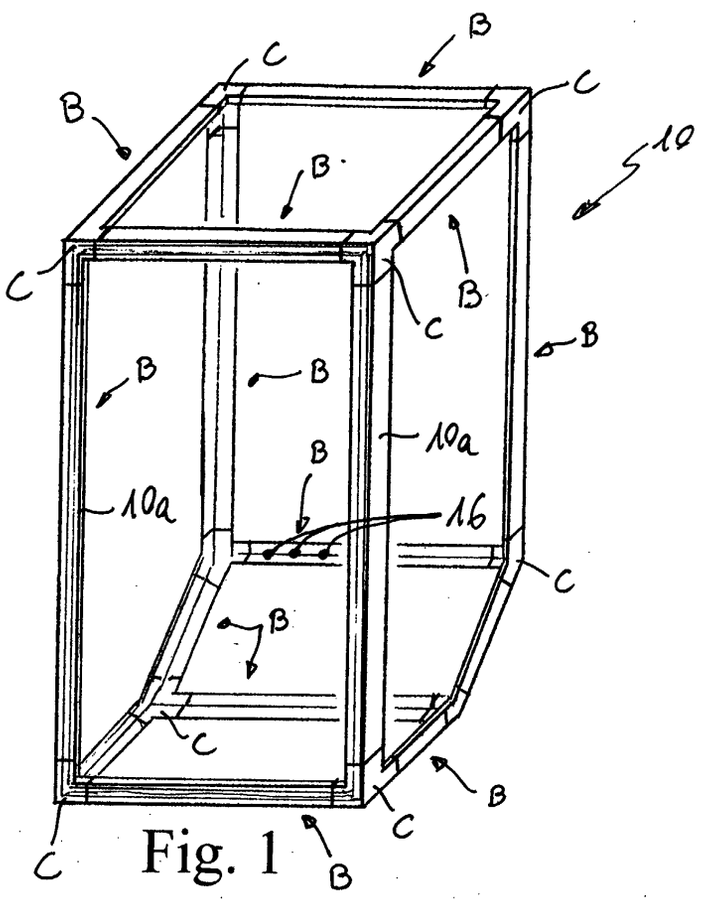

Fig. 1

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Description

[0001] The present invention relates to a refrigerator cabinet having an inner box-shaped liner and an outer liner which together define a double-walled vacuum-insulating structure. With the term "refrigerator" we mean every kind of domestic appliance in which the inside temperature is lower than room temperature, i.e. domestic refrigerators, vertical freezers, chest freezer or the like.

[0002] The good insulation-capabilities of different vacuum-insulation materials (fibre, foam or powder-based) are well known in the field of refrigeration and have been improved significantly in the last decade. Despite of these improvements and the increasing demand for reduced electricity consumption, a big-scale industrial production of vacuum-insulated refrigerators for domestic private use has not been started yet, although much development work has been invested.

[0003] The main problem is to sustain the vacuum for times of 10-15 years (usual life of a domestic appliance) without increasing too much the production cost of the product. While the traditional method, which consists in welding "vacuum-tight" structures (mostly of stainless steel), is very expensive (both in process and especially in material cost aspects), the refrigerator cabinets produced with the more cost-effective system which makes use of plastic liners (with or without anti-diffusion claddings) have a limited lifetime and therefore they are not yet in production.

[0004] The object of this invention is to provide a refrigerator cabinet of the above type that widely maintains the diffusion-performance of welded structures by using metal as diffusion barrier, but with a significant reduction of the material cost.

[0005] While the inner liner is seen by the consumer, and therefore is preferably made from aesthetically valuable and mechanically resistant stainless steel of 0,3-1,0 mm thickness, the outer liner, especially in the case of built-in products, is neither an esthetical element nor mechanically stressed, and could be made even of much thinner films.

[0006] The present invention, as defined in the attached claims, discloses how to meet the high requests of vacuum-tightness with a suitable design and cost-effective production method for the outer liner.

[0007] According to the present invention, the frame consists of structural bars and corner-like connecting elements and/or prefabricated combinations of those that have several functions, mainly they keep the inner and the outer shells on distance in the front area, integrating functional elements and space for wiring, front frame heating etc., and closing in a vacuum-tight way the front opening between the inner and the outer liner. Moreover the frame elements are engineered in a way that the inner liner, in a first step of the production process, can be attached to them in a "vacuum-tight" way (glued, welded, hot-sealed or in other ways). The frame elements can be joined together in a way to create a space between the inner liner and the outer liner that has to be assembled. This space is filled with vacuum insulation material, preferably in form of evacuable panels, plates or the like, then a thin film is sealed (glued, welded, hot-sealed) to the structural frame, in a way that the metal film creates "vacuum-tight" joints wherever the components of the outer liner finishes (e.g. in the front frame area).

[0008] The thin film making up the outer liner can be applied in one ore more pieces (foils), to balance handling problems, "vacuum tightness" (reduce the leakage through joints and plastic materials) and material cost. The final result is an outer liner that is vacuum-tight as a welded one, but that has a much lower material thickness and thus lower material cost. Round corners of the frame elements may facilitate the application of the external sealing film of the outer liner, and reduce the amount of film material needed (reduced surface and reduced diffusion). In the case the cabinet is not used for a built-in refrigerator, the outer liner is preferably covered by esthetical elements that protect and hide the significant parts of the outer liner.

[0009] According to another feature of the invention, in order to pass tubes or similar elements through the outer liner, it is proposed to do this through a hole in an element of the frame, thus increasing the sealing area and reducing the mechanical stress on the outer film.

[0010] The invention will now be explained in greater detail with reference to drawings, which show:

- Figure 1 is a perspective view of a structural frame of a refrigerator cabinet according to the present invention;
- Figure 2 is a perspective view of a refrigerator cabinet according to the invention;
- Figure 3 is an enlarged partial cross section of the wall of the refrigerator of figure 2;
- Figure 4 is a cross section on line IV-IV of figure 2;
- Figure 4a is a cross section similar to figure 4;
- Figure 5 is an enlarged view of a portion of figure 4;
- Figure 6 is a perspective view of a structural frame of a refrigerator cabinet according to a second embodiment of the present invention; and
- Figure 7 is a perspective view of a structural frame of a refrigerator cabinet according to a third embodiment of the present invention.

[0011] With reference to the drawings, with 10 is indicated the structural frame of a double-walled vacuum-insulating cabinet A that is made by rectilinear bars B connected by corner elements C, the edges of bars and the corner elements being significantly rounded. The bars B and the corner elements C are made of metal or polymeric material, in the second case the bars being preferably obtained by extrusion and the corner elements being obtained by injection moulding. Inside the box-shaped frame 10 it is located an inner shell or liner

12, with low permeability for gases and vapours, for instance a 0.12 mm stainless steel liner whose frontal edge 12a is welded or glued in W to frontal bar 10a as shown in figures 4 and 5. The space between the corners C and bars B is filled with panels of evacuable insulating material K, for instance open cells expanded polystyrene (EPS), on which an outer liner 14, thinner than the inner liner 12, is placed and welded or glued in W' to bars B and corners C (figure 5). The outer liner 14 can be made of stainless steel foils of 0.12 mm wrapped around and glued/welded on the frame 10. The foil of the outer liner 14 can be bent around one or more edges in order to reduce the number of joints necessary between single foils. The rounded shape of bar B (figure 4a) and corner elements C facilitates the application of the outer liner 14.

[0012] In order to facilitate the hermetic joining of the liners and the frame 10, both such components of the cabinet A may be covered with hot-sealable material, at least in the zone of hot-seals, or with another material different from the base material that facilitates the joining process.

[0013] With reference to figures 1 and 3, some of the bars B of the frame 10 may present through holes 16 for the passage of tubes and/or wires (not shown), without affecting the tightness of the double-walled vacuum structure of the cabinet A.

[0014] With reference to figure 5, the frontal bar 10a of the frame 10 is provided with longitudinal grooves 18a and 18b for hosting electrical cables and the so called "hot tube" respectively. A panel 20 covers the grooves 18a and 18b.

[0015] If the frame 10 is made of polymeric material, its components B and C can be treated with anti-diffusion surface-treatments, or they can be provided with anti-diffusion barriers integrated into them (for instance metal foils).

[0016] It is clear that with a cabinet according to the present invention it is very easy to change from one cabinet type to another one, without the need of investing in expensive moulds or tools. As a matter of fact the components of the frame 10 are modular components which allow building any kind of cabinet.

[0017] In another embodiment of the here described invention (figure 6), the frame 10 may be executed in a modular way using u-shaped elements X with the above described characteristics combined with bar elements, or even bigger components, as shown in the embodiment of figure 7, in which the top and bottom of the frame 10 are made by sub-assemblies Y. Moreover the frame 10 may comprise a complete front and/or rear sub-frame made from one part only, which is a combination of corner and bar elements. The advantage of this type of execution lies in the reduction of joints, thereby reducing the assembly cost of their vacuum-tight execution.

Claims

1. A refrigerator cabinet (A) having an inner box-shaped liner and an outer liner which together define a double-walled vacuum-insulating structure, **characterised in that** the double-walled vacuum-insulating structure comprises a frame (10) whose elements (B, C, X, Y, 10a) are sealed to the outer liner (14).

2. A refrigerator cabinet according to claim 1, **characterised in that** the outer liner (14) comprises a foil wrapped around and sealed to the frame (10).

3. A refrigerator cabinet according to claim 1, **characterised in that** the outer liner (14) comprises several foils each sealed to said frame (10).

4. A refrigerator cabinet according to any of the preceding claims, **characterised in that** the elements (B, C, X, Y, 10a) of the frame (10) are sealed also to the inner liner (12).

5. A refrigerator cabinet according to any of the preceding claims, **characterised in that** the outer and the inner liner (14, 12) are made of metal.

6. A refrigerator cabinet according to any of the preceding claims, **characterised in that** the frame elements (B, C, X, Y, 10a) are made of plastic material.

7. A refrigerator cabinet according to claims 5 and 6, **characterised in that** the elements (B, C, X, Y, 10a) of the frame (10) and the outer and inner liners (14, 12) are covered, at least partially, with a coating of hot sealable material.

8. A refrigerator cabinet according to any of the preceding claims, **characterised in that** the elements (B, C, X, Y, 10a) of the frame (10) present through holes (16) for the passage of tubes and/or wires, in order to facilitate the vacuum-tight sealing and to improve significantly the mechanical resistance of the sealing-joints.

9. A refrigerator cabinet according to any of the preceding claims, **characterised in that** the frame elements are designed to host wiring, screw supports and other functional elements.

10. A refrigerator cabinet according to any of the preceding claims, **characterised in that** the elements (B, C, X, Y, 10a) of the frame (10) are significantly rounded in order to facilitate the application of the outer liner (14).

11. A refrigerator cabinet according to any of the pre-

ceding claims, **characterised in that** the elements (B, C, X, Y, 10a) of the frame (10) are treated with anti-diffusion surface-treatments and/or are provided with diffusion-barriers integrated into them.

12. A refrigerator cabinet according to any of the preceding claims, **characterised in that** the frame (10) comprises prefabricated subframes (X, Y).

13. A process for manufacturing a refrigerator cabinet (A) having an inner box-shaped liner (12) and an outer liner (14) which together define a double-walled vacuum-insulating structure, **characterised in that** it comprises the following steps:

- a frame (10) is installed around the inner liner (12);
- insulating panel (K) are placed on the inner liner (12) and between elements (B, C, X, Y, 10a) of the frame (10);
- the outer liner (14) is sealed on the frame (10) in order to create a vacuum tight space between the two liners (12, 14).

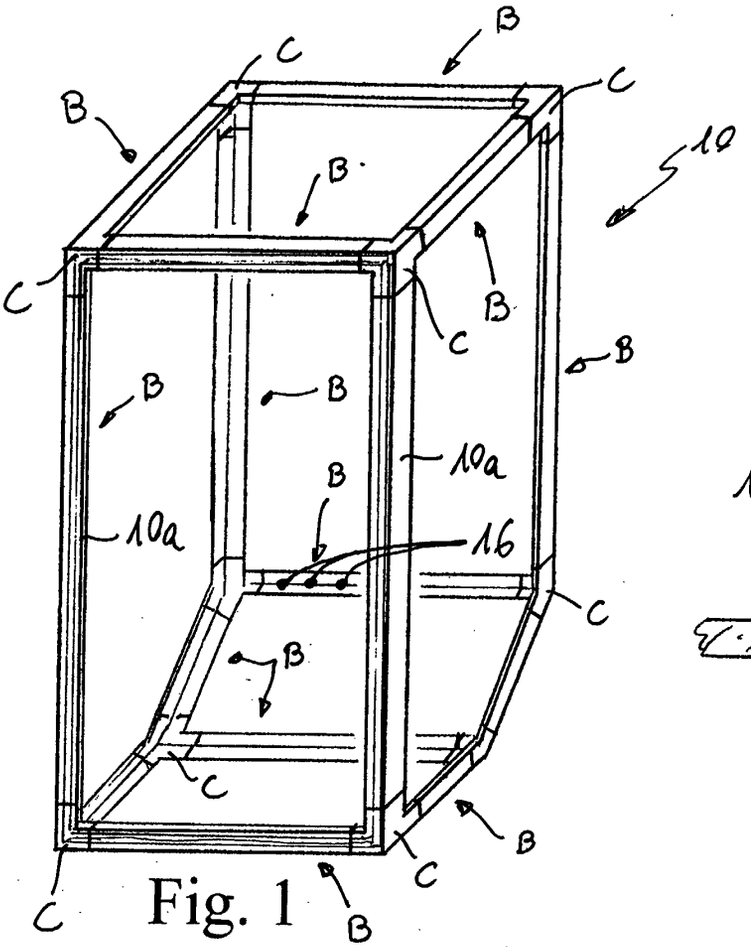

Fig. 1

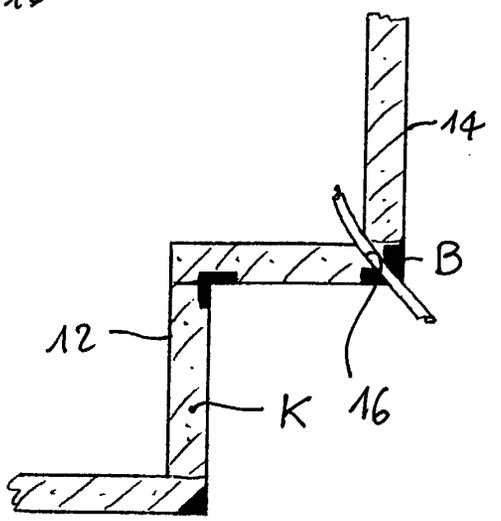

Fig.3

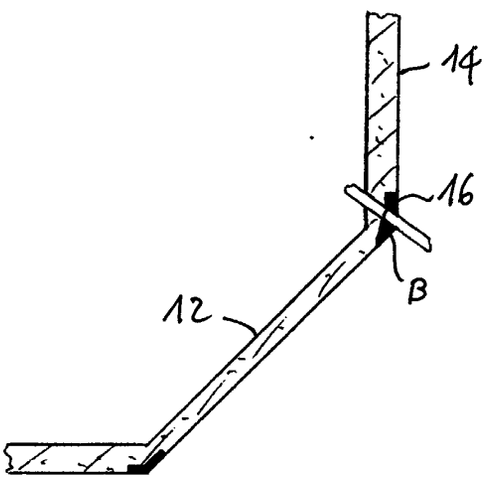

Fig. 3a

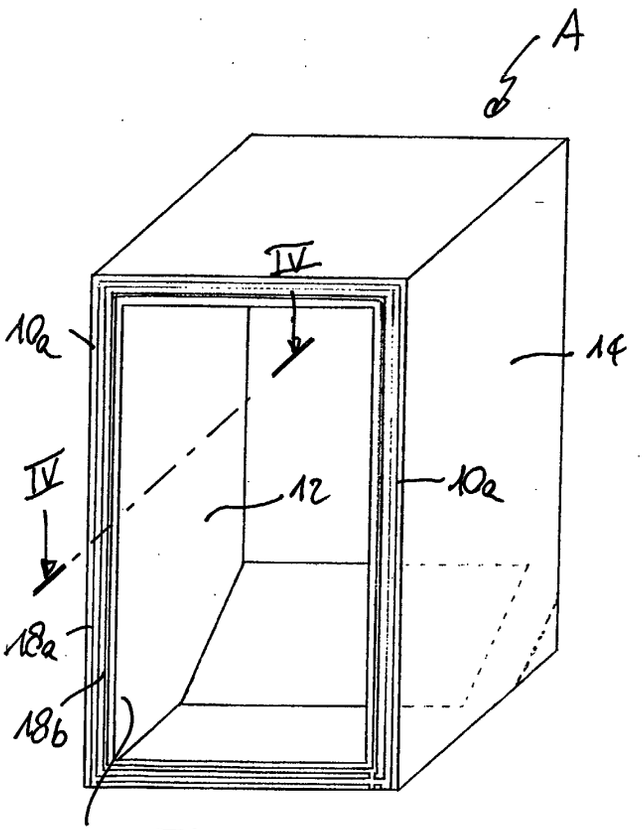

Fig. 2

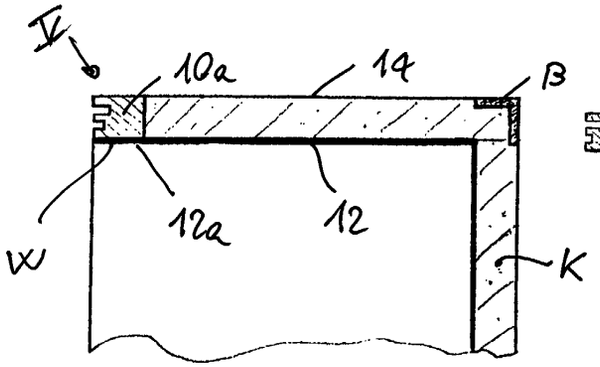

Fig. 4

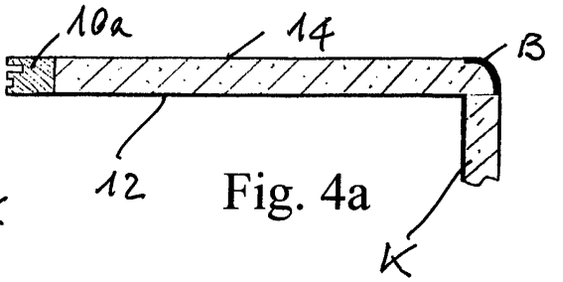

Fig. 4a

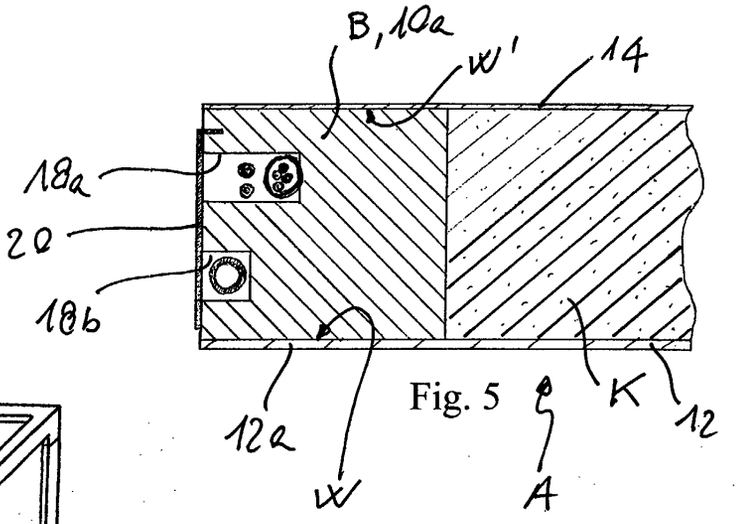

Fig. 5

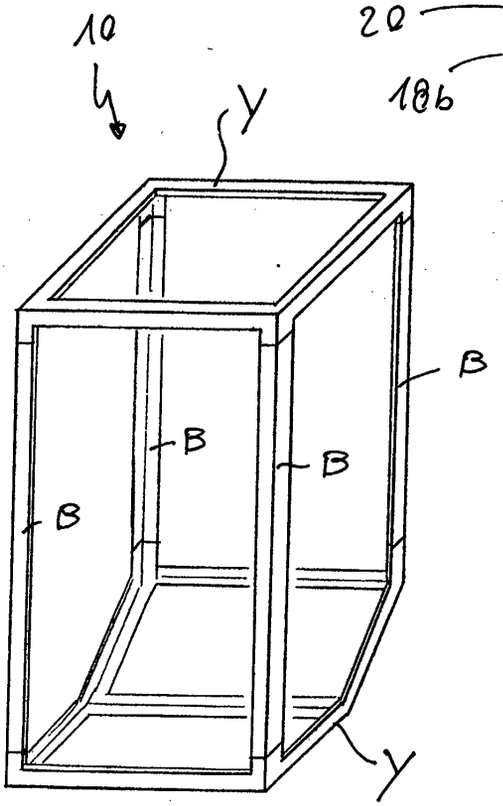

Fig. 7

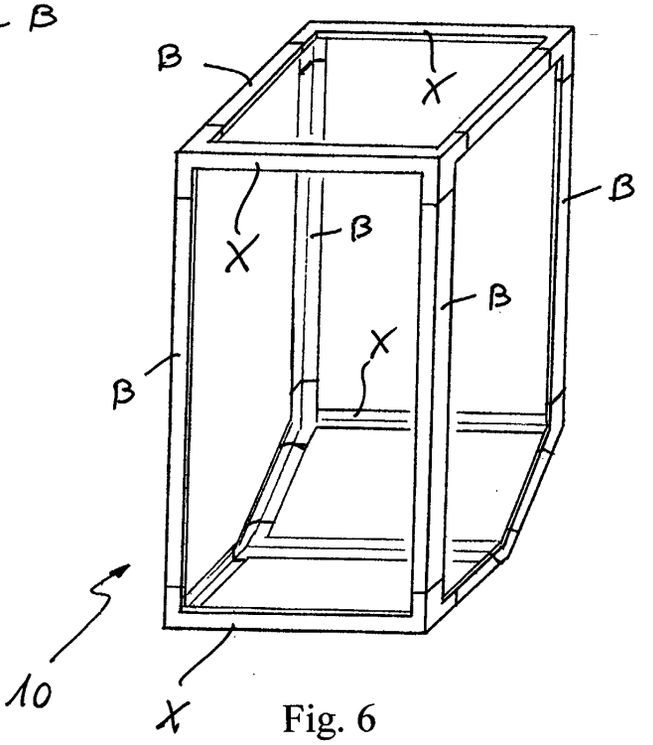

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 02 00 4224

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 July 2002	Jessen, F

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