(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 253 762 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.10.2023 Bulletin 2023/40

(21) Application number: **23164592.0**

(22) Date of filing: **28.03.2023**

(51) International Patent Classification (IPC):
F04D 29/42 *(2006.01)* ***F24F 7/06*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04D 29/4226; F24F 7/06

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **28.03.2022 BE 202205219**

(71) Applicant: **Vero Duco N.V.**
8630 Veurne (BE)

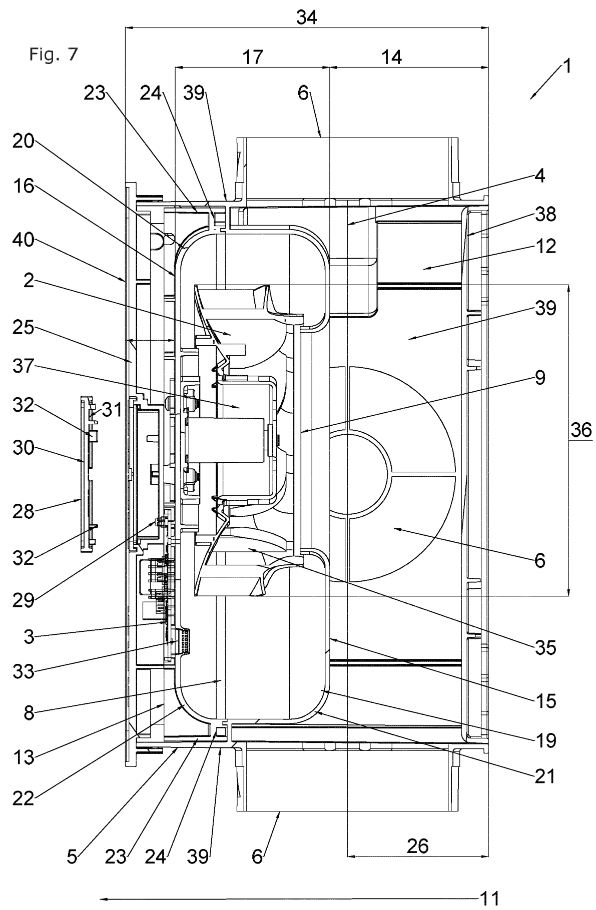
(72) Inventors:
- **RENSON, Luc Louis**
  8630 Veurne (BE)
- **DEPOTTER, Waldo**
  8630 Veurne (BE)
- **VANDAMME, Anthonie**
  8630 Veurne (BE)

(74) Representative: **Brantsandpatents bv**
Pauline Van Pottelsberghelaan 24
9051 Ghent (BE)

(54) **VENTILATION UNIT WITH OPTIMIZED COMPONENT PLACEMENT**

(57) The current invention relates to a ventilation unit, comprising a fan and a housing, wherein the housing comprises at least one connection opening for a supply duct, one connection opening for a discharge duct and a volute, wherein the volute is placed in the housing transversely to a height direction of the housing, whereby a first chamber and a second chamber are formed, where the first chamber is located on a first side and the second chamber is located on a second side of the volute, wherein connection openings for supply ducts open into the first chamber, wherein a ratio of a height of the first chamber to a height of the volute is at most 1.1, a ratio of the height of the first chamber to a height of the second chamber is at most 4, and a ratio of the height of the first chamber to a diameter of the fan is at least 0.39. The invention also relates to a method and a use.

Fig. 7



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Description

TECHNICAL FIELD

[0001] The invention relates to a ventilation unit for mechanical extraction of air, more specifically for a System C ventilation, with optimized component placement. The invention also relates to a method for assembling the ventilation unit and a use for installing a ventilation system above a false ceiling or behind a false wall.

PRIOR ART

[0002] Such a ventilation unit is known, inter alia, from NL 1 038 209. NL ’209 describes a central ventilation system comprising a ventilation element provided with a fan and a fan housing provided with openings. The ventilation unit is suitable for System C ventilation.

[0003] This known ventilation unit has the disadvantage that the fan housing is very high. This makes it difficult to build in the ventilation unit. A considerable volume is required in, for example, an equipment room of a home to place the ventilation unit. As a result, this ventilation unit is not suitable for installation in compact homes or in homes being renovated and where there was no room for a ventilation system.

[0004] Other known ventilation units are described in FR 3 072 158, FR 3 043 760 and EP 2 743 597. All these ventilation units also have a high ventilation housing that makes building them in difficult.

[0005] The present invention aims to solve at least some of the above problems or drawbacks.

SUMMARY OF THE INVENTION

[0006] In a first aspect, the present invention relates to a ventilation unit according to claim 1.

[0007] A ventilation unit according to claim 1 is advantageous because a first chamber and a second chamber are formed in the housing, wherein the ratio of the height of the first chamber to the height of the volute and the ratio of the height of the first chamber to the height of the second chamber are limited to a maximum value, resulting in a ventilation unit with a limited height. Due to the limited height, the ventilation unit is easy to build in, even in compact homes or homes being renovated and where originally there was no room for a ventilation system. Because a minimum value is also determined for the ratio of the height of the first chamber to the diameter of the radial fan, optimum operation of the ventilation unit is ensured. The limited height of the ventilation unit does not reduce the mechanical extraction of air, which would lead to sub-optimal operation of the ventilation unit.

[0008] Preferred embodiments of the ventilation unit are shown in claims 2-9.

[0009] A specific preferred form concerns a device according to claim 2.

[0010] This preferred form is advantageous because the first curvature and the second curvature ensure optimal airflow in the volute. Additionally advantageous is that the volute is recessed on the second side between the frame and the second curvature, allowing the second chamber to be extended without increasing the height of the second chamber. The surface that connects the second curvature and the frame is suitable for mounting, for example, a control board or other additional components.

[0011] In a second aspect, the present invention relates to a method according to claim 10.

[0012] This method has the advantage, among other things, that a ventilation unit can be assembled in a simple manner, which has a limited height, making the ventilation unit suitable for building in in compact homes or homes being renovated and where originally there was no room for a ventilation system, while respecting a minimum value for the ratio of the height of the first chamber to the diameter of the radial fan ensures optimum operation of the ventilation unit.

[0013] Preferred forms of the method are described in dependent claims 11-14.

[0014] In a third aspect, the present invention relates to a use according to claim 15.

[0015] This use results in an advantageous installation of a ventilation system above a false ceiling or behind a false wall. A ventilation system comprises a central ventilation unit and a system of air ducts. Compared to the height of the central ventilation unit, an air duct has a limited diameter and therefore poses no problem to be built in behind a false ceiling or behind a false wall, such as a wall of a wall hung toilet. However, a traditional central ventilation unit has a considerable height, so it is often not possible to build the traditional ventilation unit in above a false ceiling or behind a false wall, as this would lower the ceiling too much or a space, such as a toilet or a storage space, would become too small. By using a ventilation unit according to the first aspect and/or a method according to the second aspect, a ventilation unit with a limited height is available, which can be built in above the false ceiling or behind the false wall, without significantly lowering the ceiling or reducing a space, such as a toilet or storage space, too much. This is particularly advantageous for use in compact homes or homes being renovated and where originally there was no room for a ventilation system.

DESCRIPTION OF THE FIGURES

[0016]

Figure 1 shows an exploded view of a ventilation unit according to an embodiment of the present invention.

Figure 2 shows a front view of a ventilation unit according to an embodiment of the present invention.

Figure 3 shows a right side view of a ventilation unit according to an embodiment of the present invention.

Figure 4 shows a left side view of a ventilation unit according to an embodiment of the present invention.

Figure 5 shows a bottom view of a ventilation unit according to an embodiment of the present invention.

Figure 6 shows a top view of a ventilation unit according to an embodiment of the present invention.

Figure 7 shows a cross-sectional view of a ventilation unit according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0017] Unless otherwise defined, all terms used in the description of the invention, including technical and scientific terms, have the meaning as commonly understood by a person skilled in the art to which the invention pertains. For a better understanding of the description of the invention, the following terms are explained explicitly.

[0018] In this document, "a" and "the" refer to both the singular and the plural, unless the context presupposes otherwise. For example, "a segment" means one or more segments.

[0019] The terms "comprise", "comprising", "consist of", "consisting of", "provided with", "include", "including", "contain", "containing", are synonyms and are inclusive or open terms that indicate the presence of what follows, and which do not exclude or prevent the presence of other components, characteristics, elements, members, steps, as known from or disclosed in the prior art.

[0020] Quoting numerical intervals by endpoints comprises all integers, fractions and/or real numbers between the endpoints, these endpoints included.

[0021] In the context of this document, System C ventilation is a ventilation system for mechanically extracting dirty air present in a building. Unlike System D ventilation, the ventilation system does not mechanically blow fresh air into the building.

[0022] In a first aspect, the invention relates to a ventilation unit for mechanical extraction of air.

[0023] According to a preferred embodiment, the ventilation unit comprises a radial fan, a control board, a power supply, and a housing.

[0024] The radial fan comprises an impeller and a motor for driving the impeller. The motor comprises a motor shaft. The motor is preferably a brushless DC motor. This is advantageous for easy driving of the motor, while the lack of brushes means that the motor requires little or no maintenance and has a long service life. The impeller is mounted on the motor shaft. The motor is placed on a first side of the impeller. The motor may be partially positioned in the impeller. A second side of the impeller, axially opposite the first side, is open. This is advantageous for the axial intake of air in an active state of the radial fan. The impeller has backward curved blades. This means that the blades are curved in a direction that is opposite to a direction in which the impeller rotates in the active state. For example, if the impeller rotates clockwise in the active state, then the blades are curved counterclockwise. The backward curved blades blow the axially drawn air radially out in the active state. Backward curved blades are advantageous because radial fans with backward curved blades are more energetically efficient than radial fans with forward curved blades. This is particularly advantageous for a ventilation unit that is in continuous or almost continuous operation. Backward curved blades have the disadvantage compared to forward curved blades that generating an equal pressure requires a larger diameter for the impeller or a higher rotational speed. A higher rotational speed is accompanied by a higher noise production, which is why a larger diameter for the impeller is usually opted for. In the context of this document, a diameter of a radial fan is determined by the diameter of the impeller.

[0025] The housing is preferably a substantially beam-shaped housing. The housing comprises a bottom, four side walls and a top wall. The housing comprises at least one connection opening for a supply duct. A supply duct is a duct for supplying air to the ventilation unit. A supply duct is therefore a duct through which air is extracted from a room of a building and fed into the ventilation unit. The housing preferably comprises at least two connection openings for supply ducts, more preferably at least three connection openings and even more preferably at least four connection openings. Most preferably, the housing has four connection openings for supply ducts. The ventilation unit preferably comprises caps for closing connection openings for supply ducts. This is advantageous for closing unused connection openings for supply ducts. Connection openings for supply ducts are preferably arranged in side walls of the housing. The housing comprises one connection opening for a discharge duct. A discharge duct is a duct for exhausting air from the ventilation unit. A discharge duct is therefore a duct through which air is discharged from the ventilation unit out of the building. The connection opening for the discharge duct is preferably located in a side wall of the housing.

[0026] The housing comprises a volute. The volute comprises a suction opening for sucking air into the volute and a discharge opening for discharging air from the volute. The suction opening is located in a side wall of the volute. The suction opening is transverse to an axial direction of the volute. The discharge opening is transverse to a tangential direction to the volute. The radial fan is placed opposite the suction opening in the volute. The second side of the impeller faces the suction opening in the volute. As a result, air in the active state is sucked axially into the volute and into the radial fan, radially out of the fan and tangentially discharged from the volute. The discharge opening of the volute is connected to the connection opening for the discharge duct. The discharge opening is, for instance, connected to the discharge duct by means of an optionally flexible tube. The discharge opening of the volute preferably connects to the connection opening for the discharge duct.

[0027] The volute is placed in the housing transversely to a height direction of the housing, whereby a first chamber and a second chamber are formed in the housing. The height direction is a direction transverse to the bottom of the housing. The first chamber is located on a first side of the volute. The first chamber is bounded by the bottom and the side walls of the housing and the first side of the volute. The first chamber is preferably a volume that is as empty as possible. The second chamber is located on a second side of the volute, opposite in the height direction. The second chamber is bounded by the top wall and side walls of the housing and the second side of the volute. Connection openings for supply ducts and the suction opening of the volute open into the first chamber. The control board is placed in the second chamber. The control board comprises the necessary electronic circuits for controlling the radial fan.

[0028] The power supply may or may not be placed in the first chamber. The power supply supplies the control board with electrical power. Optionally, the ventilation unit comprises an additional power supply for supplying the radial fan with power. Preferably there is only a single power supply that supplies both the control board and the radial fan and any additional components with electrical power.

[0029] A ratio of a height of the first chamber to a height of the volute is at most 1.1. The height of the first chamber is measured according to the height direction of the housing. The height of the first chamber is measured from the bottom of the housing, adjacent to the first chamber, to the first side of the volute. This does not mean that the first chamber cannot extend higher than the first side of the volute from the bottom. The first chamber may possibly extend higher along part of the volute. However, the height of the first chamber is mainly limited up to the first side of the volute. The height of the volute is measured according to the height direction of the housing from the first side of the volute to the second side of the volute.

[0030] Preferably, the ratio of the height of the first chamber to the height of the volute is at most 1.08, more preferably at most 1.06, even more preferably at most 1.04 and even more preferably at most 1.02.

[0031] Preferably, the ratio of the height of the first chamber to the height of the volute is at least 0.76, more preferably at least 0.78, even more preferably at least 0.80, and even more preferably at least 0.82.

[0032] A ratio of the height of the first chamber to a height of the second chamber is at most 4. The height of the second chamber is measured according to the height direction of the housing from the second side of the volute to the top wall of the housing adjacent to the second chamber.

[0033] Preferably, the ratio of the height of the first chamber to the height of the second chamber is at most 3.8, more preferably at most 3.6, even more preferably at most 3.5 and even more preferably at most 3.4.

[0034] Preferably, the ratio of the height of the first chamber to the height of the second chamber is at least 2.7, more preferably at least 2.9, even more preferably at least 3.1 and even more preferably at least 3.3.

[0035] A ratio of the height of the first chamber to the diameter of the radial fan is at least 0.39. It will be apparent to one skilled in the art that the height of the first chamber and the diameter of the radial fan are expressed in the same unit when determining the ratio.

[0036] Preferably, the ratio of the height of the first chamber to the diameter of the radial fan is at least 0.40, more preferably at least 0.41, even more preferably at least 0.42 and even more preferably at least 0.43.

[0037] Preferably, the ratio of the height of the first chamber to the diameter of the radial fan is at most 0.54, more preferably at most 0.53, even more preferably at most 0.52 and even more preferably at most 0.51.

[0038] A radial fan with backward curved blades requires a larger first chamber compared to a radial fan with forward-facing blades to efficiently draw a given volume of air. This is disadvantageous for obtaining a ventilation unit with a limited height. The applicant established that there is a relationship between the diameter of the radial fan with backward curved blades and a minimum height required for the first chamber to efficiently draw in a given volume of air. This relationship is a ratio of the height of the first chamber to the diameter of the radial fan of at least 0.39. By approximating this ratio as closely as possible, the height of the first chamber and therefore of the ventilation unit is as limited as possible.

[0039] Compared to a radial fan with forward-facing blades, a radial fan with backward curved blades needs a larger diameter impeller to build up a certain pressure. In addition to a certain diameter, the radial fan needs a certain height for the volute in order to be able to suck in and discharge a certain volume of air. Preferably, the height of the volute is as small as possible in order to limit the height of the housing. The applicant determined that, for a given diameter of the radial fan and the previously defined ratio of the height of the first chamber to the diameter of the radial fan, a ratio of the height of the first chamber to the height of the volute of at most 1.1 is advantageous for obtaining a minimal height of the volute, whereby a certain volume of air can be efficiently drawn in.

[0040] The height of the second chamber is preferably as limited as possible in order to limit the height of the housing. A second chamber with a height that respects the ratio of the height of the first chamber to the height of the second chamber of at most 4 is sufficiently high to be able to place the control board in the second chamber. Components on the control board have sufficient free space.

[0041] A ventilation unit according to this embodiment has a limited height. Due to the limited height, the ventilation unit is easy to build in, even in compact homes or homes being renovated and where originally there was no room for a ventilation system. Because a minimum value is also determined for the ratio of the height of the first chamber to the diameter of the radial fan, optimum operation of the ventilation unit is ensured. The limited height of the ventilation unit does not reduce the mechanical extraction of air, which would lead to sub-optimal operation of the ventilation unit. A ventilation unit according to this embodiment is particularly suitable for System C ventilation.

[0042] According to a preferred embodiment, the volute is formed from two halves. The first side of the volute is in a first half. The second side of the volute is in a second half. A separation between the first half and the second half of the volute lies in a first plane transverse to the height direction of the housing.

[0043] The first half of the volute is curved from the first side of the volute with a first curvature to the separation. The first side of the volute is preferably parallel to the first plane. The first curvature preferably ends transverse to the first plane.

[0044] The second half of the volute is curved from the second side of the volute with a second curvature towards the separation. The second side of the volute is preferably parallel to the first plane. The second curvature preferably ends transverse to the first plane.

[0045] The first curvature and the second curvature preferably have a radius that is at least 5% of the diameter of the radial fan. The first curvature and the second curvature may have a different radius, but preferably have the same radius. A volute having a first curvature and a second curvature according to the present embodiment is advantageous for reducing or avoiding turbulence in corners of the volute near the first side and near the second side. This also reduces the noise level of a radial fan when it is in operation. The first curvature and the second curvature ensure optimal airflow in the volute.

[0046] Preferably the radius is at least 6% of the diameter of the radial fan, more preferably at least 7%, even more preferably at least 8% and even more preferably at least 9%.

[0047] Preferably the radius is at most 15% of the diameter of the radial fan, more preferably at most 14%, even more preferably at most 13% and even more preferably at most 12%.

[0048] The second half comprises a frame which abuts to side walls of the housing in a second plane transverse to the height direction of the housing. Thus, the second plane is parallel to the first plane. The second plane may or may not be equal to the first plane. The second plane is located at a distance from the separation that is at most equal to 55% of the radius of the second curvature. As a result, the second plane is always as close as possible to the separation, while space for a closure between the first part and the second part is possible for airtight sealing of the two halves of the volute. The second curvature and the frame in the second plane are connected by a surface. The volute is recessed on the second side between the frame and the second curvature, as a result of which the second chamber has been expanded, without the height of the second chamber having increased. The surface connecting the second curvature and the frame is particularly advantageous for mounting, for example, a control board or other additional components, such as sensors or a power supply with high components.

[0049] According to a preferred embodiment, the power supply is placed in the first chamber. The power supply is preferably both a power supply for the control board and a power supply for the radial fan. At least part of the volute is removably attached in the housing. Preferably, the removable part of the volute is the second half of the volute and the first half of the volute comprises an opening into or through which the power supply can be placed in the first chamber. The housing comprises a removable cover that closes off an opening to the second chamber. The removable cover is preferably included in the top wall of the housing or even more preferably is the top wall of the housing. The removable part of the volute and the removable cover provide access to the power supply.

[0050] This embodiment is advantageous because the removable part of the volute and the removable cover form a double-walled housing for the power supply. As a result, it is not necessary to provide an additional housing around the power supply for safety reasons, so that the power supply can be made smaller. The power supply can thus be made small enough to be placed in the first chamber, while the power supply has no or only limited influence on airflows in the first chamber. An additional advantage is that the height of the second chamber can be even smaller, so that the height of the ventilation unit is reduced even more. It is also advantageous that there is access to the power supply via the removable part of the volute and the removable cover, so that the power supply can be repaired in the event of a defect, without the entire ventilation unit having to be replaced or dismantled.

[0051] According to a further embodiment, the power supply is attached to the removable part of the volute. This is advantageous because the power supply does not have to be attached to, for example, the housing in the first chamber, which is impractical due to the presence of at least part of the volute, or as a result of which the entire volute would have to be removed each time the power supply has to be repaired. This practically amounts to completely dismantling the ventilation unit. By placing the removable part of the volute in the housing, the power supply is automatically placed in the first chamber and also attached. Preferably, the removable part of the volute is the second half of the volute and the power supply is placed in the first chamber through an opening in the first half of the volute. In that case, the second half of the volute preferably closes off the opening in the first half of the volute.

[0052] According to a preferred embodiment, connection openings for supply ducts and the connection opening for the discharge duct are circular. Connection openings for supply ducts refer to all existing connection openings for supply ducts. The circular connection openings have a center and a diameter.

[0053] The center of a circular connection opening for a supply duct is located at a first height equal to at most 70% of the diameter of the circular connection opening of said supply duct. The first height is measured along the height direction of the housing, from the bottom of the housing adjacent to the first chamber. Preferably, the center of a circular connection opening for a supply duct is at a height of at most 69% of the diameter of the circular connection opening of said supply duct, more preferably at most 68%, even more preferably at most 67%, and even more preferably at most 66%. This is advantageous because the circular connection openings for supply ducts are hereby located as close as possible to the bottom, so that an airflow through the connection openings has the freest possible access to the first chamber, even with the limited height of the first chamber. As free as possible means that the volute, seen in a direction perpendicular to the connection opening, is positioned in front of less than 50% of the surface of the connection opening, preferably in front of less than 48%, more preferably in front of less than 45%, and even more preferably in front of less than 43%. As a result, it is not necessary for the first space to have a height that is at least equal to the diameter of the connection openings for the supply ducts, so that a ventilation unit can have a limited height.

[0054] The center of the circular connection opening for the discharge duct is located at a second height, equal to at most 100% of the diameter of the circular connection opening for the discharge duct. The second height is measured along the height direction of the housing, from the bottom of the housing adjacent to the first chamber. Optionally, a connection between the discharge opening and the connection opening for the discharge duct partially takes up space in the first chamber. By limiting the second height to a maximum of 100% of the diameter of the circular connection opening for the discharge duct, the total height of the housing of the ventilation unit is limited.

[0055] The second height is preferably equal to at least 85% of the diameter of the circular connection opening for the discharge duct, more preferably at least 87%, even more preferably at least 89% and even more preferably at least 91%. This is advantageous because the connection between the discharge opening and the connection opening for the discharge duct takes up as little space as possible in the first chamber and therefore disrupts as few airflows as possible in the first chamber.

[0056] According to a preferred embodiment, a cover plate is mounted releasably on the housing. The cover plate is preferably mounted on the top wall of the housing. The cover plate closes off access to control buttons on the control board. By removing the cover plate, the control buttons on the control board can be manipulated, so that the ventilation unit can be operated and/or set. This embodiment is advantageous because it is not necessary to open the ventilation unit in order to operate and/or set the ventilation unit. By removing the cover plate, the control buttons on the control board can be manipulated directly, so that no further mechanical components are required to manipulate the control buttons on the control board from outside the ventilation unit, resulting in a simpler housing. This is possible due to the limited height of the second chamber, so that the control board is sufficiently close to the top wall of the housing.

[0057] According to a further embodiment, the cover plate comprises two sides. A first side is preferably finished flat and optionally printed with a logo or indication. A second opposite side comprises clamps for releasably clamping a wireless remote control. The wireless remote control preferably only comprises functions for operating the ventilation unit and not for setting the ventilation unit. The control board comprises a receiver for receiving messages from the wireless remote control. The cover plate can be removably attached to the housing with both the first side and the second side.

[0058] This embodiment is advantageous because by turning over the cover plate and reattaching the cover plate with the first side facing the ventilation unit, it is possible to removably attach a wireless remote control to the ventilation unit. As a result, a user can easily operate the ventilation unit without having to remove the cover plate and the wireless remote control is never lost.

[0059] According to a preferred embodiment, a humidity sensor is placed on the control board. The humidity sensor is positioned through an opening in the volute. The humidity sensor is advantageous for measuring humidity in air that is extracted from rooms in a building. The radial fan can be controlled on the basis of a measured humidity level. Placing the humidity sensor directly on the control board is also advantageous because no cable and connectors are required to connect the humidity sensor in the volute to the control board. This simplifies the ventilation unit. An additional advantage is that the control board can have a smaller height due to the lack of connectors and cable.

[0060] According to a preferred embodiment, the housing has a height, measured according to the height direction of the housing, of at most 220 mm. The housing preferably has a height of at most 215 mm, more preferably at most 210 mm and even more preferably at most 205 mm. This preferred form is advantageous because a space above a false ceiling or behind a false wall is usually larger than 220 mm, so that the ventilation unit can be built into said space. As a result, the ventilation unit is installed completely invisible in a home.

[0061] In a second aspect, the invention relates to a method for assembling a ventilation unit for mechanical extraction of air.

[0062] According to a preferred embodiment, the method comprises the steps of:

- providing a housing;
- providing a volute;
- placing the volute in the housing transverse to a height direction of the housing;
- placing a power supply;
- placing a control board in the second chamber;
- connecting the radial fan, the power supply, and the control board.

[0063] The housing is preferably a substantially beam-shaped housing. The housing comprises a bottom, four side walls and a top wall. The housing comprises at least one connection opening for a supply duct. A supply duct is a duct for supplying air to the ventilation unit. The housing preferably comprises at least two connection openings for supply ducts, more preferably at least three connection openings and even more preferably at least four connection openings. Most preferably, the housing has four connection openings for supply ducts. Connection openings for supply ducts are preferably arranged in side walls of the housing. The housing comprises one connection opening for a discharge duct. A discharge duct is a duct for exhausting air from the ventilation unit. The connection opening for the discharge duct is preferably located in a side wall of the housing.

[0064] The volute comprises a suction opening for sucking air into the volute and a discharge opening for discharging air from the volute. The suction opening is transverse to an axial direction of the volute. The discharge opening is transverse to a tangential direction to the volute. The radial fan is placed opposite the suction opening in the volute. The radial fan has backward curved blades. This means that the blades are curved in a direction that is opposite to a direction in which the blades rotate in the active state. The backward curved blades blow the axially drawn air radially out in the active state. Backward curved blades are advantageous because radial fans with backward curved blades are more energetically efficient than radial fans with forward curved blades.

[0065] The discharge opening of the volute is connected to the connection opening for the discharge duct. The discharge opening is, for instance, connected to the connection opening for the discharge duct by means of a flexible or non-flexible tube. Preferably, the discharge opening of the volute is connected to the connection opening for the discharge duct, in that the discharge opening of the volute connects to the connection opening for the discharge duct.

[0066] By placing the volute transversely to the height direction in the housing, a first chamber and a second chamber are formed in the housing. The height direction is a direction transverse to the bottom of the housing. The first chamber is located on a first side of the volute. The first chamber is bounded by the bottom and the side walls of the housing and the first side of the volute. The second chamber is located on a second side of the volute, opposite in the height direction. The second chamber is bounded by the top wall and side walls of the housing and the second side of the volute. Connection openings for supply ducts and the suction opening of the volute open into the first chamber.

[0067] The control board comprises the necessary electronic circuits for controlling the radial fan. The power supply may or may not be placed in the first chamber. The power supply supplies the control board with electrical power. Optionally, the ventilation unit comprises an additional power supply for supplying the radial fan with power. Preferably there is only a single power supply that supplies both the control board and the radial fan and any additional components with electrical power.

[0068] When the volute is placed in the housing, a ratio of a height of the first chamber to a height of the volute of at most 1.1 is obtained. The height of the first chamber is measured according to the height direction of the housing. The height of the first chamber is measured from a bottom of the housing, adjacent the first chamber, to the first side of the volute. This does not mean that the first chamber cannot extend higher than the first side of the volute from the bottom. The first chamber may possibly extend higher along part of the volute. However, the height of the first chamber is mainly limited up to the first side of the volute. The height of the volute is measured according to the height direction of the housing from the first side of the volute to the second side of the volute.

[0069] Preferably, the ratio of the height of the first chamber to the height of the volute is at most 1.08, more preferably at most 1.06, even more preferably at most 1.04 and even more preferably at most 1.02.

[0070] Preferably, the ratio of the height of the first chamber to the height of the volute is at least 0.76, more preferably at least 0.78, even more preferably at least 0.80, and even more preferably at least 0.82.

[0071] When the volute is placed in the housing, a ratio of the height of the first chamber to a height of the second chamber of at most 4 is obtained. The height of the second chamber is measured according to the height direction of the housing from the second side of the volute to the top wall of the housing adjacent to the second chamber.

[0072] Preferably, the ratio of the height of the first chamber to the height of the second chamber is at most 3.8, more preferably at most 3.6, even more preferably at most 3.5 and even more preferably at most 3.4.

[0073] Preferably, the ratio of the height of the first chamber to the height of the second chamber is at least 2.7, more preferably at least 2.9, even more preferably at least 3.1 and even more preferably at least 3.3.

[0074] When the volute is placed in the housing, a ratio of the height of the first chamber to a diameter of the radial fan of at least 0.39 is obtained. It will be apparent to one skilled in the art that the height of the first chamber and the diameter of the radial fan are expressed in the same unit when determining the ratio.

[0075] Preferably, the ratio of the height of the first chamber to the diameter of the radial fan is at least 0.40, more preferably at least 0.41, even more preferably at least 0.42 and even more preferably at least 0.43.

[0076] Preferably, the ratio of the height of the first chamber to the diameter of the radial fan is at most 0.54, more preferably at most 0.53, even more preferably at most 0.52 and even more preferably at most 0.51.

[0077] This method has the advantage, among other things, that a ventilation unit can be assembled in a simple manner, which has a limited height, making the ventilation unit suitable for building in in compact homes or homes being renovated and where originally there was no room for a ventilation system, while respecting a minimum value for the ratio of the height of the first chamber to the diameter of the radial fan ensures optimum operation of the ventilation unit.

[0078] According to a preferred embodiment, the power supply is placed in the first chamber via an opening to the second chamber. A removable part of the volute is attached in the housing via the opening to the second chamber, thereby closing off access from the second chamber to the power supply. The opening to the second chamber is closed with a removable cover after connecting the power supply, the radial fan and the control board.

[0079] This embodiment is advantageous because the removable part of the volute and the removable cover form a double-walled housing for the power supply. As a result, it is not necessary to provide an additional housing around the power supply for safety reasons, so that the power supply can be made smaller. The power supply can thus be made small enough to be placed in the first chamber, while the power supply has no or only limited influence on airflows in the first chamber. An additional advantage is that by not having the power supply in the second chamber, the height of the second chamber can be even smaller, further reducing the height of the ventilation unit. It is also advantageous that there is access to the power supply via the removable part of the volute and the removable cover, so that the power supply can be repaired in the event of a defect, without the entire ventilation unit having to be replaced or dismantled.

[0080] According to a further embodiment, the power supply is attached to the removable part of the volute when the power supply is placed in the first chamber. This is advantageous because the power supply does not have to be attached to, for example, the housing in the first chamber, which is impractical due to the presence of at least part of the volute or as a result of which the entire volute would have to be removed each time the power supply is repaired. This practically amounts to completely dismantling the ventilation unit. By placing the removable part of the volute in the housing, the power supply is automatically placed in the first chamber and also attached.

[0081] According to a preferred embodiment, a cover plate is removably attached to the housing. The cover plate closes off access to control buttons on the control board. By removing the cover plate, the control buttons on the control board can be manipulated, so that the ventilation unit can be operated and/or set. This embodiment is advantageous because it is not necessary to open the ventilation unit in order to operate and/or set the ventilation unit.

[0082] According to a preferred embodiment, a humidity sensor is placed in the volute through an opening in the volute. The humidity sensor is placed on the control board.

[0083] Placing the humidity sensor directly on the control board is particularly advantageous because no cable and connectors are required to connect the humidity sensor in the volute to the control board. This simplifies the assembly of the ventilation unit and the ventilation unit itself. An additional advantage is that the control board can have a smaller height due to the lack of connectors and cable.

[0084] One skilled in the art will appreciate that a ventilation unit according to the first aspect is preferably assembled by carrying out a method according to the second aspect and that a method according to the second aspect is preferably configured for assembly of a ventilation unit. according to the first aspect. Each feature described in this document, both above and below, can therefore relate to any of the three aspects of the present invention.

[0085] In a third aspect, the invention relates to the use of a ventilation unit according to the first aspect and/or a method according to the second aspect for installing a ventilation system above a false ceiling or behind a false wall.

[0086] This use results in an advantageous installation of a ventilation system above a false ceiling or behind a false wall. A ventilation system comprises a central ventilation unit and a system of air ducts. Compared to the height of the central ventilation unit, an air duct has a limited diameter and therefore poses no problem to be built in behind a false ceiling or behind a false wall, such as a wall of a wall hung toilet. However, a traditional central ventilation unit has a considerable height, so it is often not possible to build the traditional ventilation unit in above a false ceiling or behind a false wall, as this would lower the ceiling too much or a space, such as a toilet or a storage space, would become too small. By using a ventilation unit according to the first aspect and/or a method according to the second aspect, a ventilation unit with a limited height is available, which can be built in above the false ceiling or behind the false wall, without significantly lowering the ceiling or reducing a space, such as a toilet or storage space, too much. This is particularly advantageous for use in compact homes or homes being renovated and where originally there was no room for a ventilation system.

[0087] In what follows, the invention is described by way of non-limiting figures illustrating the invention, and which are not intended to and should not be interpreted as limiting the scope of the invention.

DESCRIPTION OF THE FIGURES

[0088] **Figure 1** shows an exploded view of a ventilation unit according to an embodiment of the present invention.

[0089] The ventilation unit (1) comprises a radial fan (2), a control board (3), a power supply (4) and a housing (5). The housing (5) comprises a bottom (38), four side walls (39) and a top wall (40). The housing (5) comprises four connection openings (6) for supply ducts and one connection opening (7) for a discharge duct. Only two connection openings (6) for supply ducts are visible in Figure 1. The connection openings (6) and (7) are provided in the side walls (39) of the housing (5). A volute (8) is placed in the housing (5) transverse to a height direction (11) of the housing (5). The height direction (11) is transverse to the bottom (38) of the housing (5). The volute (8) is formed from a first half (19) and a second half (20). The volute (8) comprises a suction opening (9) and a discharge opening (10) for air. The discharge opening (10) connects to the connection opening (7) for the discharge duct. The volute (8) forms in the housing (5) a first chamber (12) and a second chamber (13). The first chamber (12) and the second chamber (13) are not indicated in Figure 1 but are clearly visible in Figure 7. The radial fan (2) is placed opposite the suction opening (9) in the volute (8). The volute (8) has a first side (15) and a second side (16) opposite to it in the height direction (11). Only the second side (16) is clearly visible in Figure 1. The second side (16) lies in the second half (20) of the volute (8). A separation between the first half (15) and the second half (16) lies in a first plane transverse to the height direction (11). The first half (19) is curved from the first side (15) of the volute (8) with a first curvature (21) towards the separation. The second half (20) is curved from the second side (16) with a second curvature (22) towards the separation. The second half (20) comprises a frame (23) which abuts to the side walls (39) in a second plane transverse to the height direction (11). The second curvature (22) and the frame (23) are connected by a surface (24). These features are clearly visible in Figure 7. The control board (3) is attached to the second side (16) of the volute (8). The power supply (4) is attached to the second half (20) of the volute (8). The power supply (4) is placed through the second chamber (13) and through an opening in the first half (19) of the volute (8) into the first chamber (12). The second half (20) is removably attached in the housing (5). The top wall (40) is a removable cover (25) closing off an opening to the second chamber (13). The second half (20) of the volute (8) and the removable cover (25) provide access to the power supply (4) in the first chamber (12). A cord (42) is attached to the power supply (4) for connecting the power supply (4) to the mains voltage. A cover plate (28) is removably attached to the housing (5). In this embodiment the cover plate (28) is attached to the removable cover (25). The cover plate (28) has a first side (30) and an opposite side (31). Only the first side (30) is visible in Figure 1. The cover plate (28) closes off access to control buttons (29) on the control board (3). The control buttons (29) are visible in Figure 7. Caps (41) close off unused connection openings (6) for supply ducts.

[0090] **Figure 2** shows a front view of a ventilation unit according to an embodiment of the present invention.

[0091] The ventilation unit in Figure 2 is the same as the ventilation unit in Figure 1. In Figure 2, the four connection openings (6) for supply ducts and the connection opening (7) for the discharge duct are all visible. The connection openings (6) and (7) in this embodiment have a diameter of 123.9 mm. In this embodiment, the housing (5) has a width in front view, measured from the connection opening (6) on the left side of the housing (5) to the connection opening (6) on the right side of the housing (5), of 381 mm. The housing (5) in this embodiment has a depth in front view, measured from the connection openings (6) and (7) at the top to the connection opening (6) at the bottom, of 366 mm.

[0092] **Figure 3** shows a right-side view of a ventilation unit according to an embodiment of the present invention.

[0093] The ventilation unit in Figure 3 is the same as the ventilation unit in Figures 1-2. Figure 3 shows how the center of the connection opening (6) is located at a first height (26) and the center of the connection opening (7) at a second height (27). The first height (26) and the second height (27) are measured according to the height direction (11) from the bottom (38) of the housing (5). In this embodiment, the first height (26) is 79 mm and the second height (27) is 116 mm. The first height (26) is 64% of the diameter of the connection opening (6) and the second height (27) is 94% of the diameter of the connection opening (7). A height (34) of the housing (5) is measured according to the height direction (11) from the bottom (38) to the top wall (40). In this embodiment, the height (34) of the housing (5) is equal to 203.5 mm.

[0094] **Figure 4** shows a left side view of a ventilation unit according to an embodiment of the present invention.

[0095] The ventilation unit in Figure 4 is the same as the ventilation unit in Figures 1-3.

[0096] **Figure 5** shows a bottom view of a ventilation unit according to an embodiment of the present invention.

[0097] The ventilation unit in Figure 5 is the same as the ventilation unit in Figures 1-4.

[0098] **Figure 6** shows a top view of a ventilation unit according to an embodiment of the present invention.

[0099] The ventilation unit in Figure 6 is the same as the ventilation unit in Figures 1-5.

[0100] **Figure 7** shows a cross-sectional view of a ventilation unit according to an embodiment of the present invention.

[0101] The ventilation unit in Figure 7 is the same as the ventilation unit in Figures 1-6. In the cross-sectional view, the part of the housing (5) with the connection opening (7) and the discharge opening (10) is cut away. Figure (7) clearly shows how the volute (8) is placed transversely to the height direction (11) in the housing (5) and forms a first chamber (12) and a second chamber (13) there.

The first chamber (12) is bounded by the bottom (38), side walls (39) and the first side (15) of the volute (8). In this embodiment, the first chamber (12) extends along a part of the volute (8) higher than the first side (15) of the volute (8). A height (14) of the first chamber (12) is measured according to the height direction (11) from the bottom (38) to the first side (15) of the volute (8). In this embodiment, the height (14) of the first chamber (12) is equal to 74 mm. A height (17) of the volute (8) is measured according to the height direction (11) from the first side (15) to the second side (16). In this embodiment, the height (17) of the volute (8) is equal to 87 mm. The ratio of the height (14) of the first chamber (12) to the height (17) of the volute (8) is 0.85. The second chamber (13) is bounded by the second side (16) of the volute (8), side walls (39) and the top wall (40). A height (18) of the second chamber (13) is measured according to the height direction (11) from the second side (16) of the volute (8) to the top wall (40). In this embodiment, the height (18) of the second chamber (13) is 22 mm. The ratio of the height (14) of the first chamber (12) to the height (18) of the second chamber (13) is 3.4. In Figure 7 it is clearly visible that the radial fan (2) comprises an impeller (35) and a motor (37). The motor (37) is partially placed in the impeller (35). It is also clearly visible that the suction opening (9) opens into the first chamber (12). The radial fan (2) has a diameter (36). The diameter (36) is 173 mm in this embodiment. The ratio of the height (14) of the first chamber (12) to the diameter (36) of the radial fan (2) is 0.43. Figure 7 also shows that the cover plate (28) comprises a second side (31) which is opposite the first side (30). The cover plate (28) comprises clamps (32) on the second side (31) for removably clamping a wireless remote control. In Figure 7, the cover plate (28) has its second side (31) facing the housing (5), so that no remote control is clamped in the clamps (32). The cover plate (28) closes off access to control buttons (29) on the control board (3). The control buttons (29) protrude through the removable cover (25). A humidity sensor (33) is also placed on the control board (3). The humidity sensor (33) is positioned through an opening in the volute (8).

[0102] The numbered elements in the figures are:

1. Ventilation unit
2. Radial fan
3. Control board
4. Power supply
5. Housing
6. Supply duct connection opening
7. Discharge duct connection opening
8. Volute
9. Suction opening
10. Discharge opening
11. Height direction
12. First chamber
13. Second chamber
14. Height of first chamber
15. First side volute
16. Second side volute
17. Volute height
18. Height second chamber
19. First half volute
20. Second half volute
21. First curvature
22. Second curvature
23. Frame
24. Surface
25. Removable cover
26. First height
27. Second height
28. Cover plate
29. Control buttons
30. First side cover plate
31. Second side cover plate
32. Clamps cover plate
33. Humidity sensor
34. Housing height
35. Impeller
36. Radial fan diameter
37. Motor radial fan
38. Bottom housing
39. Side wall housing
40. Top wall housing
41. Cap
42. Cord

Claims

1. Ventilation unit for mechanical extraction of air, comprising a radial fan, a control board, a power supply and a housing, the radial fan having backward curved blades, wherein the housing comprises at least one connection opening for a supply duct, one connection opening for a discharge duct and a volute, the volute comprising a suction opening and a discharge opening for air, with the radial fan placed opposite the suction opening in the volute, the discharge opening being connected to the connection opening for the discharge duct, wherein the volute is placed in the housing transversely to a height direction of the housing, whereby a first chamber and a second chamber are formed in the housing, wherein the first chamber is on a first side of the volute and the second chamber is on a second opposite side of the volute, with connection openings for supply ducts and the suction opening of the volute opening into the first chamber, where the control board is placed in the second chamber, **characterized in that** a ratio of a height of the first chamber, measured according to the height direction of the housing, from a bottom of the housing, adjacent to the first chamber, to the first side of the volute, to a height of the volute, measured according to the height direction of the housing, from the first side of the volute to the second side of the volute is at most 1.1, a ratio of the height of the first chamber to a height of the second chamber, measured according to the height direction of the housing, from the second side of the volute to a top wall of the housing, adjacent to the second chamber, is at most 4, and a ratio of the height of the first chamber to a diameter of the radial fan is at least 0.39.

2. The ventilation unit according to claim 1, **characterized in that** the volute is formed from two halves, wherein the first side of the volute is in a first half and the second side of the volute is in a second half, wherein a separation between the first half and the second half lies in a first plane transverse to the height direction of the housing, wherein the first half from the first side of the volute is curved with a first curvature towards the separation and the second half from the second side of the volute is curved with a second curvature towards the separation, wherein the first curvature and the second curvature have a radius that is at least 5% of the diameter of the radial fan, wherein the second half comprises a frame, which abuts to side walls of the housing in a second plane transverse to the height direction of the housing, where the second plane is located at a distance from the separation that is at most equal to 55% of the radius of the second curvature, and where the second curvature and the frame in the second plane are connected by a surface.

3. The ventilation unit according to claim 1 or 2, **characterized in that** the power supply is placed in the first chamber, wherein at least a part of the volute is removably attached in the housing, wherein the housing comprises a removable cover, which closes off an opening to the second chamber, and wherein the removable part of the volute and the removable cover form an access to the power supply.

4. The ventilation unit according to claim 3, **characterized in that** the power supply is attached to the removable part of the volute.

5. The ventilation unit according to any of the preceding claims 1-4, **characterized in that** connection openings for supply ducts and the connection opening for the discharge duct are circular, wherein the center of a circular connection opening for a supply duct is located at a first height, equal to at most 70% of the diameter of the circular connection opening of said supply duct, wherein the center of the circular connection opening for the discharge duct is located at a second height, equal to at most 100% of the diameter of the connection opening for the discharge duct, and where the first height and the second height are measured according to the height direction of the housing, from the bottom of the housing, adjacent to the first chamber.

6. The ventilation unit according to any of the preceding claims 1-5, **characterized in that** a cover plate is attached removably on the housing, the cover plate closing off access to control buttons on the control board.

7. The ventilation unit according to claim 6, **characterized in that** the cover plate comprises two sides, wherein a second side comprises clamps for removably clamping a wireless remote control, and wherein the cover plate can be removably attached to the housing with both the first side and an opposite second side.

8. The ventilation unit according to any of the preceding claims 1-7, **characterized in that** a humidity sensor is placed on the control board, wherein the humidity sensor is positioned through an opening in the volute.

9. The ventilation unit according to any of the preceding claims 1-8, **characterized in that** the housing has a height, measured according to the height direction of the housing, of at most 220 mm.

10. Method for assembling a ventilation unit for mechanical extraction of air, comprising:

- providing a housing, wherein the housing comprises at least one connection opening for a supply duct and one connection opening for a discharge duct;
- providing with a volute, the volute comprising a suction opening and a discharge opening for air, where a radial fan is placed opposite the suction opening in the volute, the radial fan having backward curved blades;
- placing the volute in the housing, transverse to a height direction of the housing, the discharge opening of the volute being connected to the connection opening for the discharge duct, wherein a first chamber and a second chamber are formed in the housing, wherein the first chamber is on a first side of the volute and the second chamber is on a second opposite side of the volute, and with connection openings for supply ducts and the suction opening of the volute opening into the first chamber;
- placing a power supply;
- placing a control board in the second chamber;
- connecting the radial fan, the power supply, and the control board;

characterized in that when the volute is placed in the housing a ratio of a height of the first chamber, measured according to the height direction of the housing, from a bottom of the housing, adjacent to the first chamber, to the first side of the volute to a height of the volute, measured according to the height direction of the housing, from the first side of the volute to the second side of the volute of at most 1.1, a ratio of the height of the first chamber, to a height of the second chamber, measured according to the height direction of the housing, from the second side of the volute to a top wall of the housing, adjacent to the second chamber, of at most 4, and a ratio of the height of the first chamber to a diameter of the radial fan of at least 0.39 is obtained.

11. The method according to claim 10, **characterized in that** the power supply is placed via an opening to the second chamber in the first chamber, wherein a removable part of the volute is attached in the housing via the opening to the second chamber and thereby closing off access from the second chamber to the power supply, and wherein the opening to the second chamber is closed off with a removable cover after connecting the power supply, the radial fan and the control board.

12. The method according to claim 11, **characterized in that** when the power supply is placed in the first chamber, the power supply is attached to the removable part of the volute.

13. The method according to claims 10, 11 or 12, **characterized in that** a cover plate is removably attached to the housing, the cover plate closing off access to control buttons on the control board.

14. The method according to any of claims 10-13, **characterized in that** a humidity sensor is placed in the volute through an opening in the volute, the humidity sensor being placed on the control board.

15. Use of a ventilation unit according to any of claims 1-9 and/or a method according to any of claims 10-14 for installing a ventilation system above a false ceiling or behind a false wall.

FIGURES

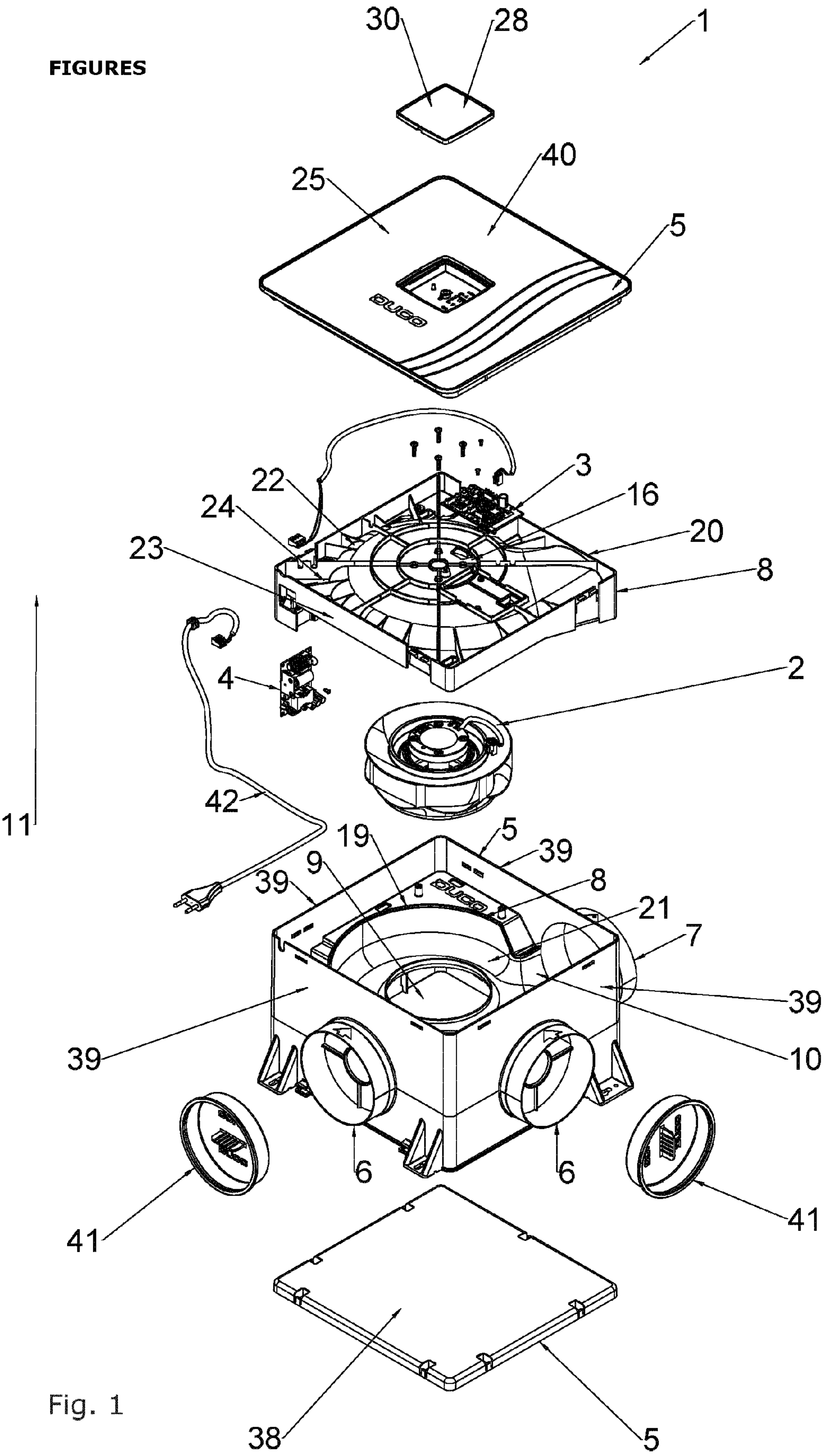


Fig. 1

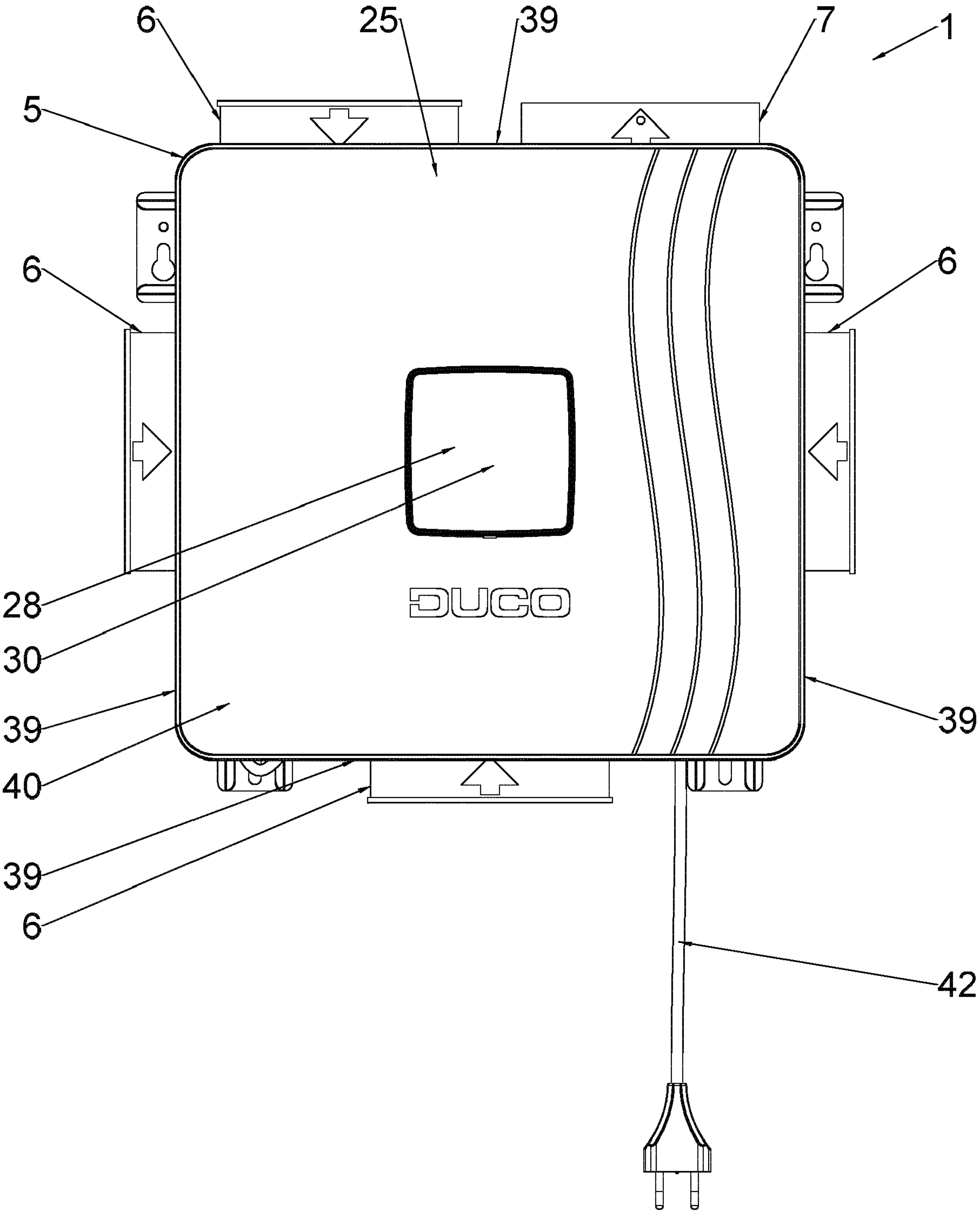


Fig. 2

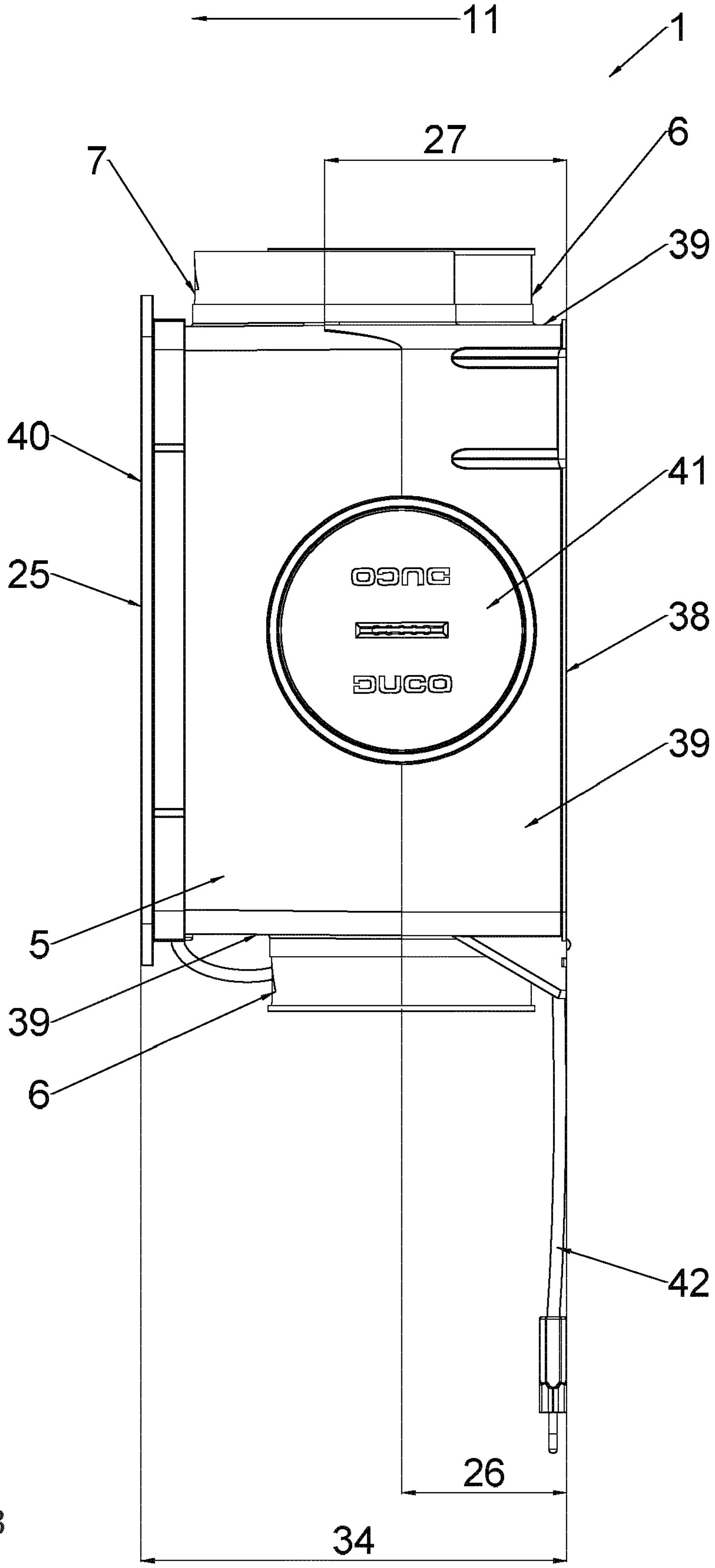


Fig. 3

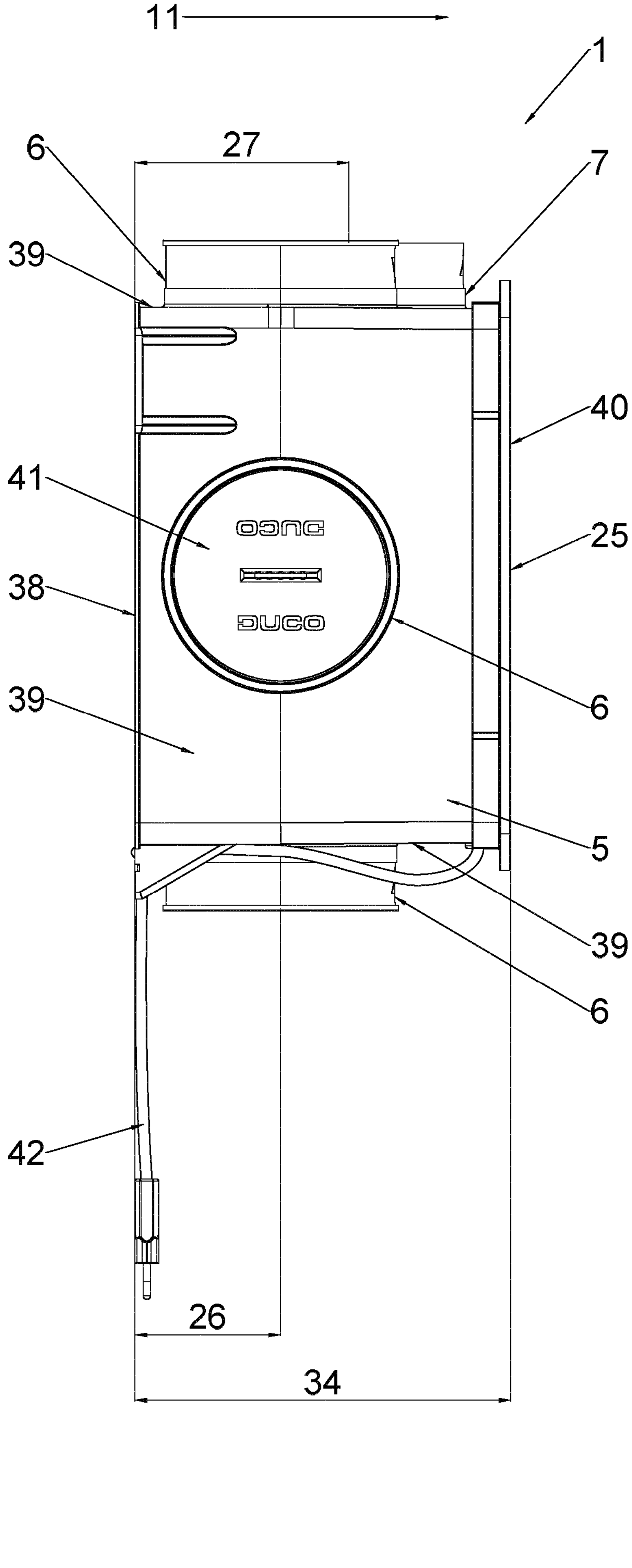


Fig. 4

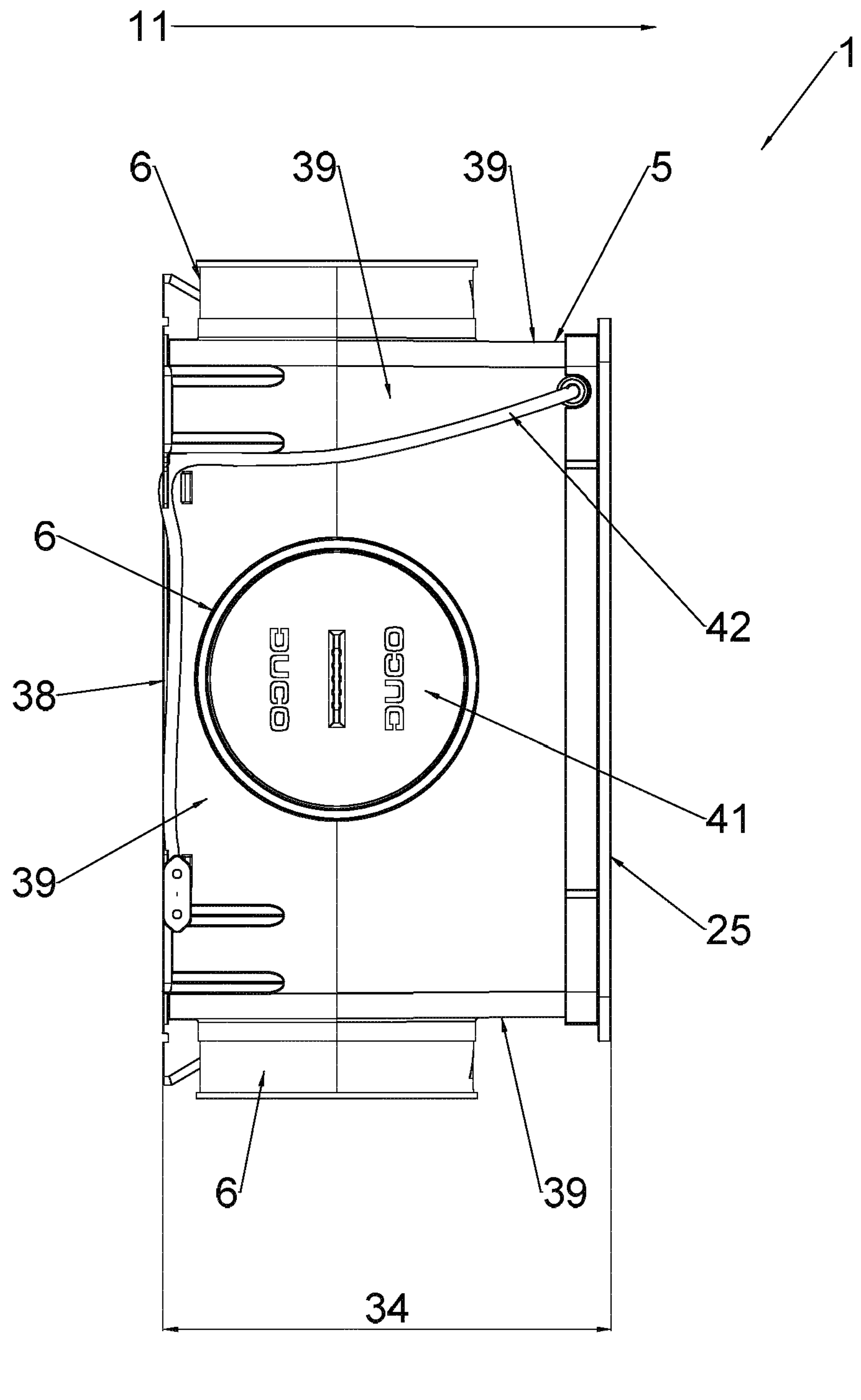


Fig. 5

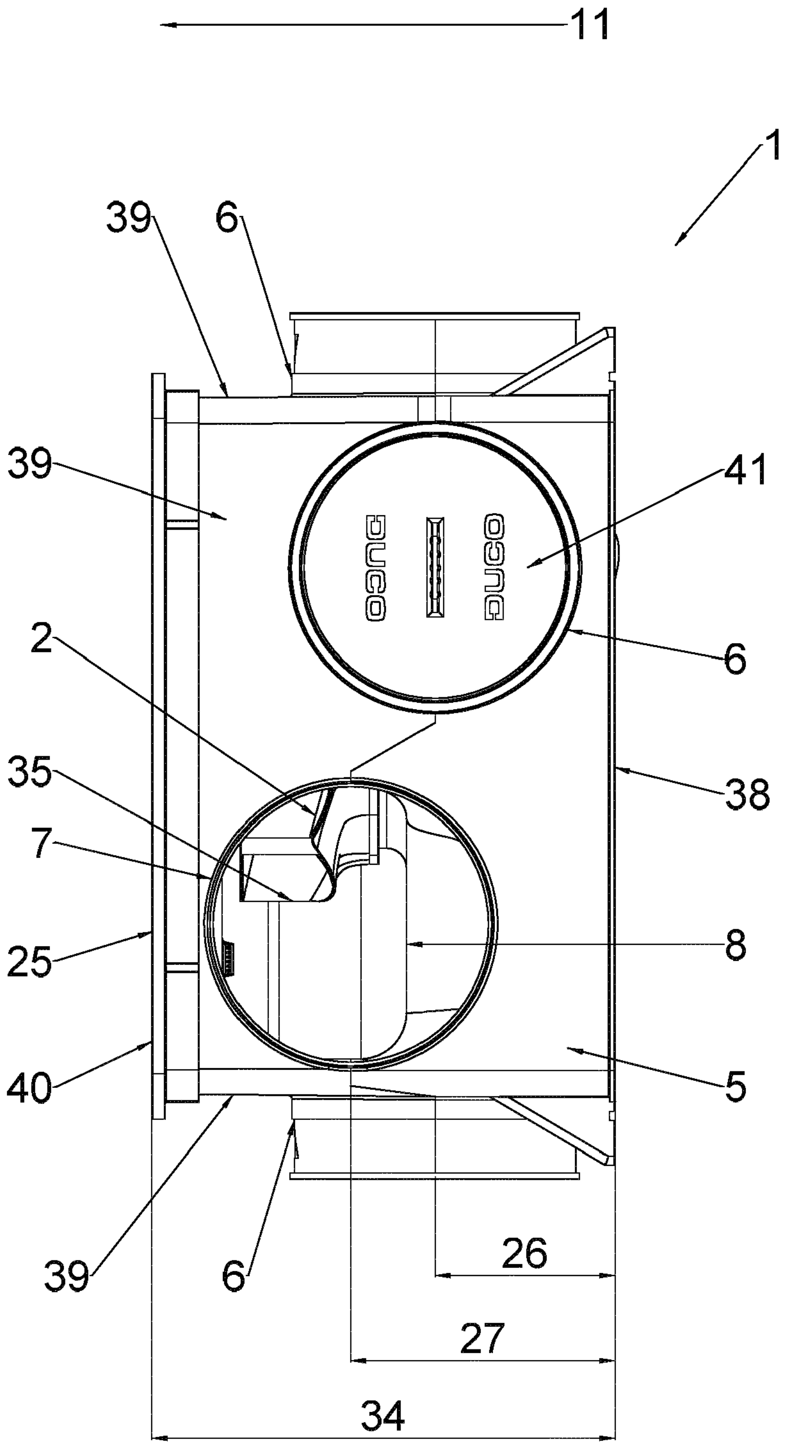
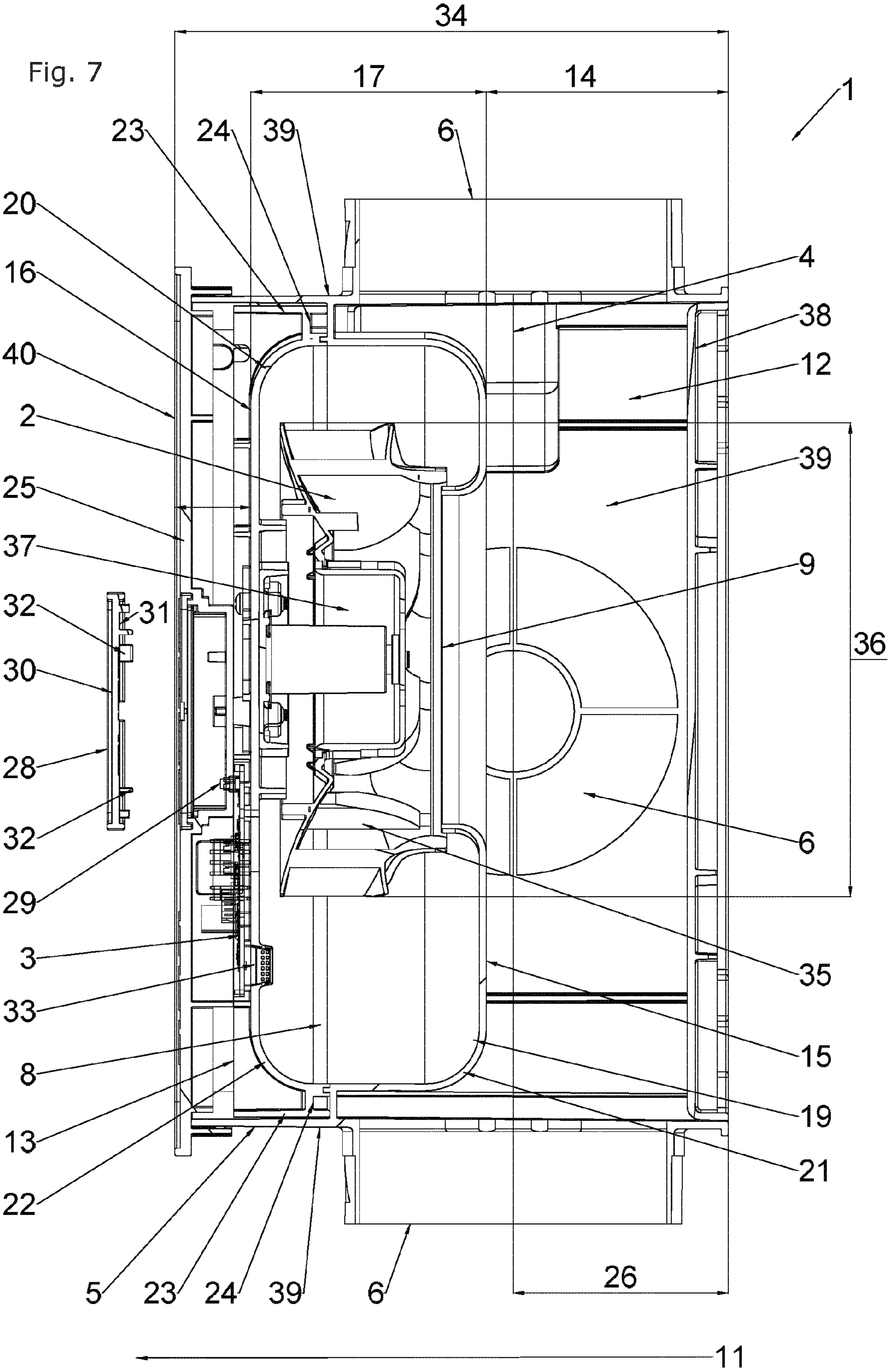


Fig. 6

Fig. 7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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 4592

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F04D
F24F

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	10 August 2023	Ingelbrecht, Peter

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