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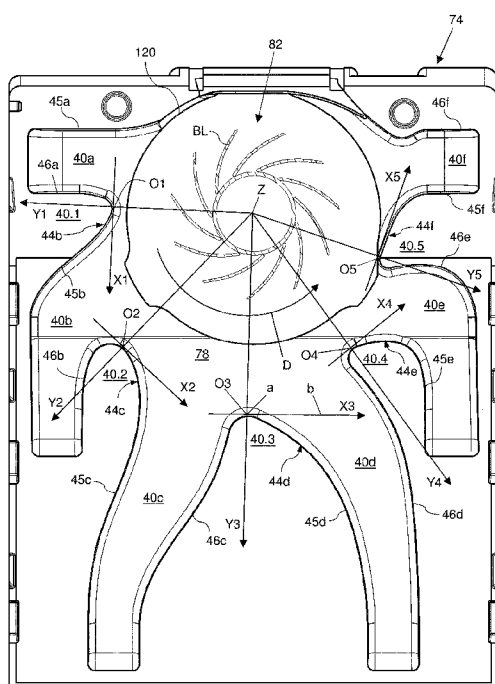


FIG. 14

(57) Abstract: The invention relates to a refrigeration appliance (1) comprising at least one compartment (10) for receiving food items and a refrigeration system (30) for cooling down air and a fan system (150) for conveying the cooled air to said least one compartment (10). The fan system (150) comprises a fan (72) comprising a rotor (82) rotating in a direction of rotation (D) around a rotation axis (Z), at least a first duct (40a-40g) and at least a second duct (40a-40g) arranged around said fan (72) for the conveyance of the air expelled by said fan (72) towards said at least one compartment (10). The first duct (40a-40g) and the second duct (40a-40g) are joined at a partition wall (40.1-40.5); wherein, by considering a reference plane that is orthogonal to the rotation axis (Z) of the rotor (82) and by considering an orthogonal coordinate system wherein: - the origin (O1-O5) is the closest point of the partition wall (40.1-40.5) to the rotation axis (Z); - Y-axis is the line laying in the reference plane and drawn from the rotation axis (Z) towards the origin (O1-O5); - X-axis is the line laying in the reference plane and drawn from the origin (O1-O5) and perpendicular to the Y-axis; at least a portion of the cross-section of the partition wall (40.1-40.5) in the reference plane shows a concave upward curve (44b-44f) while moving from the origin (O1-O5) towards positive values of the X-axis following the direction of rotation (D) of the rotor (82).

A REFRIGERATION APPLIANCE EQUIPPED WITH A FAN SYSTEM

FIELD OF THE INVENTION

- 5 The present invention relates to a refrigeration appliance, more specifically to a refrigeration appliance equipped with a fan system for circulating air within a compartment of the refrigeration appliance.

BACKGROUND ART

10

Refrigeration appliances of known types generally include an inner liner disposed within an outer cabinet. The inner liner typically defines one or more compartments, for example a fresh food compartment and a freezer compartment. Each compartment has an open front closed by a door pivotally mounted to the outer cabinet. Compartments are preferably provided with shelves and/or storage drawers to receive items therein.

15

A refrigeration system is provided to cool the compartments. The refrigeration system typically includes an evaporator for cooling down air.

20

A fan system is preferably arranged closed to the evaporator for creating a cooling air stream for the compartment/s. The air passes over the evaporator which cools the air passing therethrough and then a fan conveys the cooled air, coming from the evaporator, inside the compartment/s.

The fan typically sucks cooled air coming from the evaporator and expels it towards the compartment/s.

25

In order to convey the expelled cooled air by the fan in different zones of the appliance, for example into two compartments or in different points in the same compartment, conveying channels are opportunely realized from the fan outlet to respective air paths. In known systems, for example, conveyance channels are preferably realized in a layer of plastic foam insulation material disposed closed to the fan outlet.

30

A nagging problem for manufacturers is to realize a system with good distribution of air between channels. Bad distribution of air usually causes undesirable noise during operation. In instances where the refrigeration appliance is a domestic refrigerator, the noise can be annoying to consumers and/or give the consumer the impression that the refrigeration appliance is poorly designed

35

and/or poorly manufactured.

In particular, noise may be caused by high air speed and/or turbulent flow of air through the ducts. When air passes mainly through one channel or few channels only, the air speed resulting from the fan air flow is increased due to the small air
5 passage cross section.

Another problem of the known systems is that fewer compartments and/or fewer zones in a compartment receive the needed cold air, affecting the average cooling efficiency of the appliance.

It is therefore an object of the invention to implement a system apt to enhance the
10 smooth distribution of the cooled air compared to known systems.

It is another object of the invention to implement a system apt to reduce noise during operation of the air flowing into conveying channels.

It is a further object of the invention to implement a system apt to optimize the average cooling efficiency of the appliance.

15 It is another object of the invention to implement a system apt to reduce manufacturing time and/or costs compared to known systems taking care of efficiency and noise of the appliance.

DISCLOSURE OF INVENTION

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The applicant has found that by providing a refrigeration appliance having a compartment, a refrigeration system and a fan system for conveying cooled air to the compartment and by providing a first duct and a second duct joined at a partition wall for the conveyance of the cooled air wherein at least a portion of
25 the cross-section of said partition wall shows a concave upward curve, it is possible to solve the drawbacks of the known systems.

In a first aspect thereof, the invention therefore relates to a refrigeration appliance comprising:

- at least one compartment for receiving food items;
- 30 - a refrigeration system for cooling down air and a fan system for conveying the cooled air to said at least one compartment;

wherein said fan system comprises a fan comprising a rotor rotating in a direction of rotation around a rotation axis, at least a first duct and at least a second duct arranged around said fan for the conveyance of the air expelled by said fan
35 towards said at least one compartment, said first duct and said second duct being

joined at a partition wall;

wherein, by considering a reference plane that is orthogonal to said rotation axis of the rotor and by considering an orthogonal coordinate system wherein:

- the origin is the closest point of the partition wall to said rotation axis;

5 - Y-axis is the line laying in said reference plane and drawn from said rotation axis towards said origin;

- X-axis is the line laying in said reference plane and drawn from said origin and perpendicular to said Y-axis;

10 at least a portion of the cross-section of said partition wall in said reference plane shows a concave upward curve while moving from the origin towards positive values of said X-axis following said direction of rotation of the rotor.

As concave upward curve is intended a curve in an interval $[a, b]$ wherein all points on the curve lie above the tangent to the curve at any point in said interval $[a, b]$.

15 In the orthogonal coordinate system according to the invention, the point "a" corresponds to the origin and the point "b" is another point along the X-axis following the direction of rotation of the rotor.

According to a preferred embodiment of the invention, the fan system comprises a first opening between the first duct and the at least one compartment and a
20 second opening between the second duct and the at least one compartment allowing the conveyance of the air expelled by the fan towards the at least one compartment.

In a preferred embodiment of the invention, therefore, at least a portion of the cross-section of said partition wall in said reference plane shows a concave
25 upward curve, along its length towards said second opening, while moving from the origin towards positive values of said X-axis following said direction of rotation of the rotor.

Preferably, a chamber for air expelled by the fan is defined around the fan and the ducts fluidically communicate with the chamber.

30 Advantageously, the air follows the concavely shaped curve and is distributed in a laminar way along the duct up to its final part and then into the compartment. The air is advantageously not directly/linearly directed towards the final part of the ducts.

Advantageously, noise during operation is reduced due to laminar air flowing
35 into the duct.

In a preferred embodiment of the invention, the fan system comprises more than two ducts, wherein at least two adjacent ducts of said ducts define said first duct and said second duct.

Advantageously, by providing a plurality of ducts, preferably three or more
5 ducts, arranged around the fan and by providing the partition walls with said concave curves, the air coming from the rotor is uniformly and/or smoothly conveyed among the ducts.

According to a preferred embodiment of the invention, the rotor comprises at least one blade having a leading edge, a trailing edge and a chord line, wherein
10 the distance between said origin and the circumference determined by the trailing edge during rotation of the rotor has a value higher than 0,5 times the length of the chord line.

The chord line goes from the leading edge to the trailing edge. The leading edge is the proximal edge of the blade with respect the rotation axis and the trailing
15 edge is the distal edge of the blade with respect the rotation axis.

Preferably the rotor comprises a plurality of blades uniformly distributed around the rotation axis.

Preferably, the distance between said origin and the circumference determined by the trailing edge during rotation of the rotor has a value lower than 2 times the
20 length of the chord line.

In a preferred embodiment of the invention, the first duct, along said reference plane, comprises a first lateral wall and a second lateral wall defining a respective path wherein air flows and/or the second duct, along said reference plane, comprises a first lateral wall and a second lateral wall defining a
25 respective path wherein air flows.

Preferably, the first lateral wall of the first duct is provided upstream of the respective second lateral wall of the same first duct and/or the first lateral wall of the second duct is provided upstream of the respective second lateral wall of the same second duct, wherein the term upstream is considered with reference to the
30 direction of rotation of the rotor.

According to a preferred embodiment of the invention, the concave upward curve is defined in the first lateral wall of the respective duct.

Preferably, the first lateral wall and the second lateral wall of the duct get closer in the direction of the air stream flow.

35 Advantageously, laminar air flowing through the duct is enhanced.

In a preferred embodiment of the invention, the second lateral wall is shaped to follow the shape of the first lateral wall. In other words, the second lateral wall is curved in the same direction of the first lateral wall.

According to a preferred embodiment of the invention, the first duct and the
5 second duct are realized in a first layer receiving the fan.

In a preferred embodiment of the invention, the first layer comprises a seat to at least partially receive the fan.

Preferably, the first layer is a layer of expanded polystyrene.

In a preferred embodiment of the invention, the fan system comprises a fan
10 assembly, preferably a pre-assembled assembly.

According to a preferred embodiment of the invention, the refrigeration system comprises an evaporator to cool down air for the at least one compartment, the evaporator being arranged inside the at least one compartment at a first wall thereof, the fan assembly being arranged inside the at least one compartment and
15 associated to the evaporator for generating a cooling air stream for the at least one compartment;

wherein the fan assembly comprises, arranged side by side:

- a first layer of expanded polystyrene;
- said fan comprising said rotor;
- 20 - a cover plate;

and wherein the fan assembly comprises a fastening device apt to fasten the cover plate to the first layer to keep the fan assembly in the assembled configuration.

Preferably, the fan assembly further comprises a second layer of expanded
25 polystyrene arranged between the fan and the cover plate.

In a preferred embodiment of the invention, the first layer comprises said at least a first duct and at least a second duct and said cover plate comprises one or more air opening communicating with the first duct and the second duct when the fan assembly is assembled.

30 According to a preferred embodiment of the invention, the fastening device comprises snap fit elements.

Preferably, the fastening device comprises elastic tongues protruding from the cover plate interacting with recesses in the first layer.

According to a preferred embodiment of the invention, the fan assembly
35 comprises a mounting element apt to mount the fan to the first layer.

Preferably, the fan comprises a frame apt to support the rotor.

In a preferred embodiment of the invention, the fan assembly further comprises a fan mouth where air flows from the evaporator to the fan.

According to a preferred embodiment of the invention, the fan mouth and the
5 mounting element are integrally made.

Preferably, the refrigeration system further comprises connecting means apt to connect the fan assembly to the first wall of the compartment.

BRIEF DESCRIPTION OF THE DRAWINGS

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Further characteristics and advantages of the present invention will be highlighted in greater detail in the following detailed description of a preferred embodiment of the invention, provided with reference to the enclosed drawings. In said drawings:

- 15 - Figure 1 shows an isometric view of a refrigeration appliance according to a preferred embodiment of the present invention;
- Figure 2 shows the appliance of Figure 1 with some elements removed therefrom;
- Figure 3 shows a vertical plan sectional view of the appliance of Figure 2;
- 20 - Figure 3A shows an enlarged view of a detail of figure 3;
- Figure 3B shows an enlarged view of a detail of figure 3A;
- Figure 4 shows an isometric view of a fan assembly according to a preferred embodiment of the present invention;
- Figure 5 shows the fan assembly of Figure 4 from another point of view;
- 25 - Figure 6 shows a vertical plan sectional view of the fan assembly of Figure 5;
- Figure 7 shows an enlarged view of a detail of figure 5;
- Figure 8 shows an exploded view of the fan assembly of Figure 4;
- Figure 9 shows the exploded view of Figure 8 from another point of view;
- Figure 10 shows the fan assembly of Figure 4 with an element removed
30 therefrom;
- Figure 11 shows some elements of the fan assembly of Figure 10 isolated from the rest;
- Figure 12 shows the elements of Figure 11 from another point of view;
- Figure 13 shows a sectional view of a detail of figure 10;
- 35 - Figure 14 shows a plan view of Figure 10 with some elements removed

therefrom;

- Figure 15 shows an enlarged view of a detail of figure 14;
- Figure 16 shows the plan view of the fan assembly of Figure 14 depicting air paths flowing therethrough.

5

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring to Figures 1 and 2 a refrigeration appliance in the form of a domestic
10 refrigerator is shown, indicated generally as 1. Although the detailed description
that follows concerns a domestic stand-alone refrigerator 1, the refrigeration
appliance can be embodied by refrigeration appliances other than a domestic
refrigerator.

Furthermore, the embodiment described in detail below refers to a bottom mount
15 refrigerator, i.e. of the type including a freezer compartment disposed vertically
below a fresh food compartment. However, the refrigerator according to the
invention can have any desired configuration, for example a top mount
refrigerator wherein the freezer compartment is disposed vertically above the
fresh food compartment or a refrigerator comprising only a fresh food
20 compartment or only a freezer compartment.

Furthermore, while the present application is described with reference to a stand-
alone refrigerator it has to be noted that also a built-in solution may be
contemplated.

The refrigeration appliance 1 illustrated in the figures, hereinafter indicated as
25 refrigerator 1, comprises an outer cabinet 2 and an inner liner 22, internally
received in the outer cabinet 2. The outer cabinet 2 and the inner liner 22 are
separated by a spacing filled with thermal insulation 13, preferably a foam
insulation.

The outer cabinet 2 preferably extends in a vertical direction V and preferably
30 comprises a base 2A suitable to lay on the ground, a roof 2B and lateral side
walls 2C, 2D, 2E connecting the base 2A and the roof 2B, preferably two lateral
side walls 2C, 2D and a rear side wall 2E.

In its installed position, lateral side walls 2C, 2D and the rear side wall 2E are
preferably aligned to the vertical direction V.

35 The refrigerator 1 according to the embodiment shown in the figures preferably

represents a bottom mount type refrigerator. At this purpose, a divider portion 5 (Figure 3) is provided which divides inner liner 22 into a lower space that is used as a freezer compartment 10, and an upper space that is used as a fresh food compartment 12.

- 5 The freezer compartment 10 substantially preferably has the form of a cuboid defining a rectangularly shaped front opening 14. A door 15 is preferably pivotally mounted to the outer cabinet 2 and is movable between an open position and a closed position to cover the front opening 14.

The freezer compartment 10 preferably shows a rear wall 24 which is defined by
10 a portion of the inner liner 22, more preferably a vertical rear wall 24.

Analogously, the fresh compartment 12 substantially and preferably has the form of a cuboid defining a rectangularly shaped front opening 16. A door 17 is preferably pivotally mounted to the outer cabinet 2 and is movable between an open position and a closed position to cover the front opening 16.

- 15 In an alternative embodiment, a single door can be provided to open and close both the front openings 14, 16 of the freezer and the fresh compartments 10, 12.

The compartments 10, 12 preferably comprise shelves S and/or drawers D for receiving food items.

- A refrigeration system 30 is preferably provided to cool the compartments 10,
20 12.

The refrigeration system 30 is apt to cool down air which is circulated inside at least one compartment of refrigerator 1, preferably to cool down air which is circulated inside both compartments 10, 12.

- In the preferred embodiment of the invention, the refrigeration system 30
25 preferably comprises a closed recirculating system filled with a suitable refrigerant, for example R12 or R134a. The refrigeration system preferably comprises an electric motor-driven compressor 32, a condenser heat exchanger 34, a pressure device such as a capillary tube or a thermostatic valve (not shown) and an evaporator 38.

- 30 A collecting tray 55 is preferably arranged below the evaporator 38 to collect water formed by condensation on the evaporator 38.

- The evaporator 38 is preferably mounted inside the freezer compartment 10, whereas the compressor 32 is mounted external to the freezer compartment 10 and preferably arranged in a working chamber 21 at the bottom of the refrigerator
35 1.

The condenser heat exchanger can be a condenser tubing 34 that preferably has a serpentine configuration and is preferably externally secured to the rear side wall 2E of the outer cabinet 2 so as to form what is commonly known as a “hot wall”.

Further features of the refrigeration system 30 are not described in detail in the present application since are well known in the art.

The evaporator 38 is more preferably mounted to the rear wall 24 of the freezer compartment 10 towards the interior of the freezer compartment 10.

According to the invention, a fan system 150 is associated to the evaporator 38 for conveying the cooled air to different zones of the refrigerator 1, as better described below.

In a preferred embodiment of the invention, as illustrated in the Figures, the fan system 150 comprises a fan assembly 50 arranged closed to the evaporator 38. The fan assembly 50 is shown isolated from the rest in figures 4 to 6. In a preferred embodiment of the invention, the fan assembly 50 is a pre-assembled assembly and is advantageously pre-assembled during manufacturing of the refrigerator 1 and then it is mounted inside the freezer compartment 10 over the evaporator 38.

The fan assembly 50 is preferably connected to the rear wall 24 of the freezer compartment 10 through connecting means 60.

In the preferred embodiment illustrated in the figures, the connecting means 60 preferably comprise two lower protruding tabs 61A, 61B with holes for receiving fixing screws (not shown). The fan assembly 50 is assembled to the freezer compartment 10 by inserting its upper part in position inside the freezer compartment 10, rotating its lower part to bring the fan assembly 50 in its final position and finally fixing the fan assembly 50 to the inner liner 22 with screws inserted in the tabs 61A, 61B.

In different preferred embodiments, the connecting means may comprise other type of fasteners, such as mechanical (e.g. rivets, nuts and bolts, etc.), chemical (e.g. adhesive, epoxy, etc.), or other type of fasteners.

The function of the fan system 150, and in particular of the fan assembly 50, is to generate the cooling air stream that is conveyed and recirculated inside the freezer compartment 10 and, in the preferred embodiment here illustrated, also inside the fresh food compartment 12. The fan assembly 50 is preferably configured to draw air from the evaporator 38 and to expel it into different points of the freezer compartment 10 and into the fresh food compartment 12.

The fan assembly 50 preferably comprises a first layer 70 of expanded polystyrene, a fan 72, a second layer 74 of expanded polystyrene and a cover plate 76.

5 The first layer 70, the fan 72, the second layer 74 and the cover plate 76 are preferably arranged side by side, i.e. arranged one laterally of the other and preferably in a lateral order perpendicular to the vertical direction V. In other words, each component 70, 72, 74, 76 is at least partially stacked/in contact to the laterally adjacent component.

10 Preferably, expanded polystyrene used for the layers 70, 74, i.e. EPS, is a lightweight, rigid plastic foam insulation material made of solid polystyrene particles.

The use of EPS enhances thermal isolation of the fan assembly 50, being EPS a high-quality thermal insulator material.

15 In addition, the use of EPS enhances acoustic isolation of the fan assembly 50, in particular of noise caused by rotation of the fan 72 and of the air expelled from it. Furthermore, using of EPS simplifies the fan assembly 50 construction as EPS is an easily handled material. Still advantageously, EPS is a cheap material.

Therefore, manufacturing time and/or costs are reduced compared to known systems.

20 In a further preferred embodiment of the invention, not shown, the second layer of expanded polystyrene may be omitted.

The fan 72 preferably comprises a rotor 82 with a rotation axis Z. The rotor 82 is preferably mounted on a supporting frame 80.

25 The supporting frame 80 preferably has a spider shaped structure with arms 80A-80F supporting the rotor 52, as visible in Figure 11.

30 The fan 72 preferably comprises a centrifugal fan, preferably a radial fan. The air flows from a suction side 72A of the fan 72 facing the evaporator 38, and the air is then displaced radially, changing its direction (typically by 90°). The rotor 82 preferably consists of a rotating arrangement of vanes or blades BL, rotating around said axis Z, which act on the air. Preferably, the rotor 82 comprises a plurality of blades BL uniformly distributed around the rotation axis Z.

35 Preferably, a fan mouth 122 is arranged at the suction side 72A of the fan 72 to convey the air from the evaporator 38 to the rotor 82. The fan mouth 122 preferably faces the evaporator 38 and is preferably placed between the first layer 70 and the fan 72.

In different preferred embodiments, the fan mouth may be omitted.

A suction chamber 68 is created between the fan 72, preferably the fan mouth 122, and the outlet side 38A of the evaporator 38, as shown in Figure 3B. The fan 72 draws air from the evaporator 38 through the suction chamber 68 and expels it
5 outside the fan assembly 50, towards the freezer compartment 10 and the fresh food compartment 12, as better described later.

The air preferably flows in the compartments 10, 12 to define closed loop circuits and the fan 72 is switched on/off according to operational condition, for example the temperature level inside the compartments 10, 12 and/or opening of the
10 doors, etc.

The rotating axis Z of the rotor 82 is preferably inclined with respect to a vertical direction V.

Preferably, the rotating axis Z is inclined with respect to the rear side wall 2E of the outer cabinet 2.

15 The rotating axis Z is preferably inclined with respect to the vertical direction V of an angle W comprised between 10° and 80° , more preferably inclined of an angle W equal to 60° .

Advantageously, by inclining the rotor 82 with respect the vertical direction V the suction chamber 68 is shaped to guarantee a good fluid dynamics efficiency
20 and at the same time the space occupied by the fan 72 is minimized so that the volume of the freezer compartment 10 is not negatively affected.

In different embodiments, nevertheless, the rotating axis of the rotor may have any different inclination with respect to the vertical direction.

The fan assembly 50 preferably comprises a fastening device 90 apt to fasten the
25 cover plate 76 to the first layer 70 to keep elements of the fan assembly 50 in the assembled configuration.

Preferably, the fastening device 90 is apt to fasten the cover plate 76 to the first layer 70 to keep staked, preferably in the following order, the first layer 70, the fan 72 and the second layer 74 in their assembled position.

30 The fastening device 90 keeps the elements of the fan assembly 50 firmly together. In particular, preferably, the fan 72 is firmly sandwiched between the layers 70, 74 of expanded polystyrene EPS.

In case the second layer of expanded polystyrene is omitted, according to an alternative preferred embodiment of the invention, the fastening device is apt to
35 fasten the cover plate to the first layer to keep staked, preferably in the following

order, the first layer and the fan in their assembled position.

Preferably, the fastening device 90 comprises snap fit elements. In the preferred embodiment illustrated in the figures, the fastening device 90 comprises elastic tongues 92 protruding from the cover plate 76 which interact with respective
5 recesses 94 in the first layer 70, as better illustrated in Figure 7. Tongues 92 are preferably made in one piece with the cover plate 76 to realize a single body.

Advantageously, the fan assembly 50 with associated fastening device 90 guarantees a compact configuration that avoids/reduces vibrations between them, in particular during activation of the fan.

10 This results in a reduction of noise during operation of the refrigerator 1 and/or also an improved reliability of the refrigerator.

Furthermore, advantageously, the fastening device and the cover plate realize a single body so that there is no need of separated fastening means, thus reducing complexity of the fan assembly and simplifying assembling process steps.

15 According to an aspect of the invention, the first layer 70 comprises one or more air conveying channels 40a-40g, or ducts, for conveying cooled air expelled from the fan 72 towards the compartments 10, 12.

A chamber 78 for air expelled by the fan is therefore defined around the fan 72 itself. The ducts 40a-40g fluidically communicate with the chamber 78.

20 The ducts 40a-40g, as illustrated in Figures 8 and 10, are opened in the direction of the cover plate 76. In the assembled configuration, then, the cover plate 76 opportunely closes the ducts 40a-40g allowing the air conveyance. The first layer 70 with open channels 40a-40g are easily obtained through an injection mould process with EPS.

25 Nevertheless, in a further preferred embodiment (not shown) ducts may be realized as closed ducts directly on the first layer.

According to the preferred embodiment illustrated in the figures, there are six ducts 40a-40f that are radially arranged around the fan 72 for the air to the freezer compartment 10 and an upper duct 40g for the air to the fresh food
30 compartment 12.

The cover plate 76 preferably comprises one or more air opening 102a-102f communicating with the air conveying channels 40a-40f of the first layer 70. Cooled air advantageously enters the freezer compartment 10 through said air openings 102a-102f, which preferably are grated openings. It is preferably
35 contemplated that the cover plate 76 is made from plastic to provide an

aesthetically pleasing appearance to a user.

Generally, the fan system comprises openings between the ducts and the freezer compartment allowing the conveyance of the cooled air expelled by the fan towards the freezer compartment through the ducts.

- 5 Preferably, an intermediate sheet 105 is interposed between the first layer 70 and the cover plate 76. The intermediate sheet 105 preferably comprises holes 106a-106f aligned with the air openings 102a-102f of the cover plate 76.

The intermediate sheet 105 enhances the closure of the ducts 40a-40g of the first layer 70. The intermediate sheet 105 improves the sealing effect for the ducts
10 40a-40g, in particular in case the cover plate 76 is not perfectly planar.

In a further preferred embodiment, the intermediate sheet may be omitted.

Preferably, the first layer 70 comprises a seat 120 apt to at least partially receive the fan 72.

- A mounting element 124 is preferably used to mount the fan 72 to the first layer
15 70, preferably to the seat 120. More preferably, the mounting element 124 is preferably used to mount the frame 80 of the fan 72 to the first layer 70.

In the preferred embodiment illustrated in the figures, the mounting element 124 is integrally made with the fan mouth 122. Manufacturing time and/cost are advantageously reduced.

- 20 In different preferred embodiments, nevertheless, the mounting element and fan mouth can be two independent elements.

The mounting element 124 is arranged in the seat 120 of the first layer 70 and connected thereto. In the preferred embodiment illustrated in the figures the mounting element 124 preferably comprises an annular surface 124A that
25 preferably lays in a plane perpendicular to the axis Z of the rotor 82.

The mounting element 124 preferably comprises one or more pins 140 apt to be inserted in respective one or more through holes 142 of the first layer 70. The pins 140 preferably protrude from the annular surface 124A of the mounting element 124.

- 30 The pins 140 are axially blocked to the first layer 70 with blocking elements 146, for example internal tooth lock washers, connected at the tip of the pins 140 and abutting a surface 148 of the first layer 70, as better visible in figure 13. The pins 140, allow the constraint of the mounting element 124 to the first layer 70.

More preferably, the frame 80 of the fan 72 is connected to the mounting element
35 124 through a carrier structure 125 preferably comprising ribs 126 protruding

from the annular surface 124A of the mounting element 124.

In the preferred embodiment illustrated, the ribs 126 define connecting points for the frame 80 of the fan 72, preferably three connecting points (Figure 11).

Vibration dampening elements 130 are preferably interposed between the fan 72
5 and the mounting element 124. Preferably, the vibration dampening elements 130 are interposed between the frame 80 of the fan 72 and the mounting element 124. More preferably the vibration dampening elements 130 are interposed between the frame 80 of the fan 72 and the carrier structure 125 of the mounting element 124.

10 Vibration dampening elements 130 preferably comprise rubber washers interposed between three arms 80A, 80C, 80E of the supporting frame 80 and corresponding ribs 126 of the mounting structure 125.

Vibration dampening elements 130 advantageously absorb vibrations created by the fan rotation.

15 In a preferred embodiment of the invention, the second layer 74 comprises a seat/opening 220 apt to at least partially receive the fan 72.

The second layer 74, then, preferably comprises protruding pins 222a apt to be received in respective holes 222b of the first layer 70 when the fan assembly 50 is assembled.

20 In the assembled configuration, the second layer 74 of EPS enhances acoustic isolation of the noise caused by rotation of the fan 72 towards the internal volume of the freezer compartment 10.

As said above, the air preferably flows in the compartments 10, 12 to define closed loop circuits. Advantageously, the fan assembly 50 create an air flow
25 paths inside the fresh food compartment 12 and air flow paths in the freezer compartment 10, schematically indicated with FF, F1, F2, F3 in Figures 3 and 3A.

In particular, air flow path FF is generated by the fan assembly 50 and conveyed to the fresh food compartment 12 through the upper duct 40g of the first layer 70.

30 Air flow paths F1, F2, F3 are generated by the fan assembly 50 and conveyed to the freezer compartment 10 through the six ducts 40a-40f of the first layer 70 and air openings 102a-102f of the cover plate 76.

From the inside of the freezer compartment 10, then, the air flows back to the evaporator 38 through a gap 56 preferably defined between the lower part of the
35 cover plate 76 and the lower part of the rear wall 24 of the freezer, as indicated in

Figure 3A.

According to an aspect of the invention, as illustrated in particular in Figure 14, the ducts 40a-40f are preferably arranged in couples around the fan 72 for the conveyance of the air expelled by the fan 72 towards two respective paths.

5 The couple of ducts 40a-40f are joined at a partition wall 40.1-40.5.

In particular, according to the preferred embodiment illustrated in the Figures, the ducts 40a-40f define:

a first couple of ducts defined by the first duct 40a and the second duct 40b joined at a first partition wall 40.1;

10 a second couple of ducts defined by the second duct 40b and the third duct 40c joined at a second partition wall 40.2;

a third couple of ducts defined by the third duct 40c and the fourth duct 40d joined at a third partition wall 40.3;

15 a fourth couple of ducts defined by the fourth duct 40d and the fifth duct 40e joined at a fourth partition wall 40.4;

a fifth couple of ducts defined by the fifth duct 40e and the sixth duct 40f joined at a fifth partition wall 40.5.

Each duct 40a-40f preferably shows two opposite lateral walls, namely a first lateral wall 45a-45f and a second lateral wall 46a-46f.

20 The first lateral wall 45a-45f of each duct 40a-40f is provided upstream of the respective second lateral wall 46a-46f of the same duct 40a-40f, wherein the term upstream is considered with reference to the direction of rotation D of the rotor 82.

25 Air flows in respective path defined in each duct 40a-40f by the first and the second lateral wall 45a-45f, 46a-46f.

Partition walls 40.1-40.5 extend from a first lateral wall 45a-45f of a first duct 40a-40f and a second lateral wall 46a-46f of an adjacent second upstream duct 40a-40f, wherein the term upstream is considered with reference to the direction of rotation D of the rotor 82.

30 In alternative preferred embodiments, different numbers of couple of ducts may be provided, for example just one couple of ducts or more than five couple of ducts.

Firstly, for the scope of the present invention, a reference plane orthogonal to the rotation axis Z of the rotor 82 is considered. Plan views of Figures 14 to 16 are
35 views according to said reference plane.

Also, by considering said reference plane, an orthogonal coordinate system may be preferably defined for each couple of said ducts 40a-40f. Therefore, in the preferred embodiment illustrated in Figure 14, five orthogonal coordinate systems are defined.

5 Each orthogonal coordinate system is preferably defined as follows:

- the origin O1-O5 is the closest point of the partition wall 40.1-40.5 to the rotation axis Z of the rotor 82;

- Y-axis Y1-Y5 is the line laying in the reference plane and drawn from the rotation axis Z of the rotor 82 towards the origin O1-O5;

10 - X-axis X1-X5 is the line laying in the reference plane and drawn from the origin O1-O5 and perpendicular to the Y-axis Y1-Y5.

According to an advantageous aspect of the invention, at least a portion 44b-44f of the cross-section of the partition walls 40.1-40.5 in the reference plane shows a concave upward curve while moving from the origin O1-O5 towards positive values of the X-axis following the direction of rotation D of the rotor 82.

15 Preferably, at least a portion 44b-44f of the cross-section of the partition walls 40.1-40.5 in the reference plane shows a concave upward curve, along its length towards the openings 102a-102g, while moving from the origin O1-O5 towards positive values of the X-axis following the direction of rotation D of the rotor 82

20 In other words, the first portion 44b-44f of the first wall 45a-45f of a duct 40a-40f is a concavely shaped curve.

As concave upward curve is intended a curve in an interval [a, b] wherein all points on the curve lie above the tangent to the curve at any point in said interval [a, b].

25 In the orthogonal coordinate system according to the invention, the point "a" corresponds to the origin O1-O5 and the point "b" is another point along the X-axis following the direction of rotation D of the rotor 82, as exemplary indicated only for the third orthogonal coordinate system O3, X3, Y3 in Figure 14.

Applicant has recognized that by shaping the first portion 44b-44f of the first wall 45a-45f of a duct 40a-40f as a concave upward curve, the air coming from the rotor 82 is more smoothly conveyed into the ducts 40a-40f.

The air expelled by the rotor 82, as schematically illustrated in Figure 16, flows through each duct 40a-40f in order to reach the respective final part and then to reach the air opening 102a-102f of the cover plate 76.

35 According to an aspect of the invention, the air follows the concavely shaped

curve 45a-45f and is advantageously distributed in a laminar way along the duct 40a-40f up to its final part. Preferably, the air is not directly/linearly directed towards the final part of the duct 40a-40f.

Advantageously, noise during operation is reduced due to laminar air flowing
5 into the ducts 40a-40f.

Preferably, the second wall 46a-46f of the duct 40a-40f opposite the first wall 45a-45f is shaped to substantially follow the shape of the first wall 45a-45f, as it can be appreciated in particular with reference to third, fourth, fifth and sixth ducts 40c-40f. In particular, by watching the ducts 40c-40f as in the plane view
10 of Figure 14, the second walls 46c-46f of the ducts 40c-40f are curved in the same direction of the respective first walls 45c-45f of the duct 40c-40f, for example the second wall 46c and the first wall 45c of the third duct 40c are both slightly curved to the right.

Preferably, in the direction of the air stream flow, the duct 40a-40f narrows, i.e.
15 the first wall 45a-45f and the second wall 46a-46f get closer following the air stream flow, i.e. going towards the final part of the duct 40a-40f. Narrowing of the ducts 40a-40f enhances an efficient laminar air flowing through the ducts 40a-40f and air openings 102a-102f.

Still advantageously, by providing a plurality of ducts 40a-40f, preferably three
20 or more ducts 40a-40f, arranged around the fan 72 and by providing partition walls 40.1-40.5 joining two adjacent ducts 40a-40f having concave curves 44b-44f as described above the air coming from the rotor 82 is uniformly and/or smoothly conveyed among the ducts 40a-40f.

Preferably, when the air encounters the concave curves 44b-44f of partition walls
25 40.1-40.5 is subjected to a localized pressure drop that facilitates the uniform distribution of air among all the ducts 40a-40f and, eventually, uniform distribution of air inside the freezer compartment 10 through air openings 102a-102f of the cover plate 76. The average cooling efficiency inside the freezer compartment 10 is thus optimized.

30 According to another aspect of the invention, the ducts 40a-40f are configured so that the partition walls 40.1-40.5 are arranged around the fan 72, preferably around the rotor 82, at optimized distances, as illustrated in Figure 15.

Firstly, for the scope of the present invention, the following elements are considered (see Figure 15):

35 - the proximal edge Le of the blade/s BL with respect the rotation axis Z, also

known as leading edge Le;

- the distal edge Te of the blade/s BL with respect the rotation axis Z, also known as trailing edge Le, and the corresponding circumference determined by the trailing edge Le during the rotation of the rotor 82;

- 5 - the chord line CL of the blade/s BL, i.e. the line going from the leading edge Le to the trailing edge Te.

Then, the distances d1-d5 between the origins O1-O5 and the circumference C are considered.

- 10 According to an aspect of the invention, at least one distance d1-d5 among the distances d1-d5 preferably has a value higher than 0,5 times the length of the chord line CL, i.e.:

$d1 > 0,5 * CL$ or $d2 > 0,5 * CL$ or $d3 > 0,5 * CL$ or $d4 > 0,5 * CL$ or $d5 > 0,5 * CL$.

Preferably, more than one distance d1-d5 among the distances d1-d5 preferably have a value higher than 0,5 times the length of the chord line CL.

- 15 More preferably, all distances d1-d5 preferably have a value higher than 0,5 times the length of the chord line CL.

- Said relations indicate that the partition walls 40.1-40.5 are preferably arranged around the fan 72 above a minimum distance from the trailing edge Te of the blades BL of rotor 82, in particular when the rotor 82 rotates. The minimum
20 distance allows to keep low the noise of the air expelled by the fan and striking the partition walls 40.1-40.5.

According to another aspect of the invention, at least one distance d1-d5 among the distances d1-d5 preferably has a value lower than 2 times the length of the chord line CL, i.e.:

- 25 $d1 < 2 * CL$ or $d2 < 2 * CL$ or $d3 < 2 * CL$ or $d4 < 2 * CL$ or $d5 < 2 * CL$.

Preferably, more than one distance d1-d5 among the distances d1-d5 preferably have a value lower than 2 times the length of the chord line CL.

More preferably, all distances d1-d5 preferably have a value lower than 2 times the length of the chord line CL.

- 30 Said relations indicate that the partition walls 40.1-40.5 are preferably arranged around the fan 72 below a maximum distance, not too far, from the trailing edge Te of the blades BL of rotor 82, in particular when the rotor 82 rotates. By arranging the partition walls 40.1-40.5 not too far around the fan 72, the advantageous effect of the concave curves 44b-44f of partition walls 40.1-40.5 is
35 positively maintained.

It has thus been shown that the present invention allows all the set objects to be achieved. In particular, it makes it possible to provide a refrigeration appliance with a fan system that enhances the smooth distribution of the cooled air compared to known systems.

- 5 It is underlined that in the refrigeration appliance illustrated in the enclosed figures, the ducts are preferably realized in the layer of expanded polystyrene which receives the fan. Nevertheless, in different preferred embodiments, the ducts which are arranged around the fan/rotor according to the invention may be realized in any different way. For example, the duct may be realized as a box-
10 shaped structure formed of metal sheets joined together.

- Although an illustrative embodiment of the present invention has been described herein with reference to the accompanying drawings, it is to be understood that the present invention is not limited to that precise embodiment, and that various other changes and modifications may be affected therein by one skilled in the art
15 without departing from the scope or spirit of the invention. All such changes and modifications are intended to be included within the scope of the invention as defined by the appended claims.

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CLAIMS

1. A refrigeration appliance (1) comprising:
- at least one compartment (10) for receiving food items;
 - 5 - a refrigeration system (30) for cooling down air and a fan system (150) for conveying the cooled air to said least one compartment (10);
- wherein said fan system (150) comprises a fan (72) comprising a rotor (82) rotating in a direction of rotation (D) around a rotation axis (Z), at least a first duct (40a-40g) and at least a second duct (40a-40g) arranged around said fan (72)
- 10 for the conveyance of the air expelled by said fan (72) towards said at least one compartment (10), said first duct (40a-40g) and said second duct (40a-40g) being joined at a partition wall (40.1-40.5);
- wherein, by considering a reference plane that is orthogonal to said rotation axis (Z) of the rotor (82) and by considering an orthogonal coordinate system
- 15 wherein:
- the origin (O1-O5) is the closest point of the partition wall (40.1-40.5) to said rotation axis (Z);
 - Y-axis is the line laying in said reference plane and drawn from said rotation axis (Z) towards said origin (O1-O5);
 - 20 - X-axis is the line laying in said reference plane and drawn from said origin (O1-O5) and perpendicular to said Y-axis;
- at least a portion of the cross-section of said partition wall (40.1-40.5) in said reference plane shows a concave upward curve (44b-44f) while moving from the origin (O1-O5) towards positive values of said X-axis following said direction of
- 25 rotation (D) of the rotor (82).
2. The appliance (1) according to claim 1, **characterized in that** said fan system (150) comprises a first opening (102a-102g) between said first duct (40a-40g) and said at least one compartment (10) and a second opening (102a-102g)
- 30 between said second duct (40a-40g) and said at least one compartment (10) allowing the conveyance of the air expelled by said fan (72) towards said at least one compartment (10).
3. The appliance (1) according to claim 1 or 2, **characterized in that** said fan system (150) comprises more than two ducts (40a-40g), wherein at least two
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adjacent ducts of said ducts (40a-40g) define said first duct (40a-40g) and said second duct (40a-40g).

4. The appliance (1) according to any preceding claim, **characterized in that**
5 said rotor (82) comprises at least one blade (BL) having a leading edge (Le), a trailing edge (Te) and a chord line (CL), wherein the distance (d1-d5) between said origin (O1-O5) and the circumference (C) determined by said trailing edge (Te) during rotation of said rotor (82) has a value higher than 0,5 times the length of said chord line (CL).

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5. The appliance (1) according to claim 4, **characterized in that** the distance (d1-d5) between said origin (O1-O5) and the circumference (C) determined by said trailing edge (Te) during rotation of said rotor (82) has a value lower than 2 times the length of said chord line (CL).

15

6. The appliance (1) according to any preceding claim, **characterized in that** said first duct (40a-40g), along said reference plane, comprises a first lateral wall (45a-45f) and a second lateral wall (46a-46f) defining a respective path wherein air flows and/or said second duct (40a-40g), along said reference plane,
20 comprises a first lateral wall (45a-45f) and a second lateral wall (46a-46f) defining a respective path wherein air flows.

7. The appliance (1) according to claim 6, **characterized in that** said first lateral wall (45a-45f) of said first duct (40a-40f) is provided upstream of the respective
25 second lateral wall (46a-46f) of the same first duct (40a-40f) and/or said first lateral wall (45a-45f) of said second duct (40a-40f) is provided upstream of the respective second lateral wall (46a-46f) of the same second duct (40a-40f), wherein the term upstream is considered with reference to said direction of rotation (D) of said rotor (82).

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8. The appliance (1) according to claim 6 or 7, **characterized in that** said concave upward curve (44b-44f) is defined in said first lateral wall (45a-45f).

9. The appliance (1) according to any claim 6 to 8, **characterized in that** said
35 first lateral wall (45a-45f) and said second lateral wall (46a-46f) of said duct get

closer in the direction of the air stream flow.

10. The appliance (1) according to any claim 6 or 9, **characterized in that** said second lateral wall (46a-46f) is shaped to follow the shape of said first lateral
5 wall (45a-45f).

11. The appliance (1) according to any preceding claim, **characterized in that** said first duct (40a-40g) and said second duct (40a-40g) are realized in a first layer (70) receiving said fan (72).
10

12. The appliance (1) according to claim 11, **characterized in that** said first layer is a layer (70) of expanded polystyrene.

13. The appliance (1) according to any preceding claim, **characterized in that** said fan system (150) comprises a fan assembly (50), preferably a pre-assembled assembly (50).
15

14. The appliance (1) according to claim 13, **characterized in that** said refrigeration system (30) comprises an evaporator (38) to cool down air for said at least one compartment (10), said evaporator (38) being arranged inside said at least one compartment (10) at a first wall (24) thereof, said fan assembly (50) being arranged inside said at least one compartment (10) and associated to said evaporator (38) for generating a cooling air stream for said at least one compartment (10);
20

25 wherein said fan assembly (50) comprises, arranged side by side:

- a first layer (70) of expanded polystyrene;
- said fan (72) comprising said rotor (82);
- a cover plate (76);

and wherein said fan assembly (50) comprises a fastening device (90) apt to fasten said cover plate (76) to said first layer (70) to keep said fan assembly (50) in the assembled configuration.
30

15. The appliance (1) according to claim 14, **characterized in that** said first layer (70) comprises said at least a first duct (40a-40g) and at least a second duct (40a-40g) and said cover plate (76) comprises one or more air opening (102a-
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102g) communicating with said first duct (40a-40g) and said second duct (40a-40g) when the fan assembly (50) is assembled.

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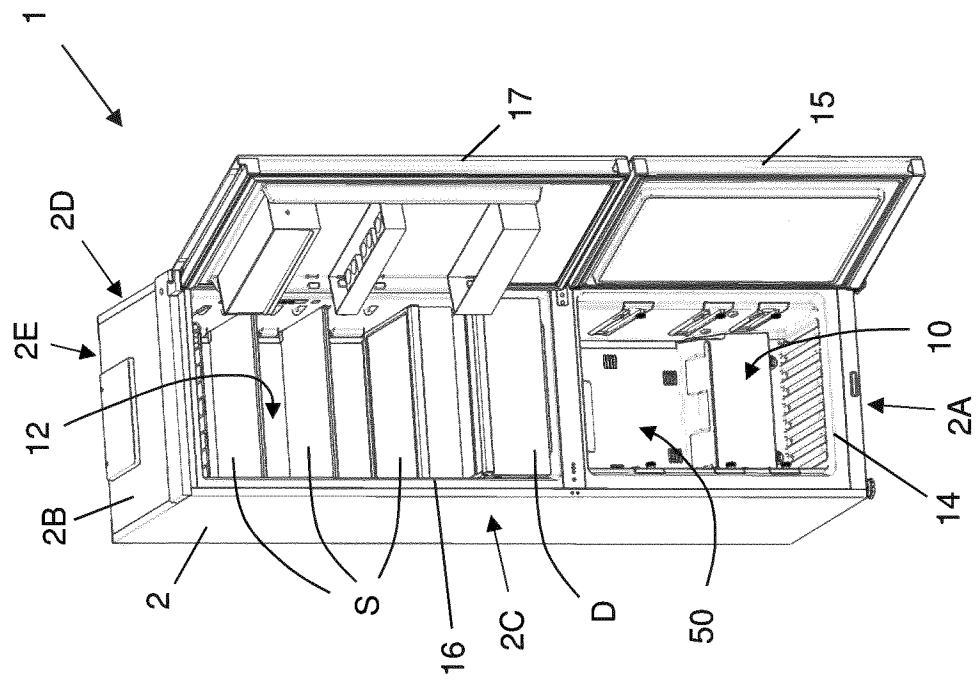


FIG. 2

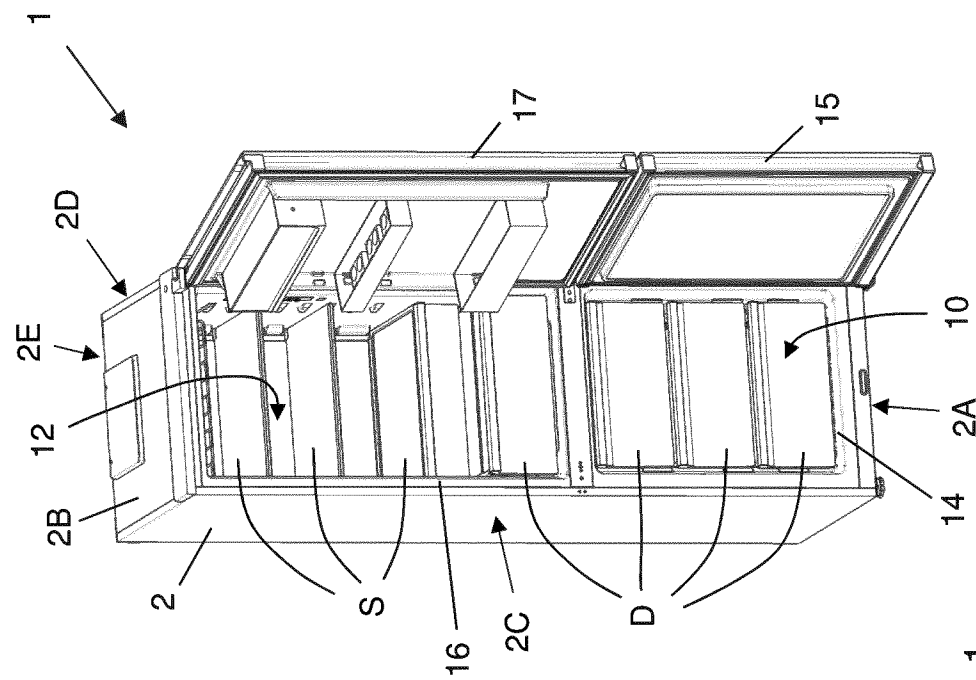


FIG. 1

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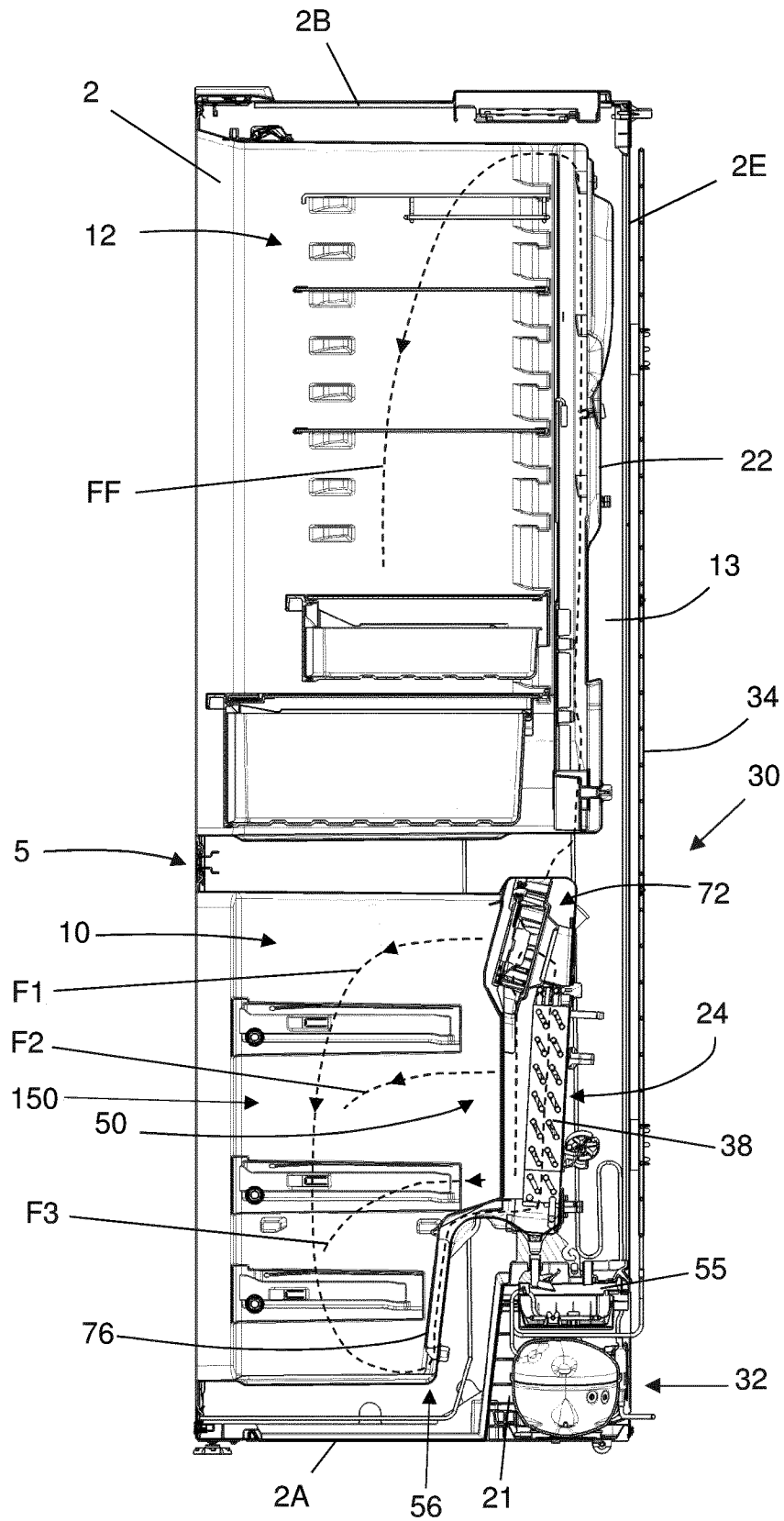


FIG. 3

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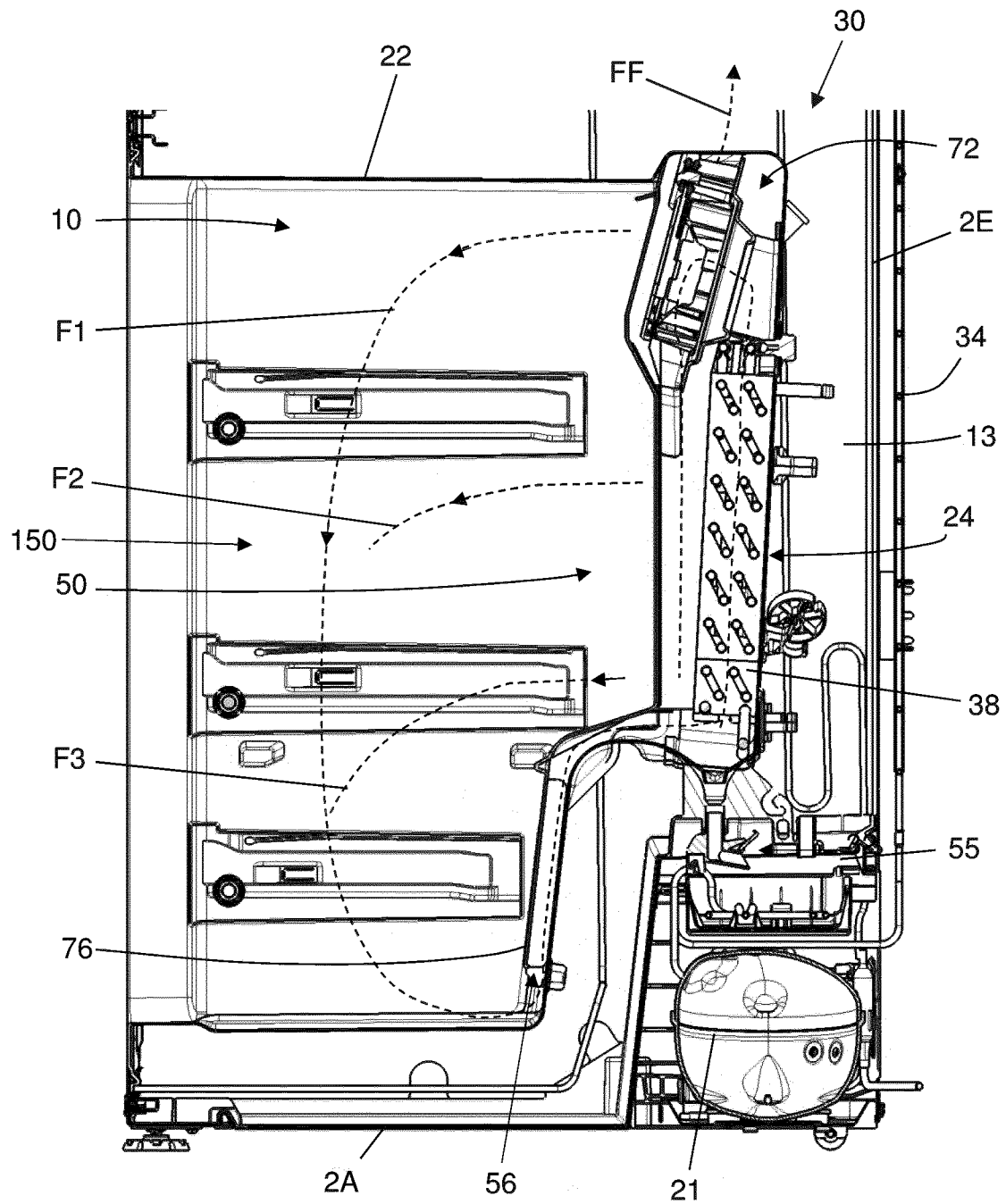


FIG. 3A

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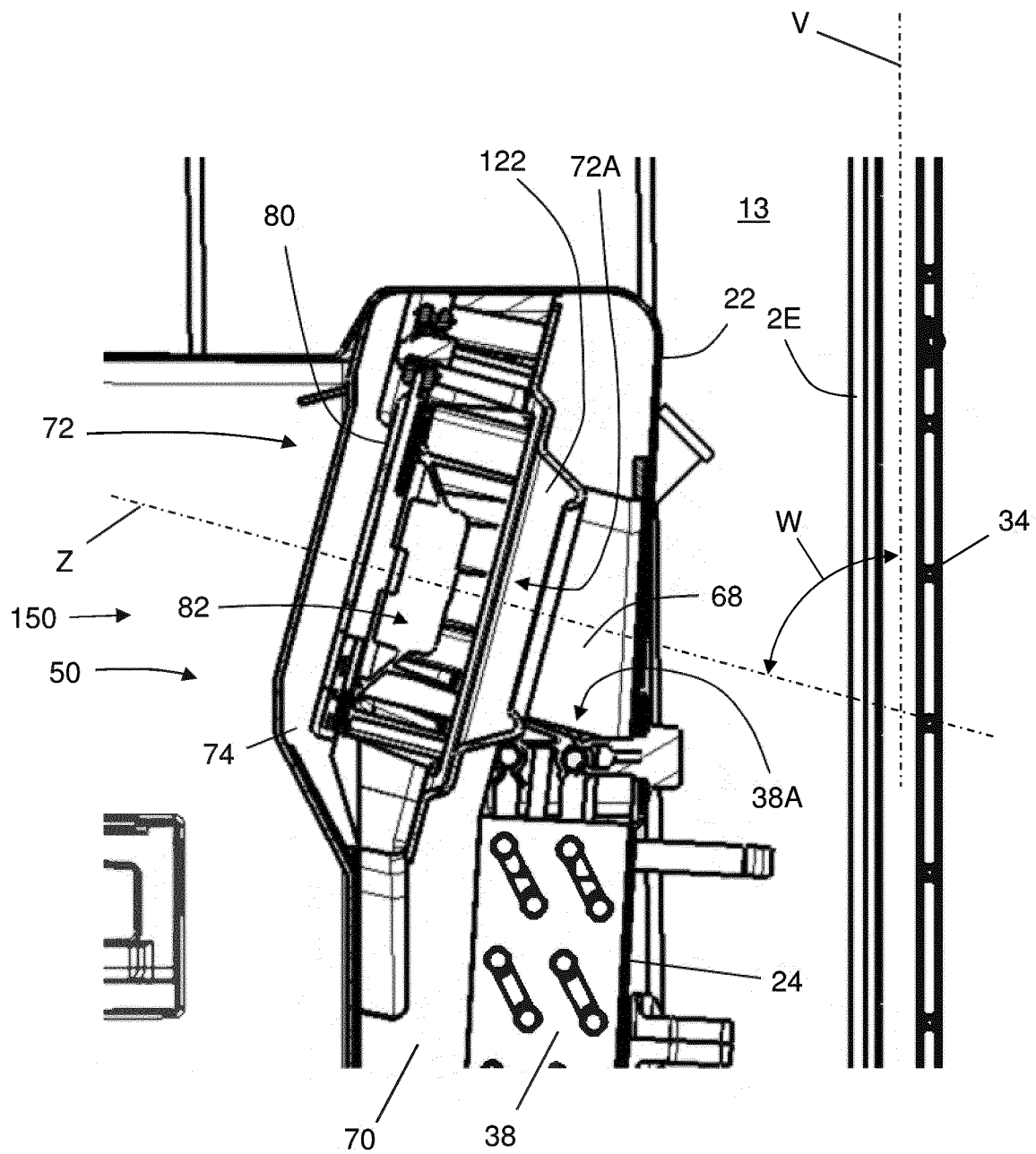
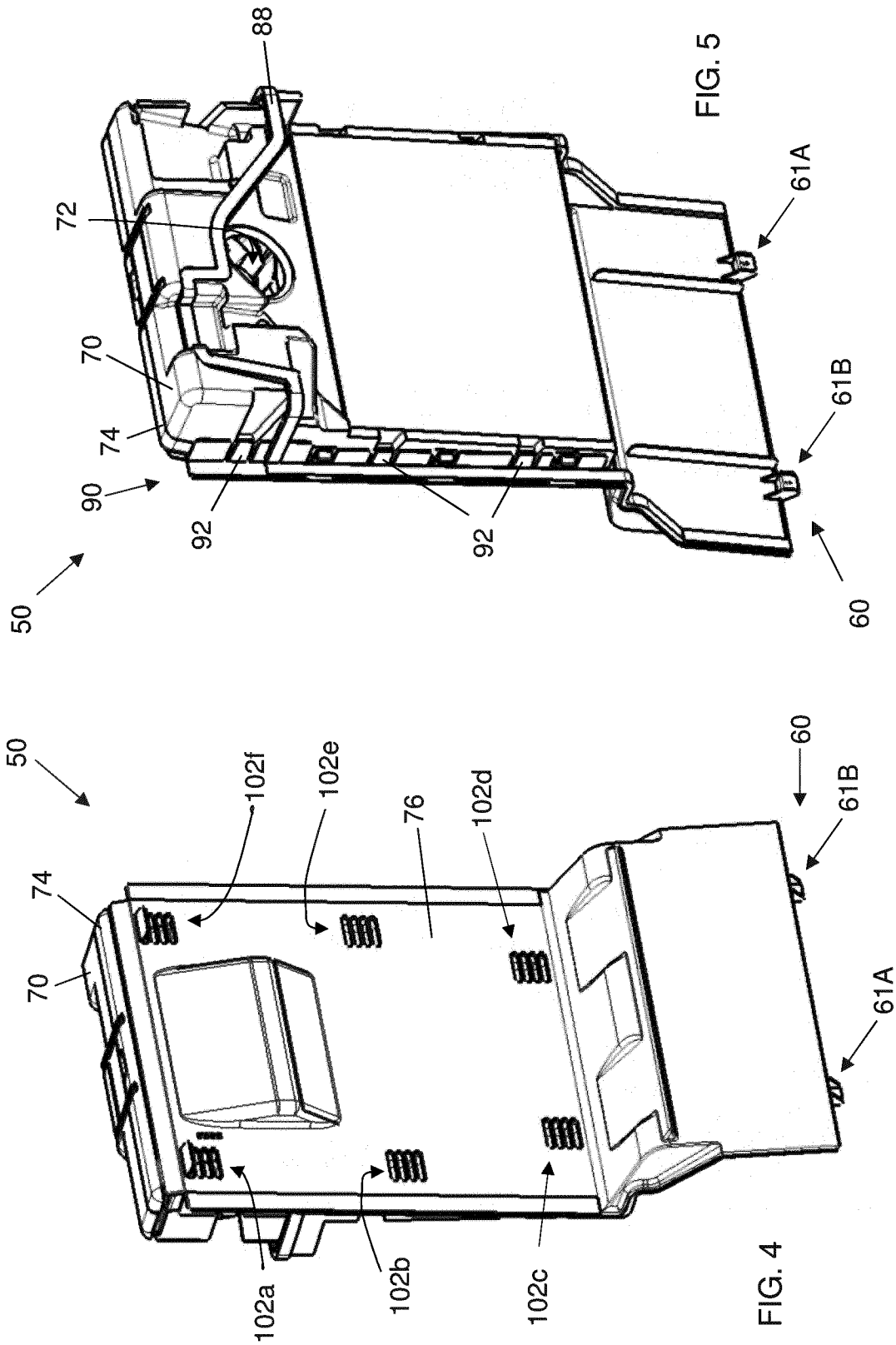


FIG. 3B



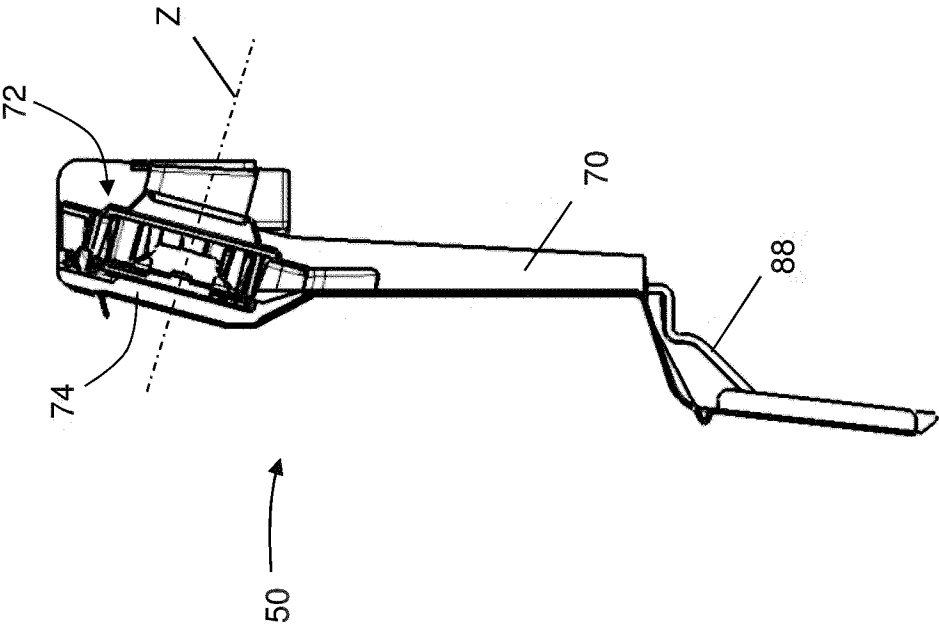


FIG. 6

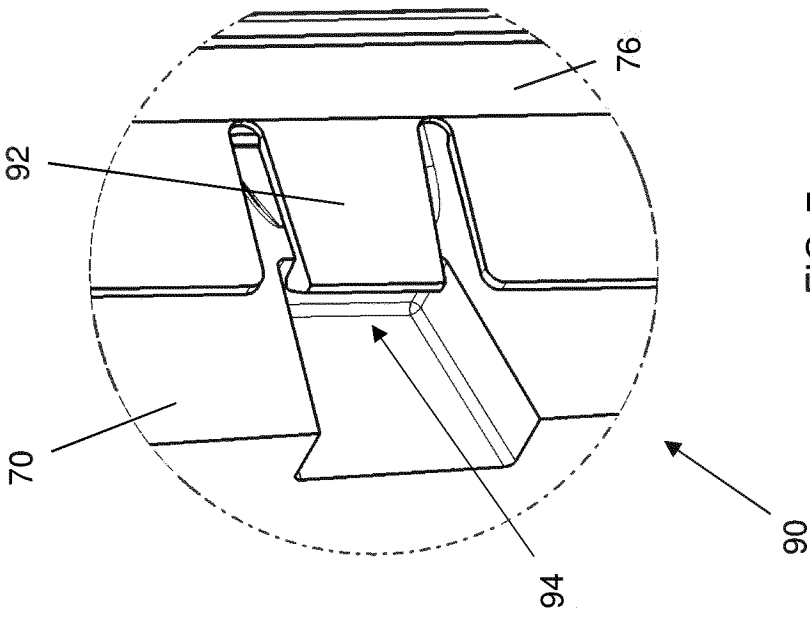


FIG. 7

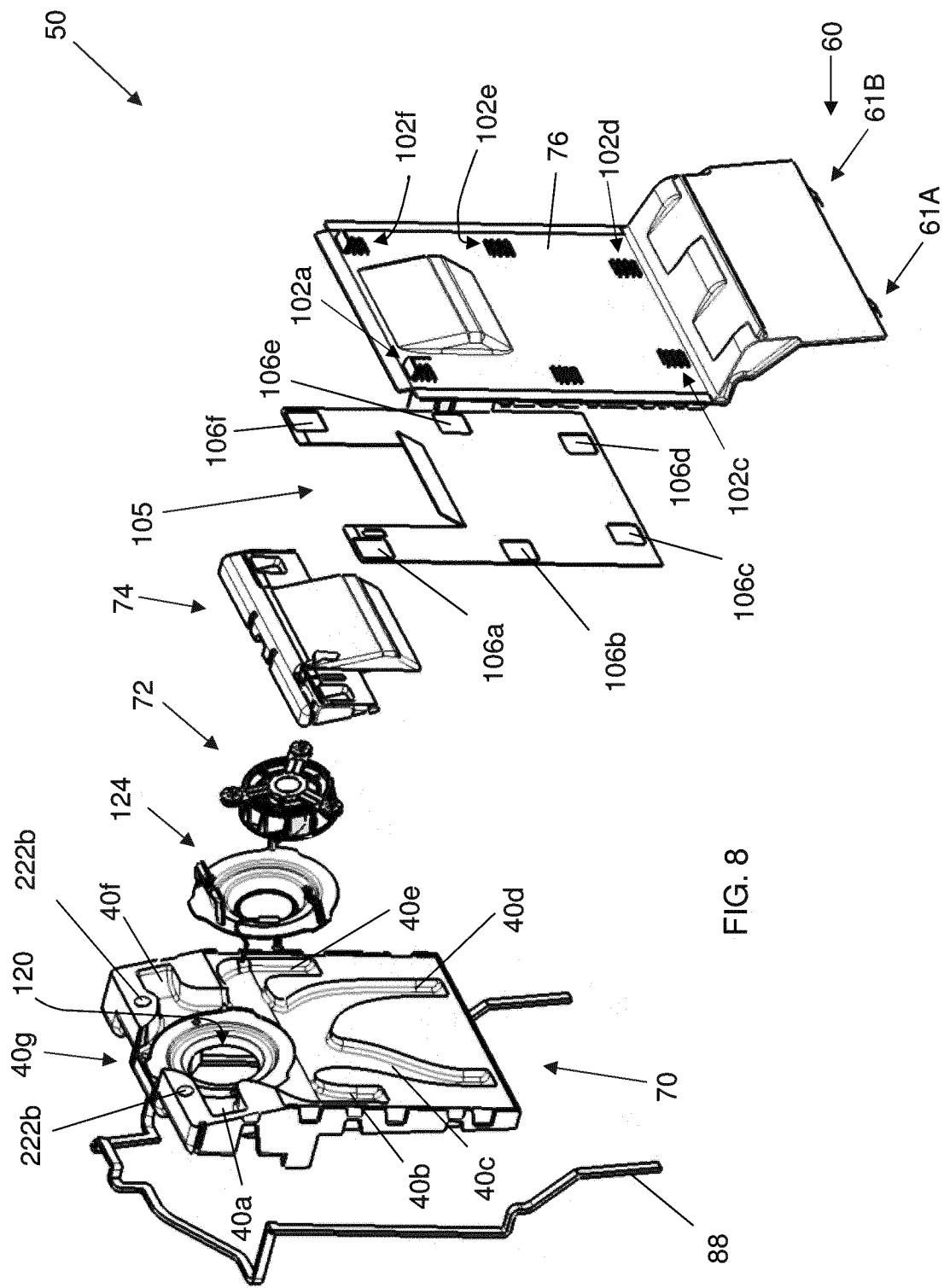


FIG. 8

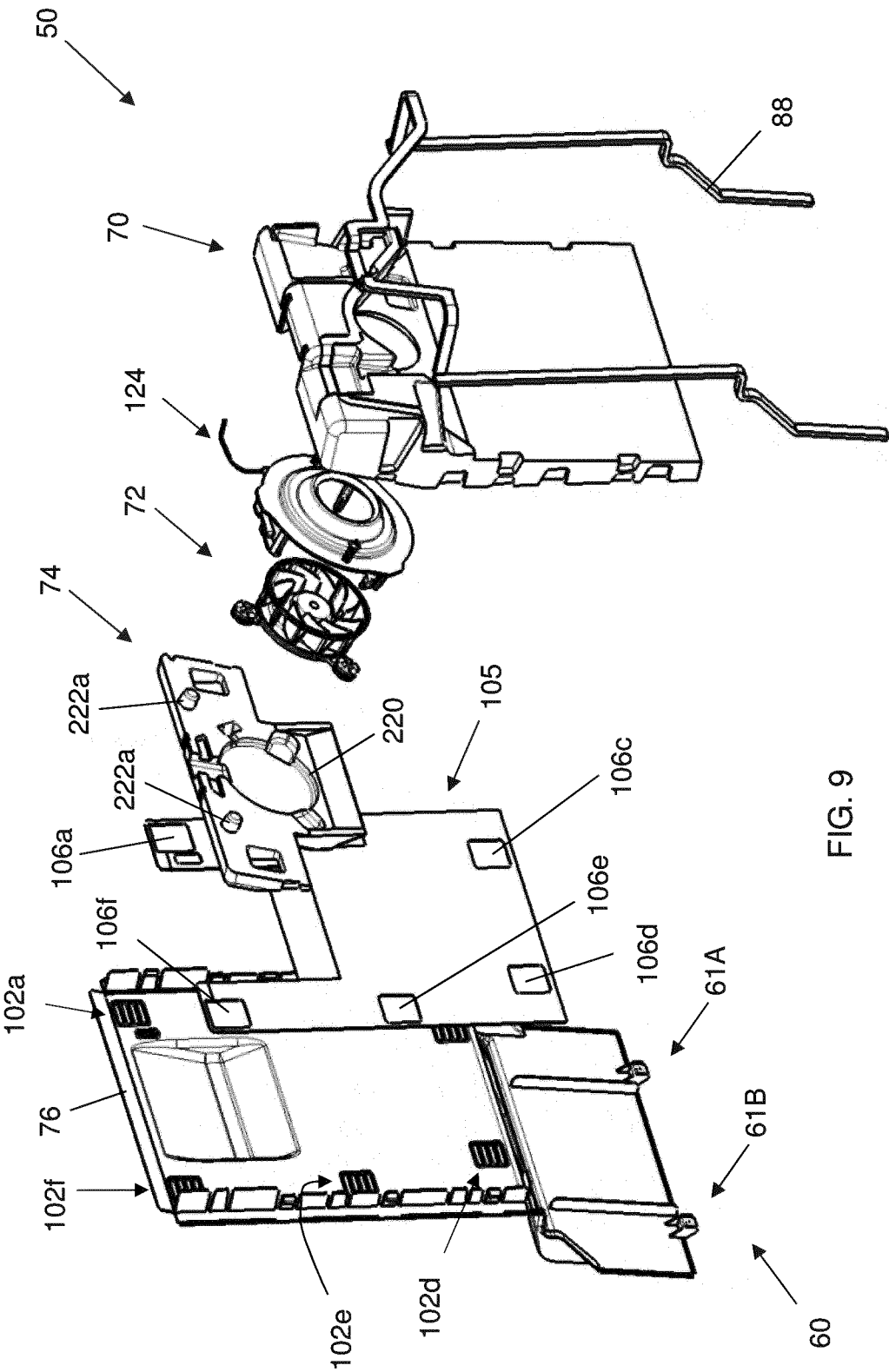


FIG. 9

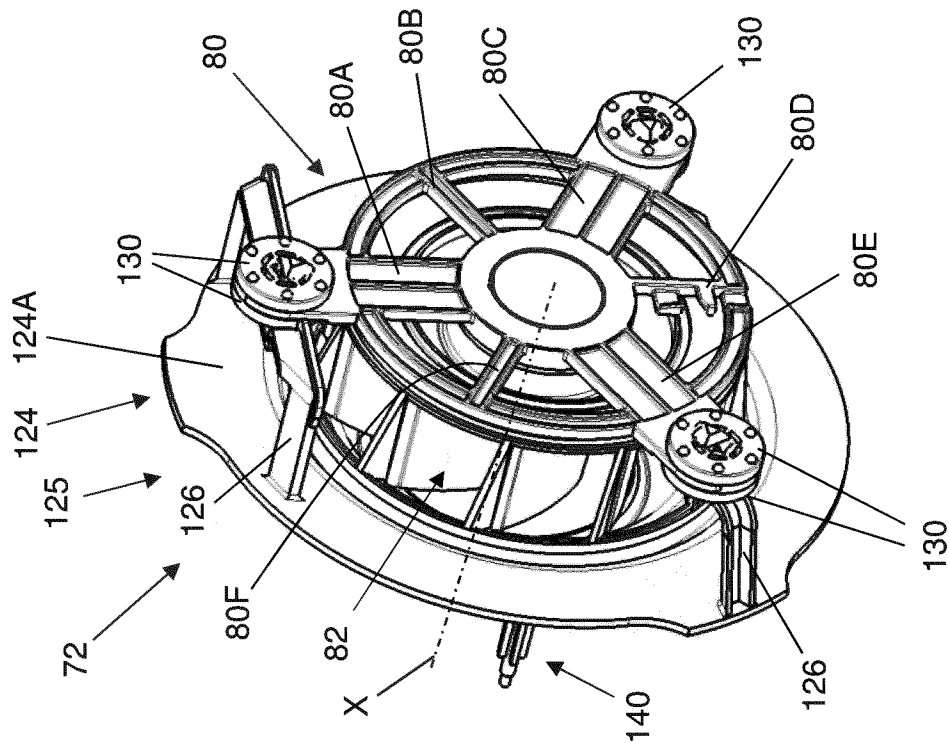


FIG. 11

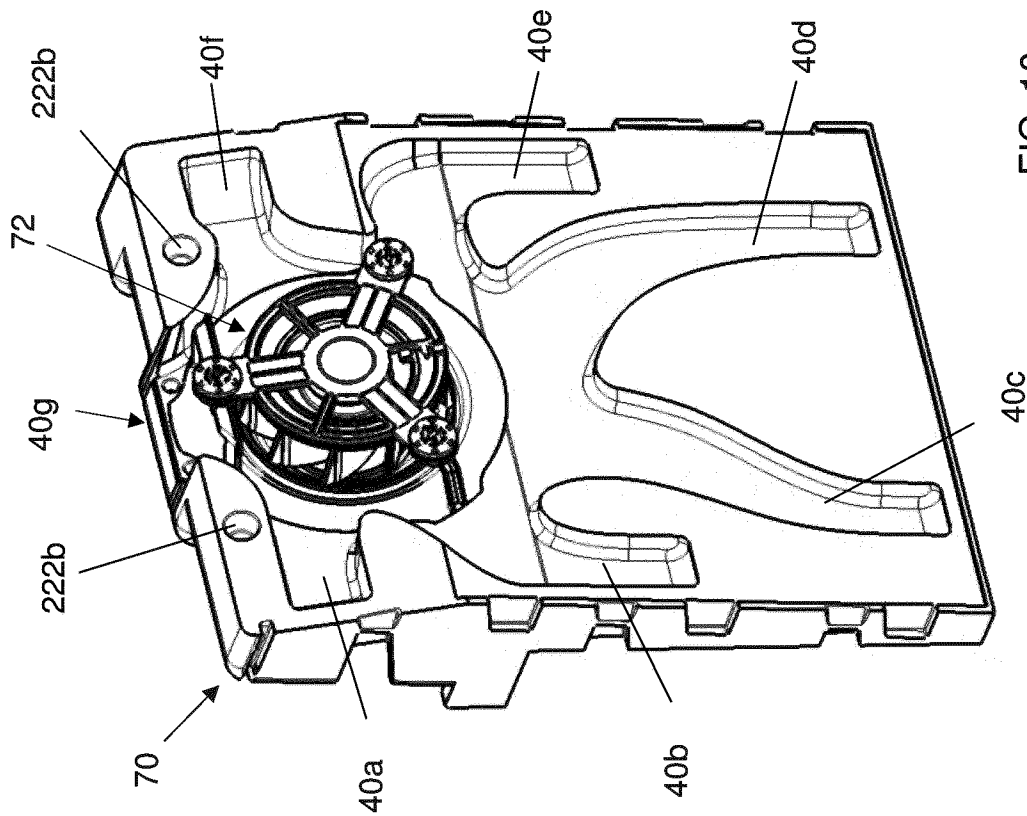


FIG. 10

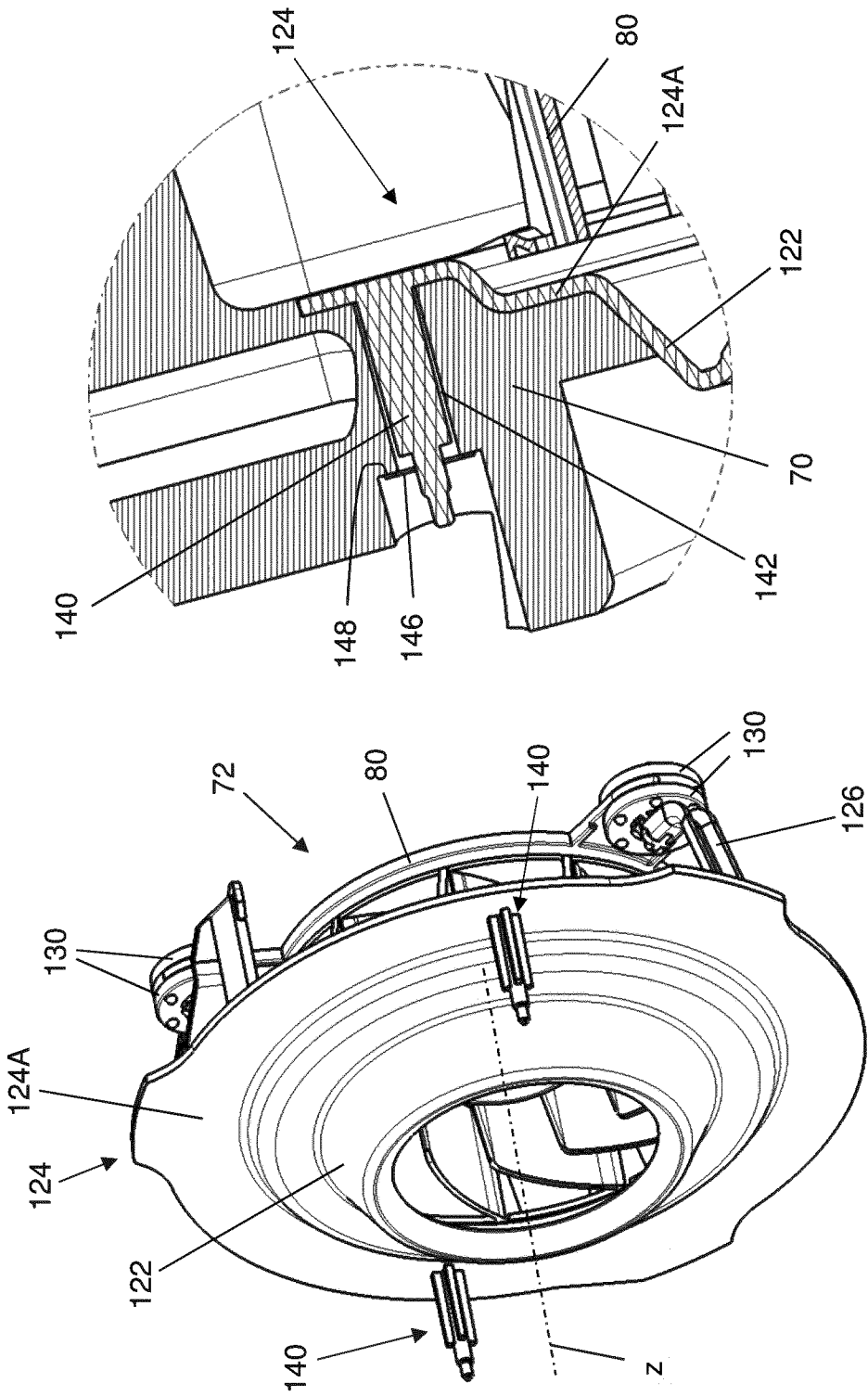


FIG. 13

FIG. 12

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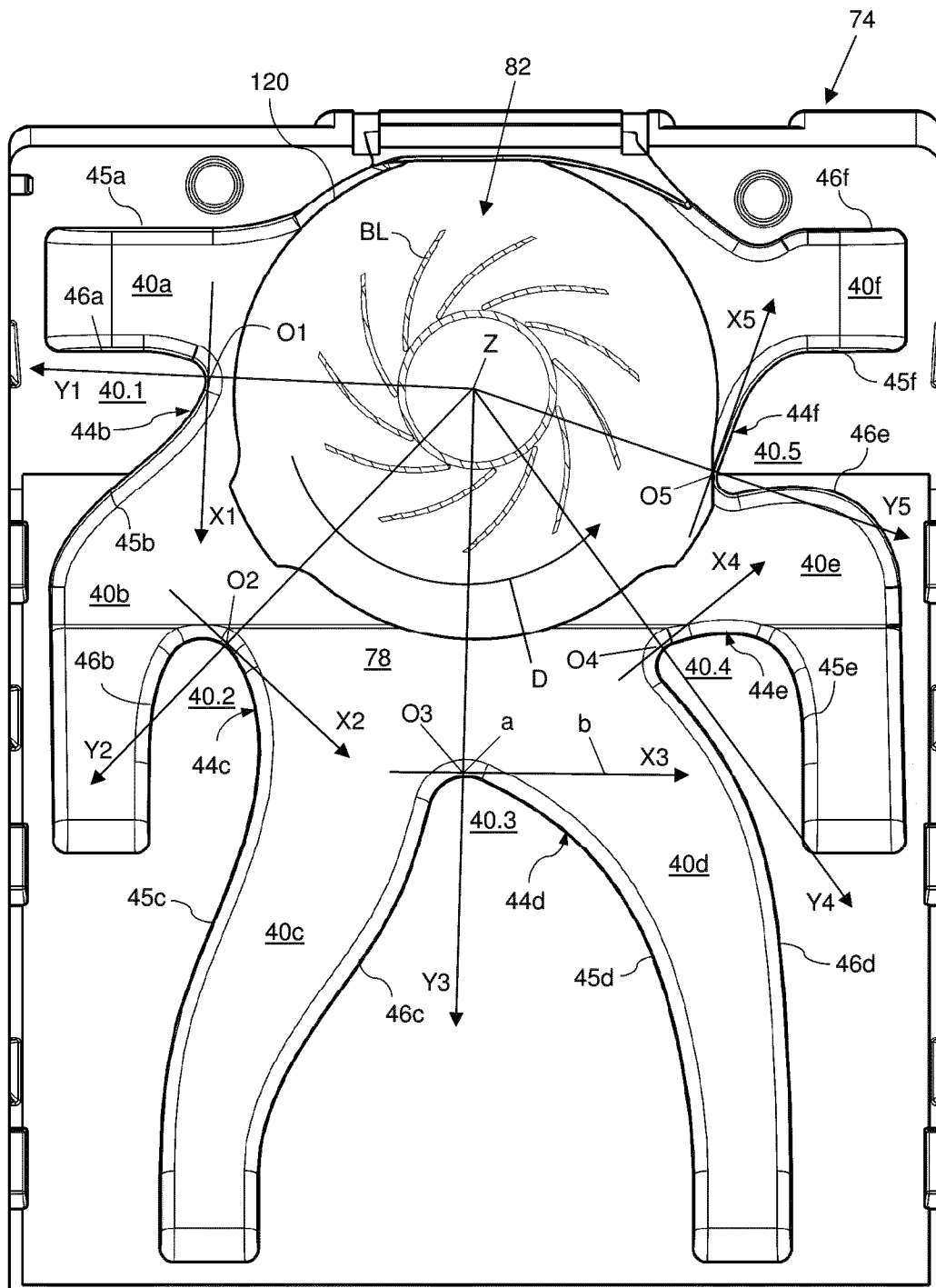


FIG. 14

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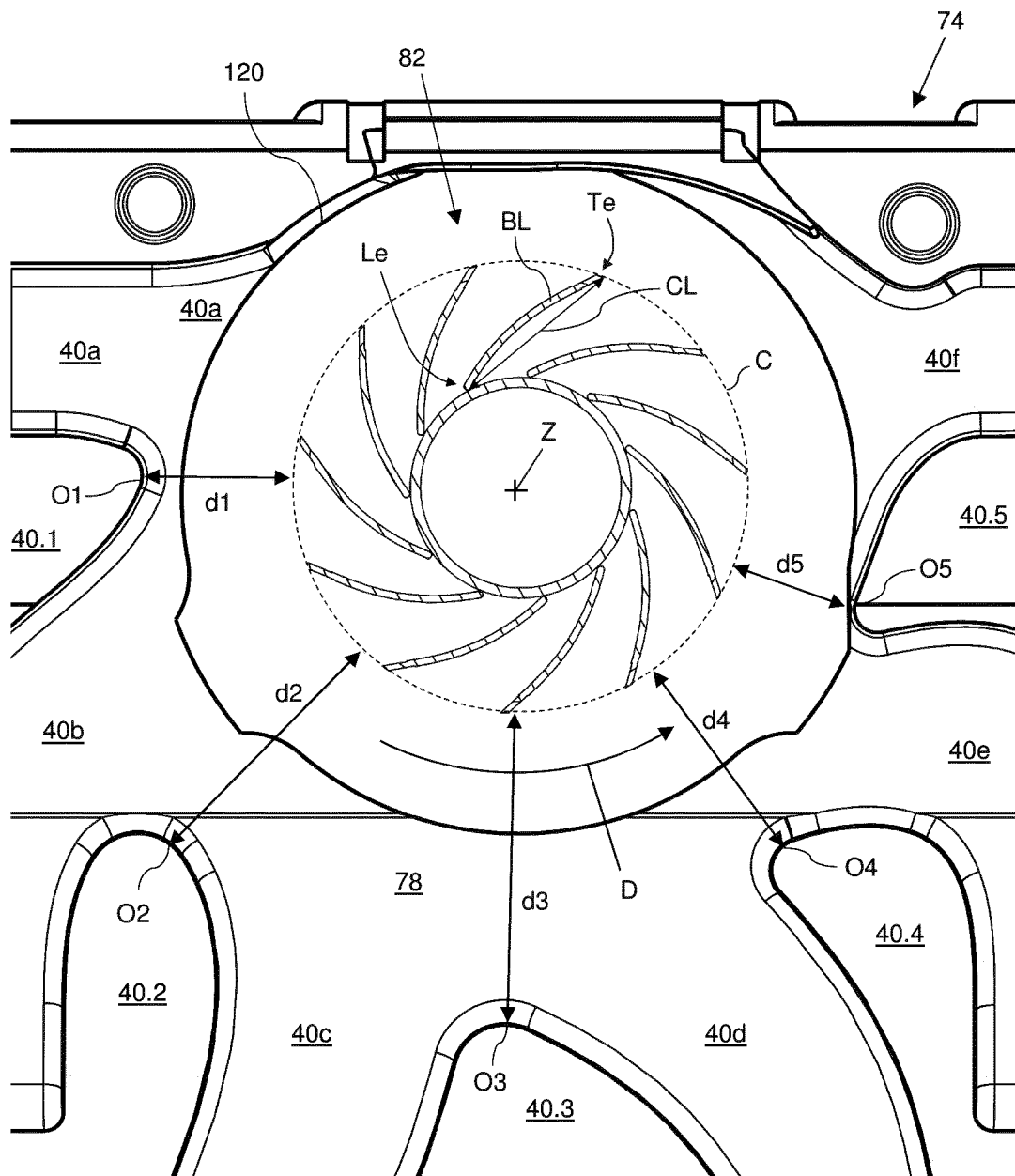


FIG. 15

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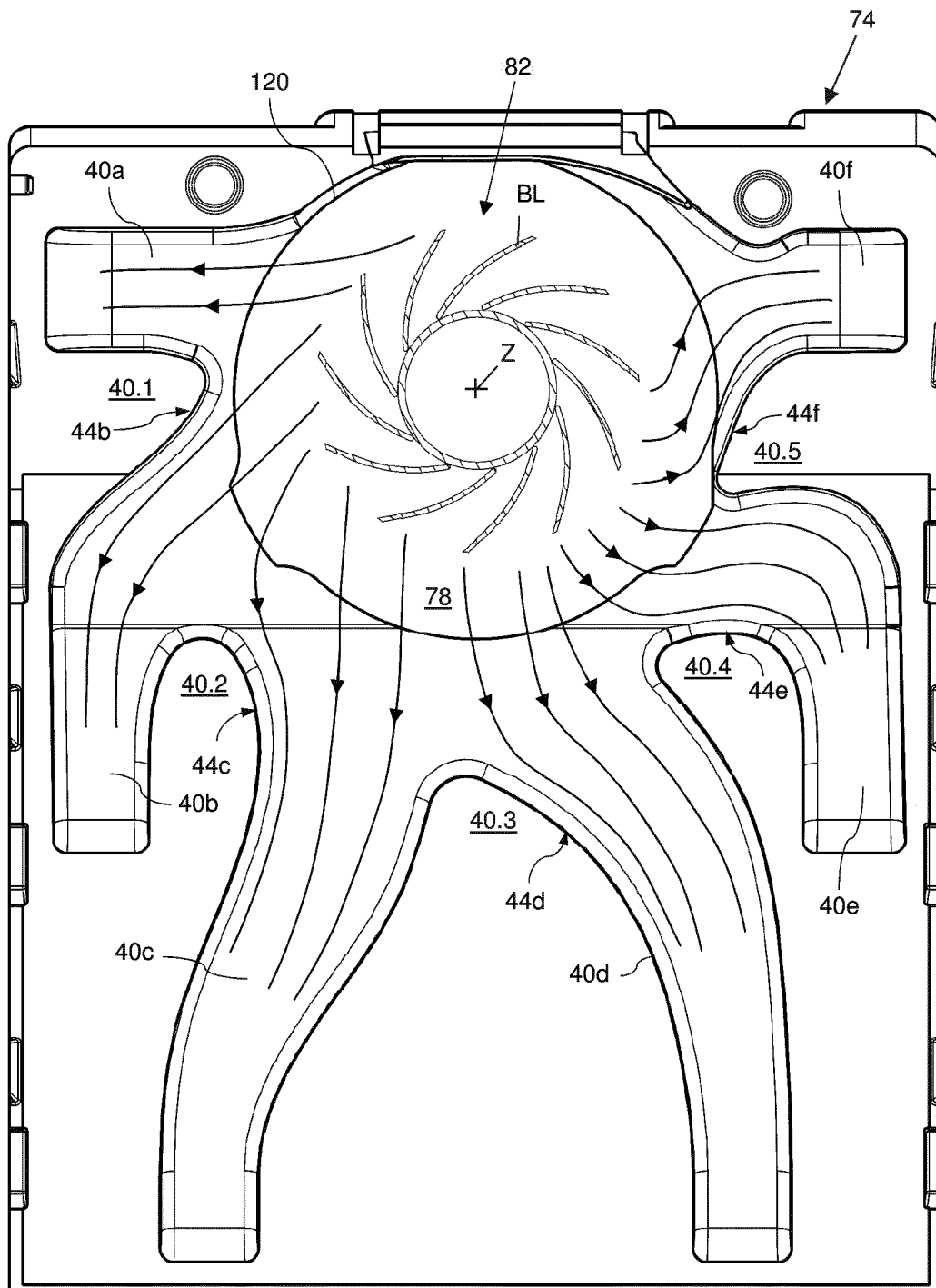


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/055001

A. CLASSIFICATION OF SUBJECT MATTER
INV. F25D17/06
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 A	US 2019/368800 A1 (CHENG XUELI [CN] ET AL) 5 December 2019 (2019-12-05) figures 1,3,4	1-3, 6-11,13 4,5,12, 14,15
X	----- CN 107 388 702 B (HEFEI HUALING CO LTD; HEFEI MIDEA REFRIGERATOR CO; MIDEA GROUP CO LTD) 6 December 2019 (2019-12-06) the whole document	1
X	----- KR 2001 0011784 A (LG ELECTRONICS INC [KR]) 15 February 2001 (2001-02-15) the whole document	1
A	----- CN 106 958 973 A (HEFEI MEILING CO LTD) 18 July 2017 (2017-07-18) figure 1	1
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search

3 May 2021

Date of mailing of the international search report

25/05/2021

Name and mailing address of the ISA/

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Authorized officer

de Graaf, Jan Douwe

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/055001

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2021/055001

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