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(71) Applicant: **ELECTROLUX APPLIANCES AKTIEBOLAG**
105 45 Stockholm (SE)

(72) Inventors:
- **GASPAROTTO, Paolo**
  33080 Porcia (IT)
- **INGARGIOLA, Paolo**
  33080 Porcia (IT)
- **SEDRANI, Michele**
  33080 Porcia (IT)
- **CRISTIANO, Francesco**
  33080 Porcia (PN) (IT)
- **ZANQUETA BENASSI, Hugo**
  33080 Porcia (PN) (IT)

(74) Representative: **Electrolux Group Patents**
AB Electrolux
Group Patents
S:t Göransgatan 143
105 45 Stockholm (SE)

(54) REFRIGERATOR

(57) Refrigerator (1) comprising: a self-supporting cabinet (2) which has a thermal-insulating structure and is internally provided with at least one, thermal-insulated storage cavity (3, 4) adapted to accommodate perishable foodstuff; and an electrically-operated cooling system (7) which is at least partially accommodated inside the self-supporting cabinet (2) and is adapted to cool down the inside of said at least one storage cavity (3, 4); the electrically-operated cooling system (7) comprising: an plate-like air-guide member (20) which is rigidly attached to a rear wall (21) of said storage cavity (3) so as to lie on the same rear wall (21) and to arrange its first (20a) and second (20b) opposite main edges each facing a respective adjacent lateral wall of the storage cavity (3); and an electrically-operated air-blowing device (22) which is accommodated inside the air-guide member (20), within a first intermediate portion (23b) of the air channel (23) extending inside the air-guide member (20) from the first main edge (20a) of the air-guide member (20) up to the opposite second main edge (20b) of the same air-guide member (20); the air-blowing device (22) being adapted to generate/produce, on command, an air-flow (f) that enters into the air-guide member (20) though one or more air inlet mouths (24) located on the first main edge (20a) of the air-guide member (20), flows along the air channel (23), and comes out of the air-guide member (20) though one or more air outlet mouths (25) located on the second main edge (20b) of the same air-guide member (20).

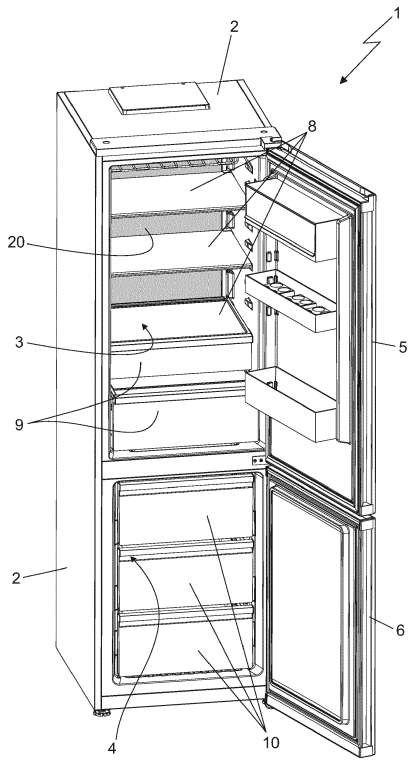

Fig. 1

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Description

[0001] The present invention relates to a refrigerator.

[0002] More specifically, the present invention preferably relates to a household refrigerator for both freezing and short-term preserving perishable foodstuff, to which the following description will make explicit reference without however losing in generality.

[0003] As is known, a household refrigerator for both freezing and short-term preserving perishable foodstuff, commonly known as combo refrigerator, generally comprises: a substantially parallelepiped-shaped, self-supporting cabinet which is structured for stably resting on the floor/ground and is internally provided with a pair of vertically-aligned and substantially parallelepiped-shaped, separate large storage cavities each of which is adapted to accommodate perishable foodstuff and communicates with the outside through a corresponding large access opening located on front of the cabinet; a pair of independent sealing doors each of which has a thermal-insulating structure and is flag hinged to the front of the self-supporting cabinet, at the height of a respective storage cavity, so as to be manually rotatable about a vertical axis to and from a closing position in which the door abuts on front of the cabinet, so as to airtight close the access opening of the same storage cavity; and finally an electrically-operated, heat-pump cooling system which is accommodated inside the cabinet and is structured to keep the inside of the upper storage cavity at a given first temperature suitable for short-term preservation of perishable foodstuffs and generally ranging between +2°C and +8°C, and the inside of the lower storage cavity at a given second temperature suitable for freezing perishable foodstuffs and generally ranging between -30°C and -10°C,

[0004] In some refrigerators currently on the market, the heat-pump cooling system of the refrigerator is additionally structured to circulate a flow of cold air in closed loop inside the/each storage cavity of the self-supporting cabinet so as to prevent air stratification inside the same cavity.

[0005] More specifically, in some refrigerators currently on the market, the low-pressure heat exchanger of the heat-pump cooling system, commonly known as evaporator, is accommodated inside a vertical air channel which is incorporated into the rear wall of the storage cavity.

[0006] The heat-pump cooling system additionally includes an electric fan which is accommodated inside the air channel and is adapted to produce an air flow that enters into the air channel through a corresponding air inlet mouth located close to the ceiling of the storage cavity, flows downwards inside the air channel across the evaporator, and then comes out of the air channel through an air outlet mouth located close to the bottom of the storage cavity. When returned into the storage cavity, the cooled air flows upwards grazing the inner face of the sealing door so as to reach again the air inlet mouth of the air channel.

[0007] Unfortunately the horizontal partitioning shelves that are usually placed inside the storage cavity of the refrigerator hinder the flow of cold air in vertical direction, thus reducing the ventilation efficiency.

[0008] Aim of the present invention is to improve air circulation inside the storage cavity of today's refrigerators, so as to minimize the temperature variations inside the same storage cavity.

[0009] In compliance with the above aims, according to the present invention there is provided a refrigerator comprising: a self-supporting cabinet which has a thermal-insulating structure and is internally provided with at least one, thermal-insulated storage cavity adapted to accommodate perishable foodstuff; and an electrically-operated cooling system which is at least partially accommodated inside the self-supporting cabinet and is adapted to cool down the inside of said at least one storage cavity; the refrigerator being characterized in that the electrically-operated cooling system comprises: a plate-like air-guide member which is rigidly attached to a rear wall of said storage cavity and is provided with a first and a second opposite main edges each facing a respective adjacent lateral wall of the storage cavity; an air channel extending inside the air-guide member from the first main edge of the air-guide member up to the opposite second main edge of the same air-guide member; and an electrically-operated air-blowing device which is accommodated inside the air-guide member within a first intermediate portion of the air channel, and which is adapted to generate/produce, on command, an airflow that enters into the air-guide member through one or more air inlet mouths located on the first main edge of the air-guide member, flows along the air channel, and comes out of the air-guide member through one or more air outlet mouths located on the second main edge of the same air-guide member.

[0010] The electrically-operated cooling system is therefore specifically structured to force the cold air to flow/circulate inside the storage cavity of the refrigerator in a nearly horizontal direction, thus to remain locally substantially parallel to any possible partitioning shelf placed within the storage cavity of the refrigerator. This solution highly improves air circulation inside the storage cavity and thus minimizes the temperature variation inside the same storage cavity.

[0011] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the electrically-operated cooling system comprises a heat-pump assembly which is provided with at least one low-pressure heat exchanger that cools down the air flowing along the air channel.

[0012] Preferably, though not necessarily, the heat-pump assembly also comprises a compressor, a high-pressure heat exchanger, placed downstream the compressor, and a refrigerant expansion device placed downstream the high-pressure heat exchanger and upstream the low-pressure heat exchanger.

[0013] Preferably, though not necessarily, the refrigerator is furthermore characterized in that said low-pressure heat exchanger is accommodated into the air-guide member, within a second intermediate portion of the air channel.

[0014] Preferably, though not necessarily, the refrigerator is furthermore characterized in that said low-pressure heat exchanger is dimensioned so as to locally take up substantially the whole section of the air channel, thus to cool down substantially the whole air flowing along the air channel.

[0015] Therefore the temperature of the cold air communing out from the second main edge of the plate-like air-guide member is the same in each of the one or more air outlet mouths of the air-guide member.

[0016] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the air channel has a substantially straight, central segment and two adjacent curved segments that are located at opposite ends of the central segment.

[0017] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the low-pressure heat exchanger is located within said central segment of the air channel.

[0018] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the air-blowing device is located within said central segment of the air channel or within one of said adjacent curved segments.

[0019] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the adjacent curved segments of the air-blowing device are substantially U-bent.

[0020] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the air channel is nearly S-shaped.

[0021] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the central segment of the air channel extends astride of the midplane of the air-guide member.

[0022] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the central segment of the air channel is substantially parallel to said first and second opposite main edges of the air-guide member.

[0023] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the air channel communicates with the inside of the storage cavity via a series of air inlet mouths that are spaced one next to the other along the first main edge of the air-guide member, and/or via a series of air outlet mouths that are spaced one next to the other along the second main edge of the air-guide member.

[0024] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the portion or portions of the air channel adjoining the/each air inlet mouth has/have a substantially converging profile, and/or the portion or portions of the air channel adjoining the/each air outlet mouth has/have a substantially converging profile.

[0025] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the air channel is at least partly delimited by the rear wall of the storage cavity.

[0026] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the plate-like air-guide member has, on its rear face, a deep groove which extends from the first main edge of the air-guide member up to the opposite second main edge of the air-guide member and which is closed by the rear wall of the storage cavity; the air channel being delimited by the rear wall of the storage cavity and by the deep grove formed on the rear face of the air-guide member.

[0027] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the air-guide member comprises: a plate-like block of thermal-insulating material; and a protective cover which is placed over the front face of said block of thermal-insulating material, and is dimensioned to partly or completely cover said block of thermal-insulating material.

[0028] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the block of thermal-insulating material is made of a polymeric material foam, and/or the protective cover is made of a solid plastic material.

[0029] Preferably, though not necessarily, the block of thermal-insulating material is made of EPS (expanded polystyrene), and more conveniently of compressed EPS.

[0030] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the plate-like air-guide member is substantially rectangular in shape.

[0031] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the suction mouth of the air-blowing device is located substantially flush with the rear face of the air-guide member, and a portion of the air channel located upstream of said air-blowing device is shaped so as to channel the airflow outside of the air-guide member.

[0032] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the air-blowing device is a centrifugal fan.

[0033] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the first intermediate portion of the air channel is at least partly cylindrical in shaped, so as to form at least part of the outer volute or ducted housing of the centrifugal fan.

[0034] Preferably, though not necessarily, the refrigerator is furthermore characterized in that said air-blowing device comprises: a centrifugal impeller that is arranged within the first intermediate portion of the air channel, with the rotation axis coincident with the central axis of the cylindrical part of the same first intermediate portion; and an electric motor which is located within the first intermediate portion of the air channel, and is adapted to support and drive into rotation the centrifugal impeller.

[0035] Preferably, though not necessarily, the refriger-

ator is furthermore characterized in that the rotation axis of the impeller is substantially perpendicular to the laying plane of the plate-like air-guide member.

[0036] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the impeller is fitted in angularly rigid manner onto the drive shaft of the electric motor.

[0037] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the electric motor is provided with an outer supporting structure designed to rigidly fit inside the first intermediate portion of the air channel.

[0038] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the supporting structure includes a number of rigid projecting spokes or legs that protrude outwards of the electric motor in a nearly radial direction, are angularly spaced around the electric motor, and are rigidly fastened/secured, at their the distal end, to the body of plate-like air-guide member.

[0039] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the distal end of at least one of said projecting spokes or legs is rigidly fastened/ secured to the body of the air-guide member with the interposition of a vibration damper.

[0040] Preferably, though not necessarily, the refrigerator is furthermore characterized in that said first intermediate portion of the air channel is a hollow recess which is formed on the rear face of the air-guide member and which is at least partly cylindrical in shape so as to accommodate an impeller of the air-blowing device, and wherein the air-blowing device additionally includes a plate-like lid which is arranged to close said hollow recess so as to complete the outer volute or ducted housing of the air-blowing device; the plate-like lid being centrally provided with a through opening defining the suction mouth of said air-blowing device.

[0041] Preferably, though not necessarily, the refrigerator is furthermore characterized in that the first intermediate portion of said air channel is a nearly cylindrical, enlarged hollow part of the deep groove formed/extending on the rear face of the plate-like air-guide member, and in that the air-blowing device additionally includes a plate-like lid which is arranged to close said enlarged hollow part of the deep groove, substantially flush with the rear face of the air-guide member, so as to close the said enlarged hollow part to complete the outer volute or ducted housing of the fan; the plate-like lid being centrally provided with a large through opening that is located above the impeller so as to form the suction mouth of said air-blowing device.

[0042] A non-limiting embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

- Figure 1 is a perspective view of a household refrigerator realized in accordance with the teachings of the present invention, with parts removed for clarity's sake;
- Figure 2 is a side view of the refrigerator shown in Figure 1, sectioned along the midplane of the appliance and with parts removed for clarity's sake;
- Figure 3 is a perspective view of the air circulation assembly incorporated into the refrigerator shown in Figures 1 and 2, with parts removed for clarity's sake;
- Figures 4 and 5 are partly exploded perspective views of the air-circulation assembly shown in Figure 3, with parts removed for clarity's sake;
- Figure 6 is a front view of the air-circulation assembly shown in Figures 3, 4 and 5, with parts removed for clarity's sake; whereas
- Figure 7 is an enlarged view of the refrigerator shown in Figure 2, with parts removed for clarity's sake.

[0043] With reference to Figures 1 and 2, reference number 1 denotes as a whole a refrigerator adapted for preserving perishable foodstuff and preferably suitable for domestic use, i.e. a household refrigerator.

[0044] Refrigerator 1 basically comprises: a preferably substantially parallelepiped-shaped, self-supporting cabinet 2 which has a thermal-insulating structure and is internally provided with at least one, preferably substantially parallelepiped-shaped, thermal-insulated storage cavity which is adapted to accommodate perishable foodstuff and communicates with the outside via a large, preferably roughly rectangular-shaped, access opening which is located on a main face/wall of the same cabinet 2; at least one sealing door that has a thermal-insulating structure and is flag hinged to the cabinet 2, so as to be manually rotatable to and from a closing position in which the door abuts on said main face/wall of the cabinet 2 to substantially airtight close the access opening of said storage cavity; and an electrically-operated cooling system which is at least partially accommodated inside the cabinet 2, and is structured/adapted to cool down the inside of said at least one, inner storage cavity.

[0045] In the example shown, in particular, the self-supporting cabinet 2 is preferably structured for stably resting on the floor/ground. Moreover the self-supporting cabinet 2 is preferably internally provided with two, substantially vertically-aligned, separate and adjacent storage cavities 3 and 4 that are thermal-insulated to one another and to the outside, are both adapted to accommodate perishable foodstuff, and finally communicate with the outside each via a respective large access opening preferably located on the main face/wall of the cabinet 2.

[0046] Preferably the refrigerator 1 furthermore comprises, for each inner storage cavity 3, 4, a respective sealing door 5, 6 which is preferably substantially rectangular in shape, and is preferably flag hinged to the front of the self-supporting cabinet 2 so as to be manually rotatable about a preferably substantially vertically-oriented, reference axis, to and from a closing position in which the door 5, 6 rests/abuts on the front face/ wall of cabinet 2 so as to cover and substantially airtight seal the access opening of the corresponding storage cavity 3 or 4.

[0047] The electrically-operated cooling system 7, in turn, is preferably structured/ adapted to separately cool down the inside of storage cavity 3 and the inside of storage cavity 4 of the self-supporting cabinet 2.

[0048] More in detail, the electrically-operated cooling system 7 is preferably adapted to cool down the inside of storage cavity 3 so as to keep the inside of storage cavity 3 at a first target temperature which is preferably suitable for short-term preservation of perishable foodstuff, and to cool down the inside of storage cavity 4 so as to keep the inside of storage cavity 4 at a second target temperature which is preferably lower than the first target temperature and is preferably suitable for long-term preservation of perishable foodstuff.

[0049] Additionally, the electrically-operated cooling system 7 is adapted to circulate the cold air in closed loop inside the storage cavity 3, and preferably also to circulate the cold air in closed loop inside the storage cavity 4.

[0050] In the example shown, in particular, the storage cavity 3 is arranged above the storage cavity 4. Clearly in an alternative embodiment the storage cavity 3 could be arranged underneath the storage cavity 4.

[0051] Furthermore the first target temperature is preferably greater than or equal to +0°C, whereas the second target temperature is lower than +0°C. More specifically, the first target temperature preferably ranges between +2°C and +8°C, whereas the second target temperature preferably ranges between -30°C and -10°C.

[0052] With reference to Figures 1 and 2, preferably the refrigerator 1 additionally comprises, inside the storage cavity 3: at least one and preferably a number of nearly horizontally-extending and preferably manually removable, partitioning shelves 8 that are adapted to support perishable foodstuff, and are arranged inside the storage cavity 3 vertically spaced to one another; and additionally or alternatively also one or more drawer containers 9 which are fitted in manually extractable manner into the storage cavity 3, preferably beneath the partitioning shelve or shelves 8, and are each adapted to accommodate vegetables and similar perishable foodstuff.

[0053] Preferably the refrigerator 1 moreover comprises at least one and preferably a number of second drawer containers 10 that are fitted in manually extractable manner into the storage cavity 4, preferably vertically-stacked to one another, and are each adapted to accommodate frozen perishable foodstuff.

[0054] In the example shown, in particular, the one or more partitioning shelves 8 are preferably made of glass, whereas the one or more drawer containers 9 and/or the one or more drawer containers 10 are preferably made of plastic material.

[0055] With reference to figures 1-7, the electrically-operated cooling system 7, in turn, comprises a heat-pump assembly 12 which includes at least one low-pressure heat exchanger, traditionally called evaporator, adapted to cool down the inside of the at least one, thermal-insulated storage cavity 3, 4 of the self-supporting cabinet 2.

[0056] In the example shown, in particular, the heat-pump assembly 12 is preferably provided with a low-pressure heat exchanger or evaporator for each storage cavity 3, 4 of the self-supporting cabinet 2.

[0057] In other words, the heat-pump assembly 12 is preferably provided with two evaporators discrete and distinct to one another. The first evaporator 13 is adapted to solely cool down the inside of storage cavity 3. The second evaporator 14, in turn, is adapted to solely cool down the inside of the storage cavity 4.

[0058] Moreover the electrically-operated cooling system 7 is specifically structured to force the cold air to flow/circulate inside the storage cavity 3 in a nearly horizontal direction, thus to remain locally substantially parallel to the partitioning shelf or shelves 8, if present, and the evaporator 13 of heat-pump assembly 12 is arranged so as to cool down the air circulating inside the storage cavity 3.

[0059] More in detail, the electrically-operated cooling system 7 of refrigerator 1 comprises: a substantially rigid, oblong and thick, plate-like air-guide member 20 which is rigidly attached to the nearly vertical, rear wall 21 of storage cavity 3 so as to hug/rest on the rear wall 21 and arrange its opposite main edges 20a and 20b each closely facing a respective adjacent and nearly vertical, lateral wall of storage cavity 3; and an electrically-operated air-blowing device 22 which is at least partly housed/ accommodated inside the air-guide member 20, within an intermediate portion of an air channel 23 that extends inside the air-guide member 20, from the first main edge 20a of air-guide member 20 up to the opposite second main edge 20b of the same air-guide member 20. The air-blowing device 22 thus defines, on the air channel 23, a first channel section that extends from the first main edge 20a of air-guide member 20 up to the air-blowing device 22, and a second channel section that extends from the air-blowing device 22 up to the opposite second main edge 20b of the same air-guide member 20.

[0060] The air-blowing device 22 is adapted to generate/produce, on command, an airflow f that enters into the plate-like air-guide member 20 through one or more air inlet mouths 24 located on the first main edge 20a of air-guide member 20, flows along the whole air channel 23, and comes out of the air-guide member 20 through one or more air outlet mouths 25 located on the second main edge 20b of the same air-guide member 20.

[0061] In addition, with reference to Figures 4, 5, 6 and 7, the evaporator 13 of heat-pump assembly 12 is preferably accommodated/recessed inside the plate-like air-guide member 20, within a second intermediate portion 23a of the air channel 23, so as to be crossed/skimmed by the airflow f flowing along the air channel 23, and is preferably also dimensioned so as to locally take up substantially the whole cross section of air channel 23, thus to cool down substantially the whole air flowing along the air channel 23.

[0062] Preferably the intermediate portion 23a of the

air channel 23 accommodating/ containing the evaporator 13 is moreover located upstream of the intermediate portion 23b of the air channel 23 accommodating/containing the air-blowing device 22.

[0063] With reference to Figures 3-6, in the example show, in particular, the plate-like air-guide member 20 is preferably shape/dimensioned so that its opposite main edges 20a and 20b are substantially rectilinear and parallel to one another. More in detail, the air-guide member 20 is preferably substantially rectangular in shape.

[0064] Additionally, the plate-like air-guide member 20 is preferably partially fitted/ recessed into a corresponding seat formed on the rear wall 21 of storage cavity 3, and/or is preferably firmly fixed to the rear wall 21 of storage cavity 3 in a rigid and stable, though easy detachable manner.

[0065] Furthermore the air-guide member 20 is preferably attached to the vertical rear wall 21 of storage cavity 3 astride of the vertical midplane of the same storage cavity 3, so as to arrange the opposite main edges 20a and 20b each at short distance from, and optionally locally substantially parallel to, the corresponding adjacent lateral wall of the storage cavity 3.

[0066] In the example shown, in particular, the plate-like air-guide member 20 is dimensioned so that the distance between each main edge 20a, 20b of the same air-guide member 20 and the corresponding adjacent lateral wall of storage cavity 3 is preferably lower than 20 mm (millimeters) and optionally ranges between 5 and 15 mm (millimeters). Preferably the opposite main edges 20a and 20b of air-guide member 20 are moreover substantially equidistant from the corresponding lateral walls of the storage cavity 3.

[0067] With reference to Figures 4, 5 and 6, the air channel 23 of air-guide member 20, in turn, communicates with the inside of the storage cavity 3 via a series of air inlet mouths 24 that are suitably spaced one next to the other, along the first main edge 20a of air-guide member 20, and/or via a series of air outlet mouths 25 that are suitably spaced one next to the other, along the second main edge 20b of air-guide member 20.

[0068] Moreover, the portion or portions of air channel 23 adjoining the/each air inlet mouth 24 preferably has/have a substantially converging profile. Similarly the portion or portions of air channel 23 adjoining the/each air outlet mouth 25 preferably has/have a substantially converging profile.

[0069] Preferably the air channel 23 furthermore has a substantially straight, central segment and two adjacent intermediate curved segments that are located at opposite ends of the central segment and are preferably bent backwards with respect to the same central segment. Moreover the intermediate segments of air channel 23 are preferably substantially U-bent and are preferably located one close to the ceiling of storage cavity 3, and the other close to the bottom of storage cavity 3.

[0070] The evaporator 13 of heat-pump assembly 12 is preferably located within the central segment of air channel 23, whereas the air-blowing device 22 is preferably located within one of the two intermediate segments of air channel 23.

[0071] Clearly in an alternative embodiment also the air-blowing device 22 could be located within the central segment of air channel 23.

[0072] More in detail, in the example shown the evaporator 13 of heat-pump assembly 12 is preferably located nearly in the middle of the aforesaid central segment of air channel 23, whereas the air-blowing device 22 is preferably located within the upper intermediate segment of air channel 23, i.e. the intermediate segment close to the ceiling of storage cavity 3.

[0073] Preferably the central segment of air channel 23 moreover extends substantially parallel to the main edges 20a and 20b of air-guide member 20, optionally while remaining substantially astride of the midplane M of the same air-guide member 20.

[0074] With reference to Figures 5 and 6, in the example shown, in particular, the air channel 23 is preferably substantially S-shaped.

[0075] Additionally the air channel 23 in air-guide member 20 is preferably at least partly delimited by the rear wall 21 of storage cavity 3.

[0076] With reference to Figures 2-7, in the example shown, in particular, the rear face of air-guide member 20, i.e. the face of air-guide member 20 directly facing the rear wall 21 of storage cavity 3, is preferably provided with a superiorly-opened, deep groove which extends from the main edge 20a of air-guide member 20 up to the opposite main edge 20b of air-guide member 20, preferably following a substantially S-shaped path, and which is superiorly closed by the rear wall 21 of storage cavity 3.

[0077] The air channel 23 is preferably delimited by the rear wall 21 of storage cavity 3 and by the deep groove formed on the rear face of the air-guide member 20.

[0078] Therefore a first portion of the, preferably substantially S-shaped, deep groove formed on the rear face of air-guide member 20 is preferably shaped/dimensioned to accommodate the air-blowing device 22, whereas a second portion of the same deep groove is preferably shaped/dimensioned to accommodate the low-pressure heat exchanger or evaporator 13 of heat-pump assembly 12.

[0079] Preferably, the plate-like air-guide member 20 furthermore has a sandwich structure.

[0080] More in detail, with particular reference to Figures 3, 4 end 5, the air-guide member 20 preferably comprises: a substantially rigid and preferably also substantially rectangular-shaped, plate-like block/piece 28 of thermal-insulating material, i.e. a thick slab of thermal-insulating material, with a thickness preferably ranging between 5 and 40 mm (millimetres); and a substantially rigid, plate-like protective cover 29 which is placed over the front face of block 28, i.e. the face of block 28 opposite to the rear wall 21 of storage cavity 3, and is dimensioned to at least partially and more conveniently completely cover the block 28 of thermal-insulating material.

[0081] In other words the protective cover 29 is preferably dimensioned to hide substantially the whole plate-like block 28 of thermal-insulating material.

[0082] The deep groove delimiting at least part of the air channel 23 is preferably formed directly on the rear face of block 28, i.e. on the opposite side of the protective cover 29.

[0083] In the example shown, in particular, the block 28 is preferably made of a polymeric material foam, such as for example EPS (acronym of expanded polystyrene) and more conveniently of compressed EPS, whereas the protective cover 29 is preferably made of a solid/non-foamed plastic material, preferably via an injection moulding process.

[0084] Preferably the protective cover 29 is furthermore rigidly secured directly to the rear wall 21 of storage cavity 3, so as to press and firmly hold the block 28 in abutment against the rear wall 21 of storage cavity 3.

[0085] In the example shown, in particular, the protective cover 29 is preferably rigidly secured to the rear wall 21 via a number of protruding snap-on fasteners 30 and/or one or more anchoring screw/s (not shown in the figures), which preferably engage in pass-through manner the thick block 28 of thermal-insulating material before reaching the rear wall 21 of storage cavity 3.

[0086] With reference to Figures 4, 5, 6 and 7, the air-blowing device 22, in turn, is preferably an electrically-operated centrifugal fan, and the intermediate portion 23b of air channel 23 containing/accommodating the air-blowing device 22 is preferably at least partly cylindrical in shaped, so as to form at least part of the outer volute or ducted housing of said centrifugal fan.

[0087] In other words, the air-blowing device 22 preferably comprises: a centrifugal impeller 34 preferably having a drum-like structure, which is arranged within the substantially cylindrical-shaped, intermediate portion 23b of air channel 23, with the rotation axis substantially coincident with the central axis of the cylindrical part of the same intermediate portion 23b; and a small electric motor 35 which is located within the intermediate portion 23b of the air channel 23, preferably underneath the centrifugal impeller 34, and is adapted to drive into rotation the centrifugal impeller 34.

[0088] Preferably, the impeller 34 is additionally arranged within the intermediate portion 23b of air channel 23 with its rotation axis substantially perpendicular to the laying plane of the plate-like air-guide member 20.

[0089] Preferably the electric motor 35 moreover directly support the impeller 34.

[0090] More in detail, the impeller 34 is preferably fitted in angularly rigid manner onto the distal end of the drive shaft of electric motor 35, whereas the electric motor 35 is located within the intermediate portion 23b of air channel 23 with the rotation axis of the drive shaft substantially coincident with the central axis of the intermediate portion 23b.

[0091] Preferably the electric motor 35 is additionally provided with an outer supporting structure 36 specifically designed to rigidly fit inside the intermediate portion 23b of air channel 23, so as to stably hold in place the electric motor 29 nearly in the middle of the same intermediate portion 23b.

[0092] With reference to Figure 4, in the example shown, in particular, the outer supporting structure 36 preferably includes a number (three in the example shown) of rigid projecting spokes or legs 37 that protrude outwards of the electric motor 35 in a nearly radial direction, are angularly spaced around the electric motor 35, and are rigidly fastened/secured, at their the distal end, to the body of air-guide member 20, or rather to the block 28 of thermal-insulating material, preferably by means of anchoring pins or other fasteners.

[0093] Preferably the distal end of at least one and, more conveniently each projecting spoke or leg 37 is rigidly fastened/secured to the body of air-guide member 20 with the interposition of a vibration damper 38.

[0094] Moreover, with reference to Figures 5, 6 and 7, in the example shown the deep groove formed/extending on the rear face of plate-like air-guide member 20 preferably includes a nearly cylindrical, first enlarged hollow part which is shaped/dimensioned to contain/accommodate the whole air-blowing device 22 and which, therefore, forms the intermediate portion 23b of air channel 23.

[0095] The electric motor 35, moreover, is preferably arranged inside the aforesaid first enlarged hollow part with the rotation axis of the drive shaft substantially perpendicular to the laying plane of the plate-like air-guide member 20.

[0096] With reference to Figures 4-7, preferably the air-blowing device 22, or rather the centrifugal fan, additionally comprises a substantially rigid, plate-like lid 39 which is arranged to close the first enlarged hollow part of the groove formed on rear face of air-guide member 20, so as to complete the outer volute or ducted housing of the centrifugal fan, and which is preferably centrally provided with a large, preferably substantially circular in shape, through opening 39a which is located immediately above, and is preferably also substantially coaxial to, the impeller 34 so as to form the suction mouth of the air-blowing device 22, or preferably of the centrifugal fan.

[0097] In the example shown, in particular, the plate-like lid 39 is preferably made of plastic material, and the through opening 39a is preferably located at the end of a funnel-shaped central portion which is shaped so as to guide/channel the air towards the center of the impeller 34.

[0098] With particular reference to Figure 7, preferably the plate-like lid 39 is moreover substantially flush with the rear face of the air-guide member 20 and the deep groove formed on the rear face of air-guide member 20 preferably includes, immediately upstream of the enlarged hollow portion closed by the same plate-like lid 39, a ramp portion that guides the airflow f outside of the air-guide member 20 and towards the rear wall 21 of storage cavity 3.

[0099] In other words, the intermediate portion 23b of

the air channel 23 is preferably a hollow recess which is formed on the rear face of the air-guide member 20, or rather of the plate-like block 28 of thermal-insulating material, and which is at least partly nearly cylindrical in shape so as to accommodate the impeller 34 of the air-blowing device 22. The air-blowing device 22 preferably additionally includes the plate-like lid 39 which is arranged to close said hollow recess so as to complete the outer volute or ducted housing of the air-blowing device 22, and which is preferably centrally provided with a through opening 39a defining the suction mouth of the air-blowing device 22.

[0100] Preferably the suction mouth/opening of the air-blowing device 22, or rather of the centrifugal fan, is therefore located flush with the rear face of the plate-like air-guide member 20, and an intermediate portion of air channel 23 located upstream of the air-blowing device 22 is preferably shaped so as to channel the airflow f outside of the air-guide member 20.

[0101] In other words the intermediate portion of air channel 23 located immediately upstream of the suction mouth/opening of the air-blowing device 22, or rather of the centrifugal fan, is mostly delimited by the rear wall 21 of storage cavity 3.

[0102] With reference to Figures 4-7, on the other hand, the low-pressure heat exchanger or evaporator 13 of heat-pump assembly 12 is preferably a finned-pack heat exchanger, and is preferably housed within a nearly rectangular, second enlarged hollow part of the groove formed/ extending on the rear face of air-guide member 20. Preferably this second enlarged hollow part of the groove is moreover located immediately upstream of the ramp portion of the same groove.

[0103] With reference to Figure 2, similarly to evaporator 13, also the low-pressure heat exchanger or evaporator 14 of heat-pump assembly 12 is preferably adapted to cool down the air circulating inside the storage cavity 4.

[0104] More in detail, evaporator 14 is preferably a finned-pack heat exchanger, and is preferably attached to the nearly vertical, rear wall 40 of storage cavity 4.

[0105] Preferably the electrically-operated cooling system 7 additionally comprises: a substantially rigid, partitioning panel 41 which is attached to the rear wall 40 of storage cavity 40, over the evaporator 14, so as to hide the evaporator 14 and form, together with the rear wall 40, a nearly vertical air channel 42 wherein the cold air can freely circulate; and a second electrically-operated air-blowing device 43 which is attached on the back of partitioning panel 41 and is adapted to generate/produce, on command, an ascending airflow that enters into the air channel 42 from an air inlet mouths located close to the bottom of storage cavity 4, flows upwards across the evaporator 14 and then returns back into the storage cavity 4.

[0106] More in detail, the air-blowing device 43 is preferably located immediately above the evaporator 14, and is preferably fitted/housed into the air inlet of a plate-like manifold structure 44, which is preferably made of a thermal-insulating material, is firmly fixed to the back of partitioning panel 41 so as to lie onto and protect the evaporator 14, and is provided with a number of air outlets that communicate with the inside of storage cavity 4 and are arranged at different heights from the bottom of storage cavity 4.

[0107] Preferably the airflow produced by the air-blowing device 43 therefore returns back into the storage cavity 4 through the plate-like manifold structure 44 attached to the back of partitioning panel 41.

[0108] In the example shown, in particular, the plate-like manifold structure 44 is preferably made of a polymeric material foam, whereas the partitioning panel 41 is preferably made of plastic material, preferably via an injection moulding process. Preferably the air-blowing device 43, in turn, is an electrically-operated axial fan.

[0109] With reference to Figure 2, in addition to low-pressure heat exchangers or evaporators 13 and 14, the heat-pump assembly 12 preferably finally comprises: an electrically-operated compressor 45 that is preferably housed into a specific compressor compartment formed on the back of the cabinet 2, and is adapted to compress a low-temperature and low-pressure gaseous-state refrigerant arriving from any one of evaporators 13 and 14 for supplying, at outlet/delivery, a flow of high-temperature and high-pressure refrigerant; a high-pressure heat-exchanger 46, traditionally called condenser, which receives the high-temperature and high-pressure gaseous-state refrigerant from compressor 45, is located outside of the cabinet 2, preferably on the rear wall of cabinet 2 (i.e. opposite to the large access openings of storage cavities 3 and 4), and is structured to allow the high-temperature and high-pressure refrigerant arriving from compressor 45 to release heat to the outside environment, thus reducing its temperature; and a refrigerant expansion device, such as a capillary tube, which is interposed between the condenser 46 and both evaporators 13 and 14, and is adapted to cause the rapid expansion of the high-pressure refrigerant flowing from condenser 46 to any one of evaporators 13 and 14, so to rapidly highly reduce both temperature and pressure of the same refrigerant.

[0110] Operation of refrigerator 1 is clearly inferable from the above description and does not require further explanations.

[0111] The particular structure of the electrically-operated cooling system 7 has several advantages.

[0112] Firstly the cooling system 7 improves the air circulation inside the storage cavity 3 because the cold air flows/circulates inside the storage cavity 3 in a nearly horizontal direction, while remaining locally substantially parallel to the partitioning shelf or shelves 8, if present.

[0113] Moreover, the temperature of the air coming out from the side of platelike member 20 is always the same irrespective of the position/height of the air outlet mouth 25 on the main edge 20b of the air-guide member 20, thus minimizing temperature variation inside the storage

cavity 3.

[0114] Clearly, changes may be made to the refrigerator 1 without, however, departing from the scope of the present invention.

[0115] For example, rather than being a centrifugal fan, the air-blowing device 22 may be an electrically-operated axial fan. Clearly also in this case the intermediate portion 23b of air channel 23 may be shaped so as to form at least part of the ducted housing of the fan.

[0116] Moreover, rather than being firmly secured/fastened to the body of air-guide member 20, the distal ends of the projecting spokes or legs 37 of the outer supporting structure 36 may be rigidly fastened/secured to the plate-like lid 39.

Claims

1. Refrigerator (1) comprising: a self-supporting cabinet (2) which has a thermal-insulating structure and is internally provided with at least one, thermal-insulated storage cavity (3, 4) adapted to accommodate perishable foodstuff; and an electrically-operated cooling system (7) which is at least partially accommodated inside the self-supporting cabinet (2) and is adapted to cool down the inside of said at least one storage cavity (3, 4);
   the refrigerator (1) being **characterized in that** the electrically-operated cooling system (7) comprises:

   - a plate-like air-guide member (20) which is rigidly attached to a rear wall (21) of said storage cavity (3) and is provided with a first (20a) and a second (20b) opposite main edges each facing a respective adjacent lateral wall of the storage cavity (3);
   - an air channel (23) extending inside the air-guide member (20) from the first main edge (20a) of the air-guide member (20) up to the opposite second main edge (20b) of the same air-guide member (20); and
   - an electrically-operated air-blowing device (22) which is accommodated inside the air-guide member (20) within a first intermediate portion (23b) of the air channel (23), and which is adapted to generate/produce, on command, an air-flow (f) that enters into the air-guide member (20) through one or more air inlet mouths (24) located on the first main edge (20a) of the air-guide member (20), flows along the air channel (23), and comes out of the air-guide member (20) through one or more air outlet mouths (25) located on the second main edge (20b) of the same air-guide member (20).

2. Refrigerator according to Claim 1, wherein the electrically-operated cooling system (7) comprises a heat-pump assembly (12) which is provided with at least one low-pressure heat exchanger (13) that cools down the air flowing along the air channel (23).

3. Refrigerator according to Claim 2, wherein said low-pressure heat exchanger (13) is accommodated into the air-guide member (20), within a second intermediate portion (23a) of the air channel (23).

4. Refrigerator according to any one of the preceding claims, wherein the air channel (23) has a central segment and two adjacent curved segments that are located at opposite ends of the central segment.

5. Refrigerator according to Claim 4, wherein the low-pressure heat exchanger (13) is located within said central segment of the air channel (23).

6. Refrigerator according to Claim 4 or 5, wherein the air-blowing device (22) is located within said central segment of the air channel (23) or within one of said adjacent curved segments.

7. Refrigerator according to Claim 4, 5 or 6, wherein the central segment of the air channel (23) is parallel to said first (20a) and second (20b) opposite main edges of the air-guide member (20).

8. Refrigerator according to any one of the preceding claims, wherein the portion or portions of the air channel (23) adjoining the/each air inlet mouth (24) has/ have a converging profile, and/or the portion or portions of the air channel (23) adjoining the/each air outlet mouth (25) has/have a converging profile.

9. Refrigerator according to any one of the preceding claims, wherein the air channel (23) is at least partly delimited by the rear wall (21) of the storage cavity (3).

10. Refrigerator according to Claim 9, wherein the plate-like air-guide member (20) has, on its rear face, a deep groove which extends from the first main edge (20a) of the air-guide member (20) up to the opposite second main edge (20b) of the air-guide member (20) and which is closed by the rear wall (21) of the storage cavity (3); the air channel (23) being delimited by the rear wall (21) of the storage cavity (3) and by the deep groove formed on the rear face of the air-guide member (20).

11. Refrigerator according to any one of the preceding claims, wherein the air-guide member (20) comprises: a plate-like block of thermal-insulating material (28); and a protective cover (29) which is placed over the front face of said block of thermal-insulating material (28), and is dimensioned to partly or completely cover said block of thermal-insulating material (28).

12. Refrigerator according to any one of the preceding claims, wherein the suction mouth of the air-blowing device (22) is located substantially flush with the rear face of the air-guide member (20), and a portion of the air channel (23) located upstream of said air-blowing device (22) is shaped so as to channel the airflow (f) outside of the air-guide member (20).

13. Refrigerator according to any one of the preceding claims, wherein the air-blowing device (22) is a centrifugal fan and wherein the first intermediate portion (23b) of the air channel (23) is at least partly cylindrical in shaped, so as to form at least part of the outer volute or ducted housing of the centrifugal fan.

14. Refrigerator according to Claim 13, wherein said air-blowing device (22) comprises: a centrifugal impeller (34) that is arranged within the first intermediate portion (23b) of the air channel (23), with the rotation axis coincident with the central axis of the cylindrical part of the same first intermediate portion (23b); and an electric motor (35) which is located within the first intermediate portion (23b) of the air channel (23), and is adapted to support and drive into rotation the centrifugal impeller (34).

15. Refrigerator according to any one of preceding claims, wherein said first intermediate portion (23b) of the air channel (23) is a hollow recess which is formed on the rear face of the air-guide member (20) and which is at least partly cylindrical in shape so as to accommodate an impeller (34) of the air-blowing device (22), and wherein the air-blowing device (22) additionally includes a plate-like lid (39) which is arranged to close said hollow recess so as to complete the outer volute or ducted housing of the air-blowing device (22); the plate-like lid (39) being centrally provided with a through opening (39a) defining the suction mouth of said air-blowing device (22).

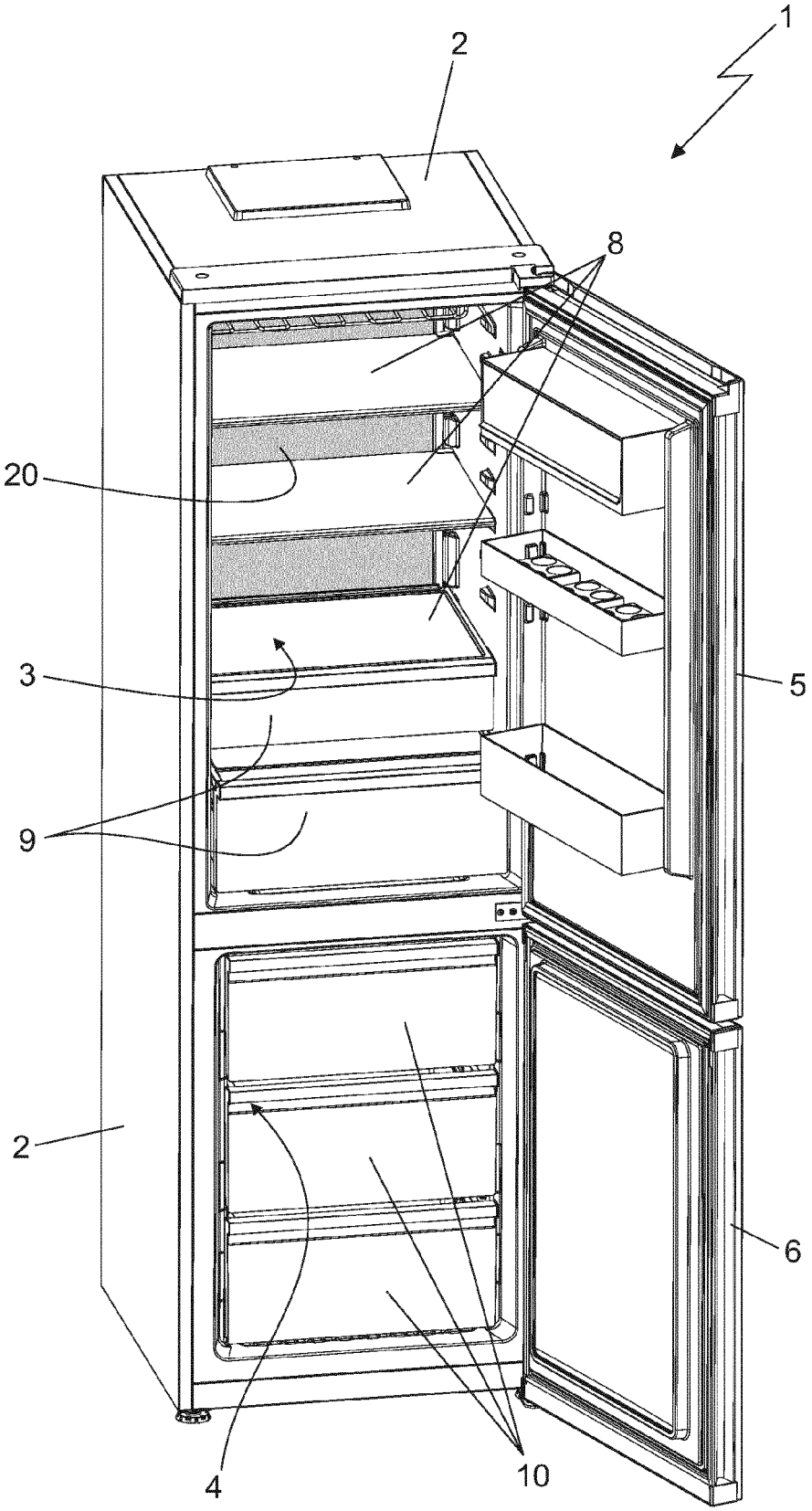

Fig. 1

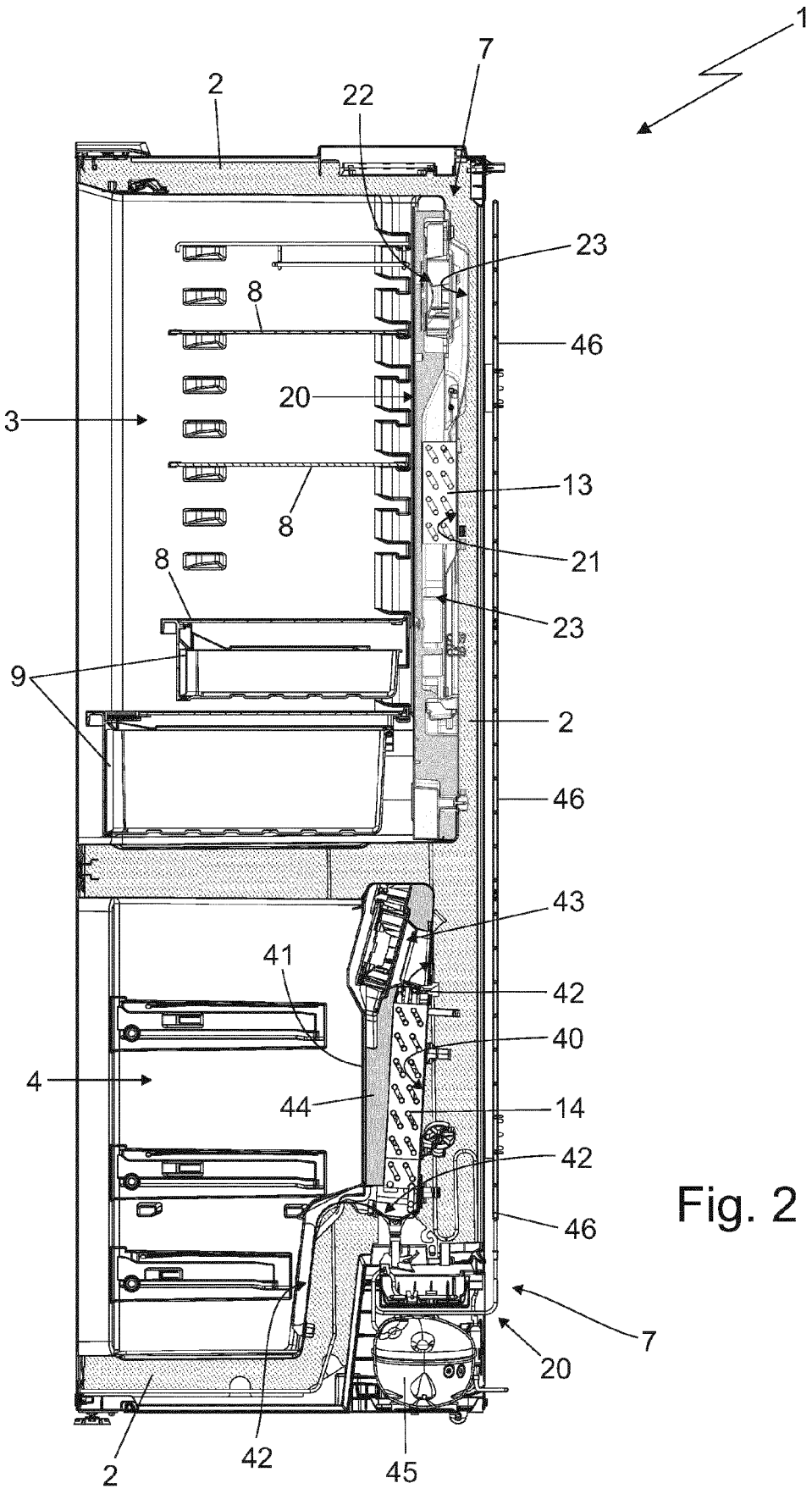
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Fig. 2

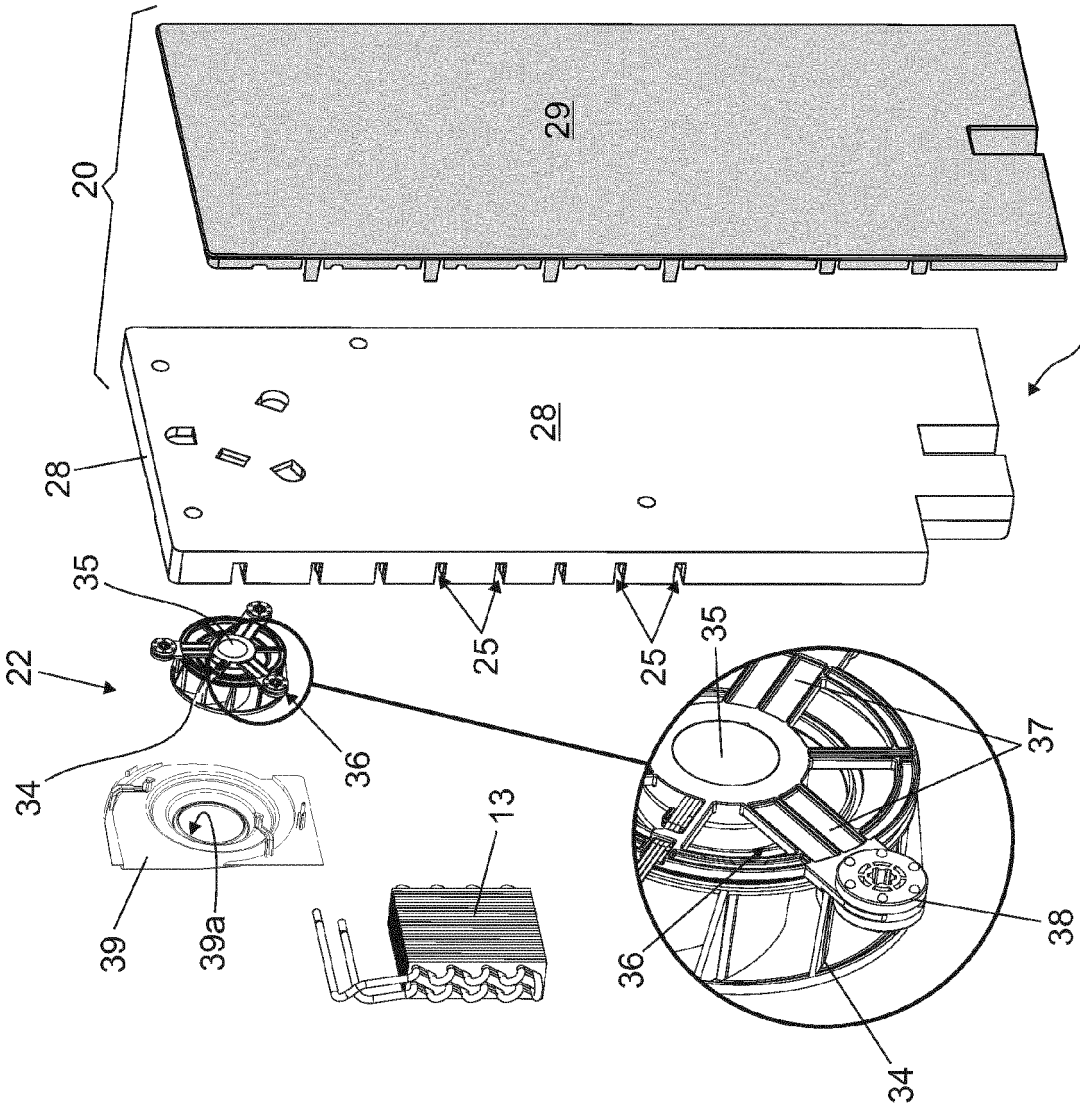
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Fig. 4

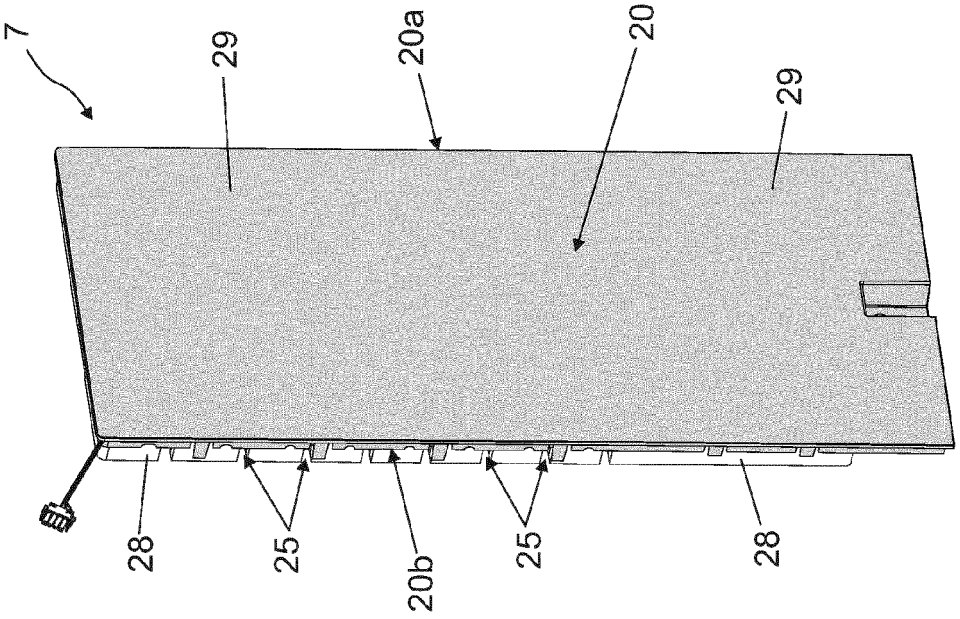
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Fig. 3

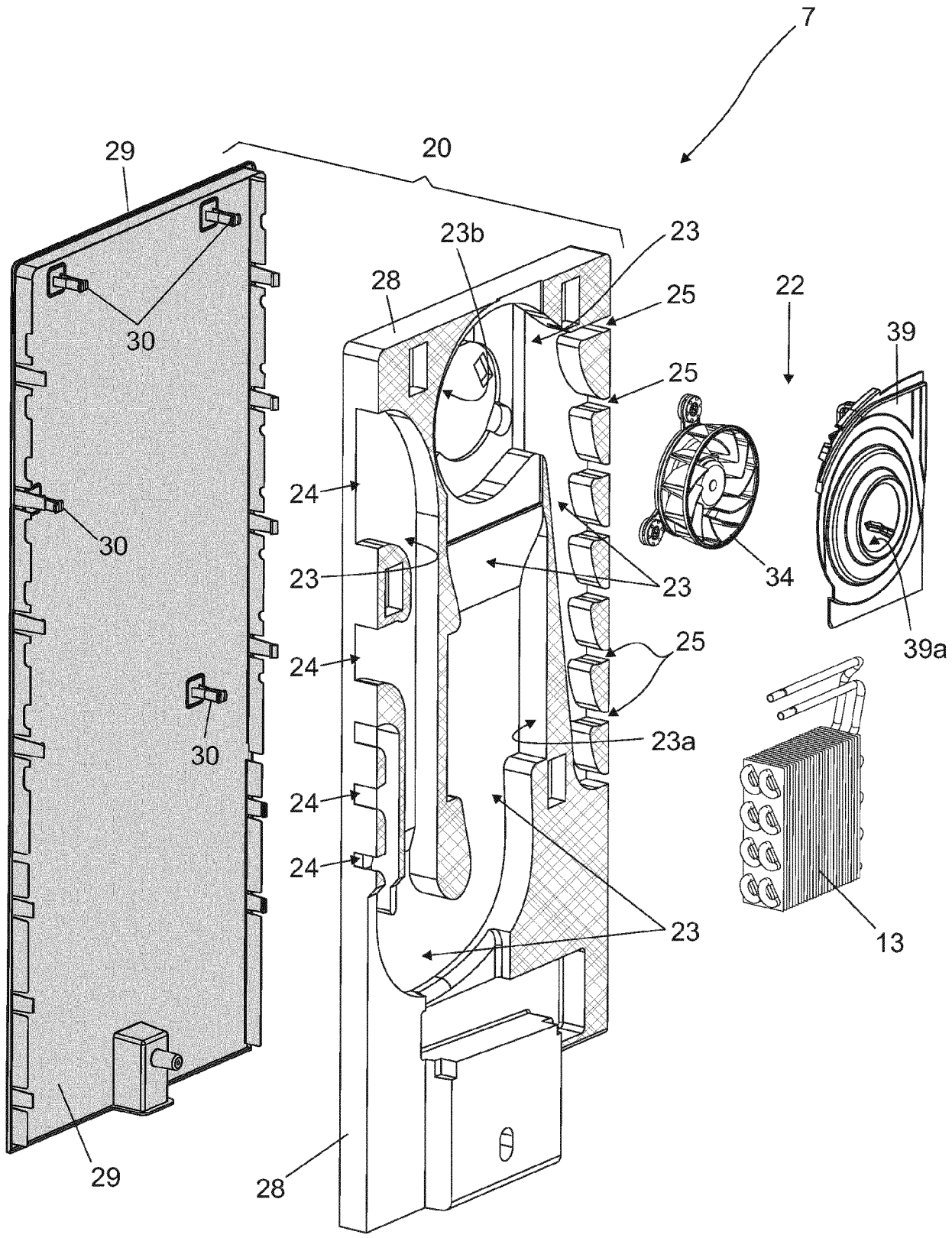
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Fig. 5

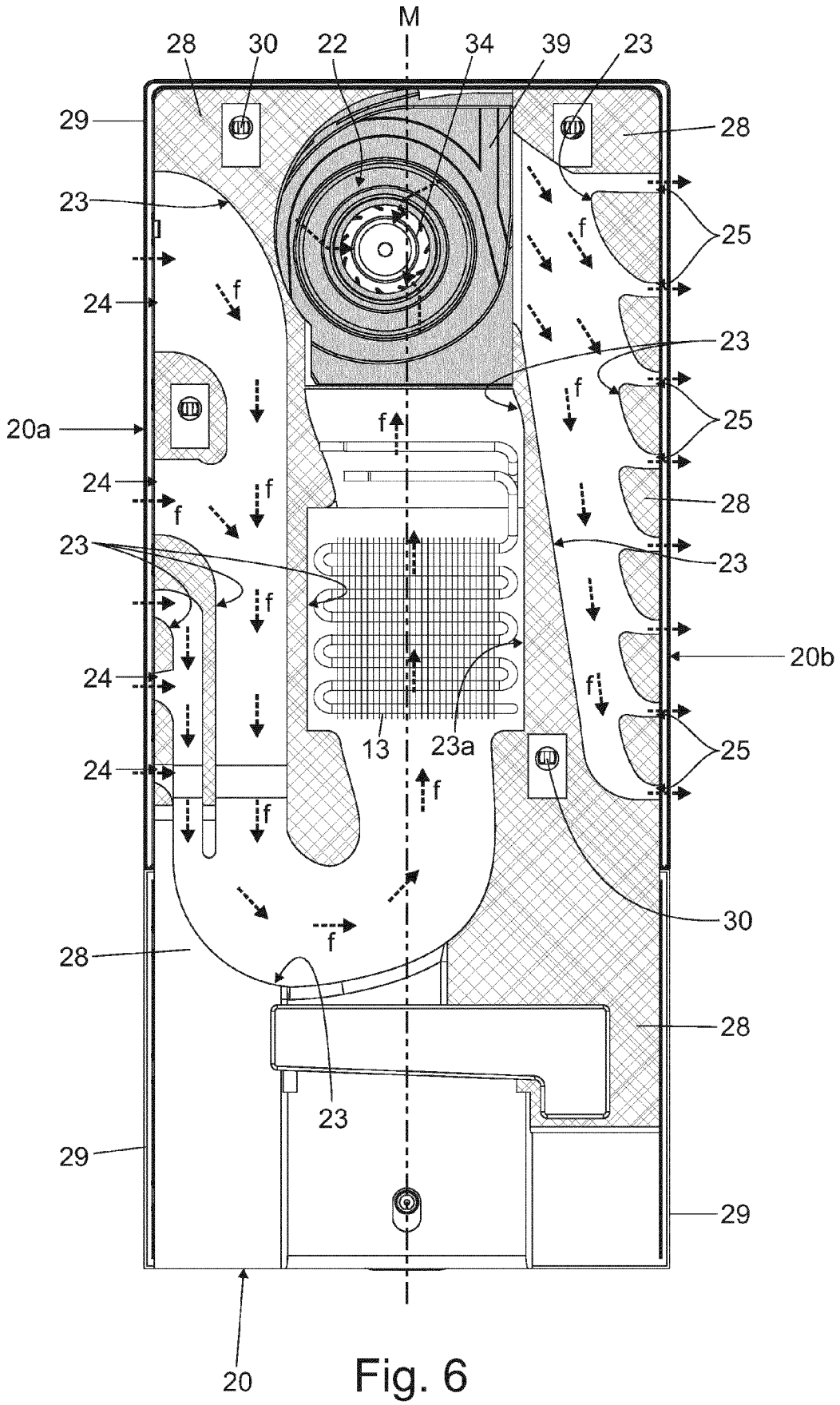
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Fig. 6

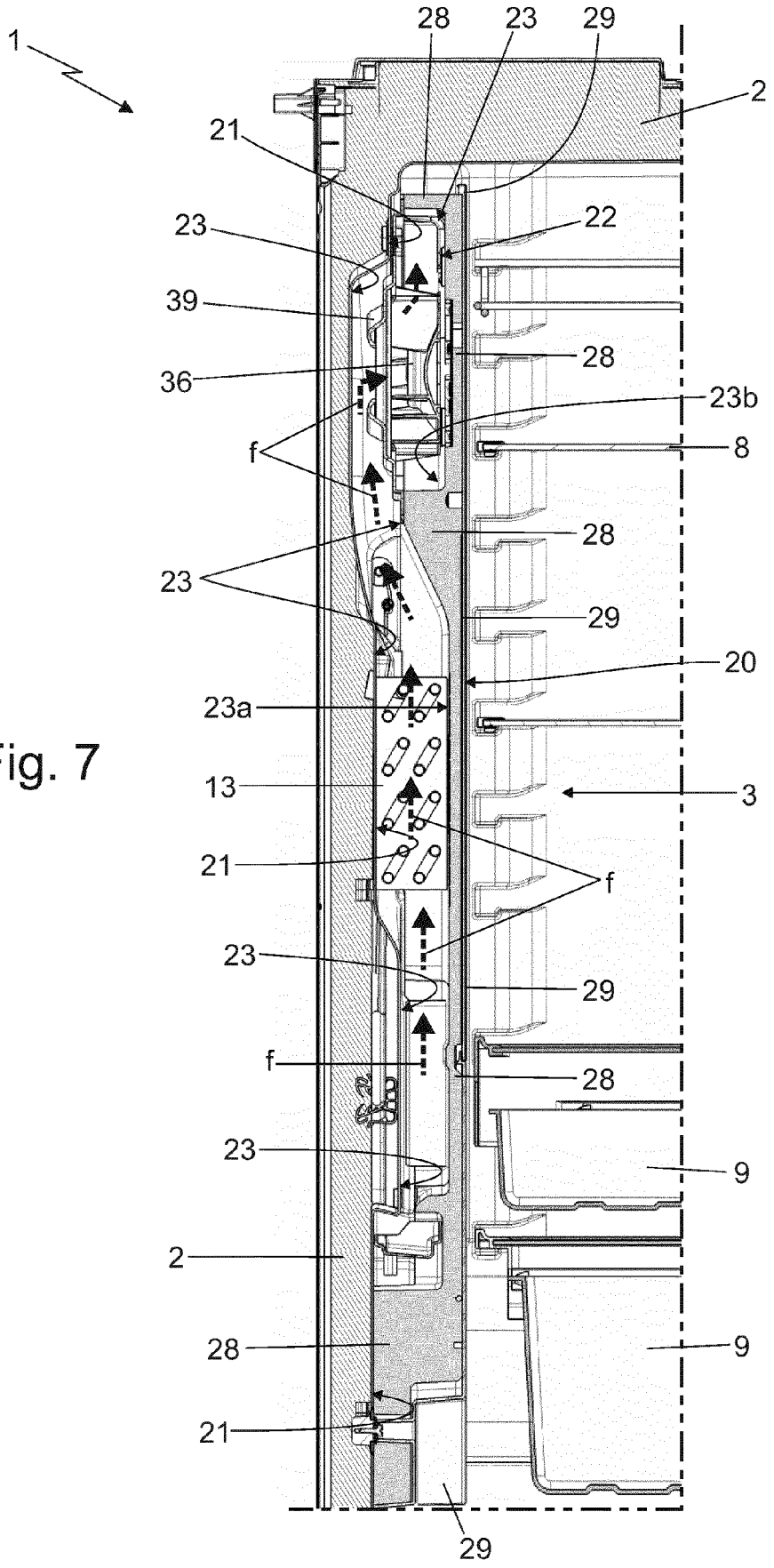
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Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 5288

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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
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