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(54) **EXTRACTOR UNIT**

(57) An extractor unit (100) comprising a casing (2) provided with an outlet (4) comprising an ending portion (6) suitable for being coupled with a connection of an extraction pipe (8), and a coupling portion (7) having a tapered shape in the width direction, with increasing width going from the inlet section (40) to the intermediate section (42) so as to allow for a fluid expansion in the

coupling portion; the central portion (20) of the casing has a height (H1) greater than the height (H) of the ending portion (6) of the outlet, in such a way that the coupling portion (7) has a tapered shape in the height direction, with decreasing height going from the inlet section (40) to the intermediate section (42).

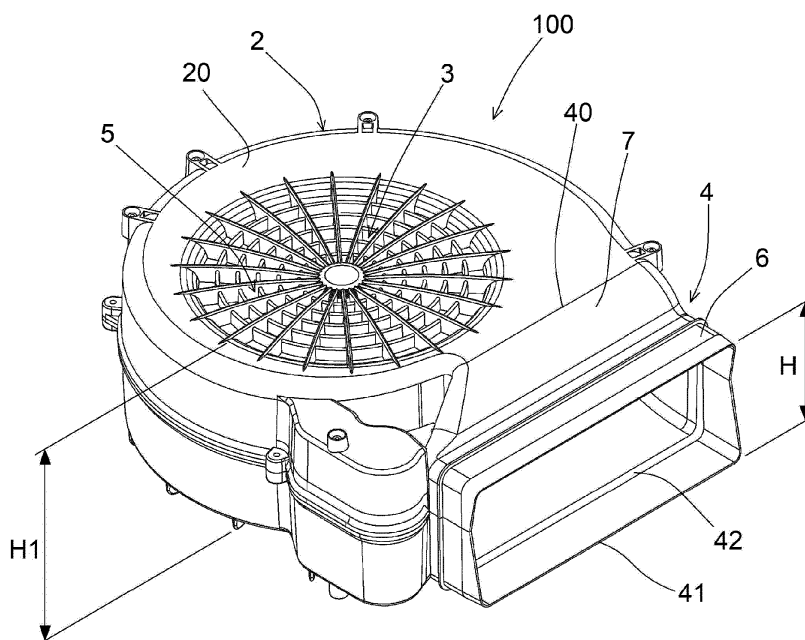


FIG. 10

Description

[0001] The present invention relates to an extractor unit, specifically to a centrifugal electric fan for household appliances, such as extractor hoods.

[0002] Extractor units are known in the household appliance industry for being used in extractor hoods disposed above the cooktop and in extractor hoods integrated under the cooktop. In each case, said extractor units are employed to evacuate fumes from the cooktop.

[0003] Such an extractor unit comprises a centrifugal fan having a squirrel-cage impeller with forward curved blades, which is rotatably mounted in a stator casing with a substantially cylindrical development. Sections that are basically identical to each other are obtained by intersecting the casing of the fan with a bundle of parallel planes perpendicular to the axis of the impeller. The main plane is the plane that passes at mid-height of the blades of the impeller. Such a centrifugal fan has an inlet (extraction) disposed axially in the casing and an outlet (delivery) disposed laterally in the casing.

[0004] Two types of extractor units are known on the market:

- extractor units with a rectangular outlet; and
- extractor units with a circular outlet.

[0005] With reference to Figs. 1 to 4, an extractor unit according to the prior art is shown, it being comprehensively indicated with reference numeral 200.

[0006] The extractor unit (200) comprises an impeller (1), rotatably mounted in a casing (2) so as to rotate about an axis (X).

[0007] The impeller (1) is a cylindrical squirrel-cage impeller with forward curved blades.

[0008] The casing (2) is in the shape of a receptacle including a central portion (20) of basically cylindrical shape, wherein the impeller (1) is rotatably mounted. In particular, when seen in a sectional view along the main plane, i.e. a plane orthogonal to the axis (X) of the impeller, the central portion (20) of the casing is not cylindrical, but has a spiral shape (logarithmic spiral profiles are known in the literature).

[0009] The casing (2) comprises an inlet (3) to extract the air and an outlet (4) to eject the extracted air.

[0010] The inlet (3) is a circular opening that is disposed axially in the central portion (20) of the casing. The inlet (3) is normally covered by a grille (5).

[0011] The outlet (4) is a conduit or a coupling that protrudes laterally from the central portion (20) of the casing. Thus, the outlet (4) has an inlet section (40) that is connected to the central portion (20) of the casing and an outlet section (41) that is suitable for being coupled with a connection of an extraction pipe or conduit of an air extraction system.

[0012] Specifically, the outlet (4) has an ending portion (6) and a coupling portion (7) disposed between the central portion (20) of the casing and the ending portion (6)

of the outlet. The coupling portion (7) is disposed between the inlet section (40) and an intermediate section (42). The ending portion (6) is disposed between the intermediate section (42) and the outlet section (41).

[0013] Figs. 1 to 5 show an extractor unit (200) with rectangular outlet (4).

[0014] The ending portion (6) of the outlet must have standardized dimensions in order to be coupled with a standard connection of an air extraction pipe with rectangular section. Therefore, the intermediate section (42) and outlet section (41) of the ending portion (6) of the outlet have the same rectangular dimensions. By way of example, as shown in the drawings in Fig. 5, the outlet section (40) of the outlet (4) has a height (H) of 99 mm and a width (W) of 219 mm. These dimensions are constant throughout the ending portion (6) of the outlet.

[0015] As shown in Figs. 1, 3, and 4, the entire outlet (4) has a constant height (H) from the inlet section (40) to the outlet section (41); otherwise said, the ending portion (6) and the coupling portion (7) have the same height (H). In addition, the central portion (20) of the casing has a height (H1) that is substantially equal to the height (H) of the outlet (4).

[0016] For this type of extractor units, a careful design of the casing (2) is essential because the function of the casing (2) is to collect the fluid entering from the inlet (3) and to convey said fluid out of the impeller (1) towards the outlet (4).

[0017] The fluid inside the casing (2) is subjected to a dynamic pressure and to a static pressure. Thus, the energy transmitted to the fluid by the impeller (1) has a kinetic component due to the dynamic pressure and a static component due to the static pressure. In impellers with forward curved blades, the kinetic component is greater than the static component. On the contrary, in impellers with backward curved blades, the kinetic component is smaller than the static component.

[0018] Given that the kinetic component in impellers with forward curved blades is greater than the static component, turbulence is created in the casing (2) and it is therefore necessary to reduce the kinetic component of the fluid flow.

[0019] It is known that in order to reduce the kinetic component of a fluid flow in a conduit, the conduit must be widened and the fluid flow must be expanded. Consequently, in order to reduce the kinetic component of the fluid flow in the casing (2), it is necessary to transform the dynamic pressure of the fluid into static pressure by means of an expansion of the fluid flow in the casing (2) before the fluid exits the casing (2) of the extractor unit.

[0020] To this end, research activities have addressed the design of particular profiles of the central portion (20) of the casing with respect to the main plane. In fact, the profile of the central portion (20) of the casing allows for a gradual controlled expansion of the fluid around the impeller (1) towards the outlet (4).

[0021] Profiles of the central portion (20) of the spiral-shaped casing obtained by connecting a plurality of arcs

of circumferences having centers at different positions and different radii of curvature are known. Moreover, profiles of the central portion (20) of the casing obtained by means of mathematical functions, such as logarithmic spiral or the like are known. With these geometric solutions of the profiles of the central portion (20) of the casing, a greater recovery of static pressure is achieved with advantages in terms of noise emission and efficiency.

[0022] However, the fluid expansion in the central portion (20) of the casing is not sufficient to reduce the kinetic component of the fluid flow. Therefore, fluid expansion must also be provided at the outlet (4).

[0023] The prior art does not contain any precepts on a particular geometry of the outlet (4). In fact, the theory would require to further continue the expansion of the fluid flow exiting the central portion (20) of the casing with a diverging rectilinear channel, having a gradually increasing section from the inlet section (40) of the outlet to the outlet section (41) of the outlet. An obvious solution would be to realize a long tapered trumpet with increasing dimensions from the inlet to the outlet.

[0024] However, the theoretical precepts are in conflict with the constraints of maximum overall dimensions that are to be met by the product. In fact, the length of the outlet (4) must be limited and a part from its length is occupied by the ending portion (6), which must have fixed standardized dimensions. Therefore, any structural changes can only be made to the coupling portion (7) of the outlet.

[0025] With reference to Fig. 6, the coupling portion (7) of the outlet comprises:

- the inlet section (40) of rectangular shape having an inlet surface (Si) (highlighted with diagonal lines); and
- the intermediate section (41) of rectangular shape having an outlet surface (So).

[0026] In order to achieve a fluid expansion, the outlet surface (So) must be greater than the inlet surface (Si). According to the prior art, such a geometric relationship is obtained because the width (W) of the outlet surface (So) is greater than the width (Wi) of the inlet surface (Si). Instead, the heights (H) of the inlet surface and of the outlet surface are equal.

[0027] The width (W) of the outlet surface (So) is approximately twice the width (Wi) of the inlet surface (Si). Therefore, the outlet surface (So) is approximately twice as large as the inlet surface (Si), thus ensuring a fluid expansion.

[0028] However, it should be considered that the length (L) of the coupling portion (7) is limited, such a length (L) being approximately 20-40 mm. In addition, the increase in the width of the coupling portion (7) is not symmetrical, and occurs only in one side of the coupling portion. These factors create an abrupt (not gradual) expansion of the fluid flow in the coupling portion. Such abrupt expansion of the fluid creates the detachment of the fluid flow, with

the formation of vortexes that induce pulsations of fluid velocity fields and pressures, resulting in higher noise emissions and lower efficiency and performance of the extractor unit.

[0029] Figs. 7 and 8 show bidimensional examples of flow, respectively on cross-sections and on planes orthogonal to the axis of the impeller, wherein the outlet (4) of the extractor unit is coupled to an extraction pipe (8). Both figures show the formation of vortices (F1, F2) in the extraction pipe (8) near the outlet section (41) of the outlet of the extractor unit. The vortices (F1, F2) have axes parallel to the axis (X) of the impeller (1).

[0030] In reality, the flow in the outlet (4) is tridimensional and is therefore far more complex than as shown in Figs. 7 and 8.

[0031] Fig. 9 shows a bidimensional example of flow on an axial section on a meridian plane whereon the axis of the impeller lies, wherein the outlet (4) of the extractor unit is coupled to the extraction pipe (8). Fig. 9 shows the formation of first vortices (F3) coming out of the impeller and of second vortices (F4) in the extraction pipe (8). Said vortices (F3, F4) have axes orthogonal to the meridian plane whereon the axis (X) of the impeller lies. The first vortices (F3) are due to the non-uniform distribution of the velocities coming out of the single blade of the impeller. The flow velocities will increase on any meridian plane from the inlet (3) to the base of the impeller (1).

[0032] As mentioned above, a trivial solution of such a vortex generation problem would be to increase the length of the outlet (4), for instance by creating a trumpet-shaped outlet, which allows a gradual expansion of the flow. However, such a solution is not feasible because the outlet (4) could not be coupled with the connection of the extraction pipe (8). Therefore, compromise solutions are accepted, with sudden abrupt changes in the section of the outlet that systematically generate the detachment of the fluid flow.

[0033] EP3620721 describes an extractor unit according to the preamble of independent claim 1. Such an extractor unit comprises a casing and an impeller, rotatably mounted in a central portion of the casing. The casing comprises an inlet for extracting a fluid and an outlet for delivering the extracted fluid. The impeller is a cylindrical impeller with backward curved blades relative to the rotational direction of the impeller.

[0034] Such an impeller with backward curved blades is impaired by the fact that a high noise is produced. In particular, by comparing an impeller with backward curved blades with an impeller with forward curved blades, it can be seen that the impeller with backward curved blades has a small number of large blades, i.e. blades with a high radial extension (difference between the outer diameter and the inner diameter of the impeller). Conversely, an impeller with forward curved blades has a large number of small blades, i.e. blades with a small radial extension.

[0035] The aeroacoustic noise produced by a fan in-

creases as the impeller diameter increases. Therefore, impellers with forward curved blades, having a reduced radial extension, produce less noise than impellers with backward curved blades.

[0036] The purpose of the present invention is to eliminate the drawbacks of the prior art by providing an extractor unit that is capable of guaranteeing a gradual control of the fluid flow along the outlet of the extractor unit without having to excessively modify the dimensions of the ending portion of the outlet.

[0037] Another purpose of the present invention is to provide such an extractor unit that is noiseless and efficient.

[0038] Still another purpose of the present invention is to provide such an extractor unit provided with an ending portion of the outlet that is suitable for being coupled with standard connections of extraction pipes.

[0039] These purposes are achieved in accordance with the invention with the features of the appended independent claim 1.

[0040] Advantageous achievements of the invention appear from the dependent claims.

[0041] Further features of the invention will appear clearer from the following detailed description, which refers to a merely illustrative and therefore nonlimiting embodiment thereof, shown in the appended drawings, wherein:

Fig. 1 shows a perspective view of an extractor unit according to the prior art;

Fig. 2 shows a plan view of the extractor unit of Fig. 1;

Fig. 3 shows a side view of the extractor unit of Fig. 1;

Fig. 4 shows an axial view taken along the sectional plane IV-IV of Fig. 2;

Fig. 5 shows a plan view and a side view of the extractor unit of Fig. 1 with dimensions;

Fig. 6 shows a diagrammatic view illustrating a coupling portion of the outlet of the extractor unit according to the prior art;

Figs. 7 and 8 show two-dimensional diagrams along planes orthogonal to the axis of the impeller, illustrating a fluid flow in a casing of an extractor unit of the prior art coupled with an extraction pipe;

Fig. 9 shows a two-dimensional diagram along a meridian plane whereon the axis of the impeller lies, illustrating a fluid flow in a casing of an extractor unit of the prior art coupled to an extraction pipe;

Figs. 10 and 11 show perspective view of the extractor unit according to the invention, taken from different angles;

Fig. 12 shows a plan view of the extractor unit of Fig. 10;

Fig. 13 shows a side view of the extractor unit of Fig. 10;

Fig. 14 shows an axial view taken along the sectional plane XIV-XIV of Fig. 12;

Fig. 15 shows a schematic view illustrating a coupling portion of the outlet of the extractor unit accord-

ing to the invention; and

Fig. 16 shows a two-dimensional schematic view along a meridian plane whereon the axis of the impeller lies, illustrating a fluid flow in a casing of an extractor unit according to the invention coupled to an extraction pipe.

[0042] With reference to Figs. 10 to 16, an extractor unit according to the invention is described, which is comprehensively indicated by the reference numeral 100.

[0043] Hereafter, elements that are equal or corresponding to those already described are indicated with the same reference numerals, omitting a detailed description.

[0044] The extractor unit (100) has a casing (2) comprising:

- a central portion (20) wherein an impeller (1) is rotatably mounted around an axis (X),
- an inlet (3) disposed axially in the central portion (20), and
- an outlet (4) protruding laterally from the central portion.

[0045] The air is extracted axially from the inlet (3) into the central portion (20) of the casing, is ejected radially from the impeller (1), and is conveyed towards the outlet (4).

[0046] The impeller (11) is a cylindrical squirrel-cage impeller with forward curved blades.

[0047] The central portion (20) of the casing is substantially shaped like a cylindrical receptacle, preferably having a spiral-shaped section along a plane orthogonal to the axis of the impeller.

[0048] The outlet (4) comprises:

- an ending portion (6) suitable for being coupled with a connection of an extraction pipe, and
- a coupling portion (7) that connects the ending portion (6) with the central portion (20) of the casing.

[0049] The coupling portion (7) is disposed between an inlet section (40) connected to the central portion (20) of the casing and an intermediate section (42) connected to the ending portion (6) of the outlet.

[0050] The ending portion (6) is disposed between the intermediate section (42) and an outlet section (41) consisting of an ending edge of the ending portion (6).

[0051] The ending portion (6) has a rectangular section having a suitable height (H) and a suitable width (W) in such a way to be coupled with a connection of an extraction pipe.

[0052] The coupling portion (7) has a tapered shape in the width direction, with increasing width going from the inlet section (40) to the intermediate section (42).

[0053] According to the invention, the central portion (20) of the casing has a height (H1) greater than the height (H) of the ending portion (6) of the outlet. Conse-

quently, the coupling portion (7) has a tapered shape in the height direction, with decreasing height going from the inlet section (40) to the intermediate section (42).

[0054] Such a decreasing tapering in the height direction, as opposed to increasing tapering in the width direction, avoids an abrupt expansion of the fluid and instead generates a gradual expansion of the fluid in the coupling portion (7), preventing the formation of turbulence and vortices.

[0055] Otherwise said, the inlet section (40) between the central portion (20) of the casing and the coupling portion (7) has a height (Hi) equal to the height (H1) of the casing. The intermediate section (42) between the coupling portion (7) and the ending portion (6) has a height (H) equal to the height (H) of the ending portion.

[0056] With reference to Fig. 15, the intermediate portion (7) of the outlet has the inlet section (40) of rectangular shape with an inlet surface (Si) and the intermediate section (41) of rectangular shape with an outlet surface (So). The inlet surface (Si) has a height (Hi) and a width (Wi). The outlet surface (So) has a height (H) and a width (W).

[0057] According to the invention, the height (Hi) of the inlet surface (Si) is greater than the height (H) of the outlet surface (So) (i.e. $H_i > H$) and, as in the prior art, the width (W) of the outlet surface (So) is greater than the width (Wi) of the inlet surface (i.e. $W > W_i$).

[0058] In each case, in order to achieve a fluid expansion, the outlet surface (So) must be greater than the inlet surface (Si). Therefore, the difference between the width (W) of the outlet surface (So) and the width (Wi) of the inlet surface must be greater than the difference between the height (Hi) of the inlet surface (Si) and the height (H) of the outlet surface (So). That is to say, the following relationships must be satisfied:

$$(W - W_i) > (H_i - H)$$

$$H_i > H$$

$$W > W_i$$

[0059] From experimental tests, the best results were obtained with a height reduction of the coupling portion (7) of about 15-30%. For example, with a height reduction of 20%, the height (Hi) of the inlet surface must be 125% of the height (H) of the outlet surface.

[0060] Therefore, the height (H1) of the central portion (20) of the casing that is equal to the height (Hi) of the inlet section (40) must be 120-150% of the height (H) of the ending portion (6) of the outlet. In such a case, the width (Wi) of the inlet section (40) must be 40-60% of the width (W) of the ending portion (6) of the outlet.

[0061] If the height (H) of the ending portion (6) of the outlet has the standardized dimension of 99 mm, the

height (H1) of the central portion (20) of the casing must be comprised between 120 mm and 150 mm.

[0062] Referring to Fig. 10, the coupling portion (7) has a length (L) that must be limited because of space issues. By way of example, the length (L) of the coupling portion (7) can be 20-40 mm.

[0063] In such a case, the height (H1) of the central portion (20) of the casing is selected so that a gradual flow variation can be obtained in the short length of the coupling portion (7).

[0064] Fig. 16 shows a two-dimensional example of flow on an axial section on a meridian plane whereon the axis of the impeller (1) lies, wherein the outlet (4) of the extractor unit is coupled to an extraction pipe (8). Fig. 16 shows a regular flow (F5) in the coupling portion (7), without creating any vortices in the extraction pipe (8).

[0065] Equivalent variations and modifications may be made to the present embodiment of the invention, within the scope of those skilled in the art, without departing from the scope of the invention as expressed by the appended claims.

Claims

1. Extractor unit (100) comprising a casing (2) and an impeller (1); the casing (2) comprising:

- a central portion (20) wherein the impeller (1) is rotatably mounted around an axis (X),
 - an inlet (3) disposed axially in the central portion (20), and
 - an outlet (4) protruding laterally from the central portion;
- the outlet (4) comprising:

- an ending portion (6) suitable for being coupled with a connection of an extraction pipe (8), and
- a coupling portion (7) that connects the ending portion (6) of the outlet with the central portion (20) of the casing;

wherein the coupling portion (7) is disposed between an inlet section (40) connected to the central portion (20) of the casing and an intermediate section (42) connected to the ending portion (6) of the outlet; and the ending portion (6) is disposed between the intermediate section (42) and an outlet section (41) consisting of an ending edge of the ending portion (6); wherein

the ending portion (6) has a rectangular section having a height (H) and a width (W); the coupling portion (7) has a tapered shape in the width direction, with increasing width going from the inlet section (40) to the inter-

mediate section (42) in order to allow for a fluid expansion in the coupling portion; the central portion (20) of the casing has a height (H1) greater than the height (H) of the ending portion (6) of the outlet, so that the coupling portion (7) has a tapered shape in the height direction, with decreasing height going from the inlet section (40) to the intermediate section (42);
characterized in that
 the impeller (11) has forward curved blades and
 the height (H1) of the central portion (20) of the casing is 120-150% of the height (H) of the ending portion (6) of the outlet.

2. The extractor unit (100) according to claim 1, wherein the inlet section (40) has a width (Wi) that is 40-60% of the width (W) of the ending portion (6) of the outlet.
3. The extractor unit (100) according to any one of the preceding claims, wherein the coupling portion (7) has a length (L) of 20-40 mm.
4. The extractor unit (100) according to any one of the preceding claims, wherein the impeller (11) is a cylindrical squirrel-cage impeller.
5. The extractor unit (100) according to claim 4, wherein the impeller (11) has forward curved blades.
6. The extractor unit (100) according to any one of the preceding claims, wherein the central portion (20) of the casing is shaped like a substantially cylindrical receptacle.
7. The extractor unit (100) according to claim 6, wherein the central portion (20) of the casing has a spiral-shaped section along a plane orthogonal to the axis (X) of the impeller.

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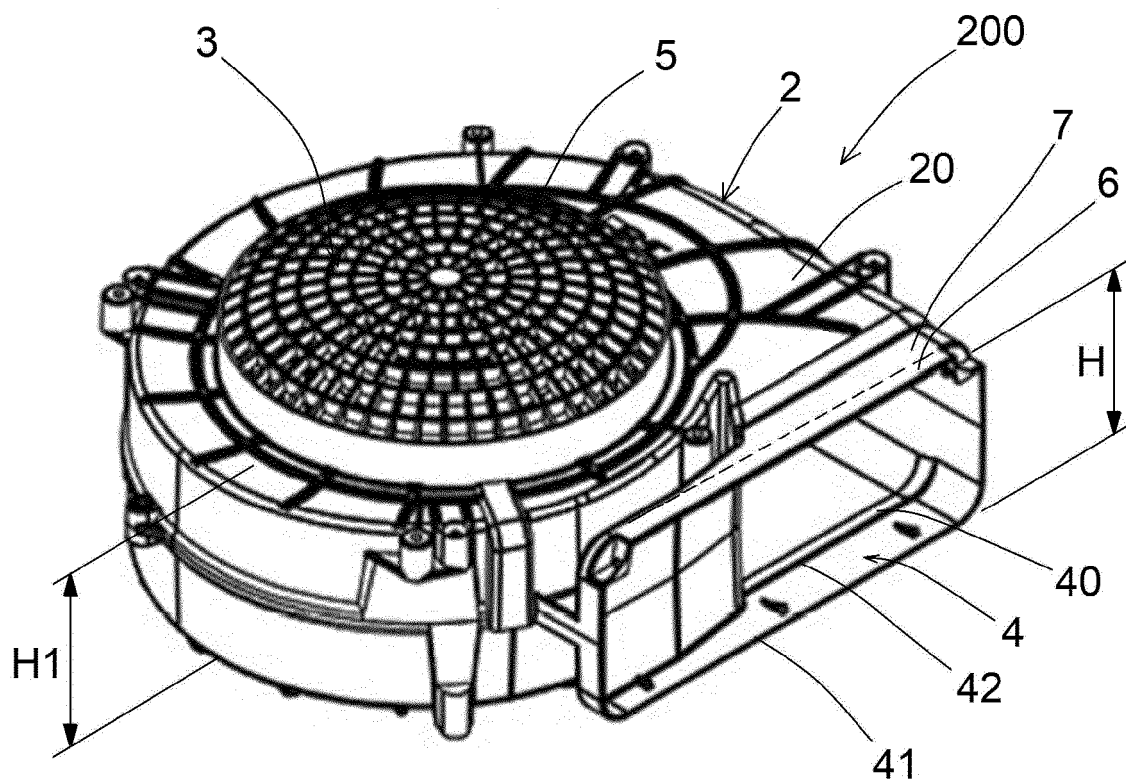


FIG. 1
PRIOR ART

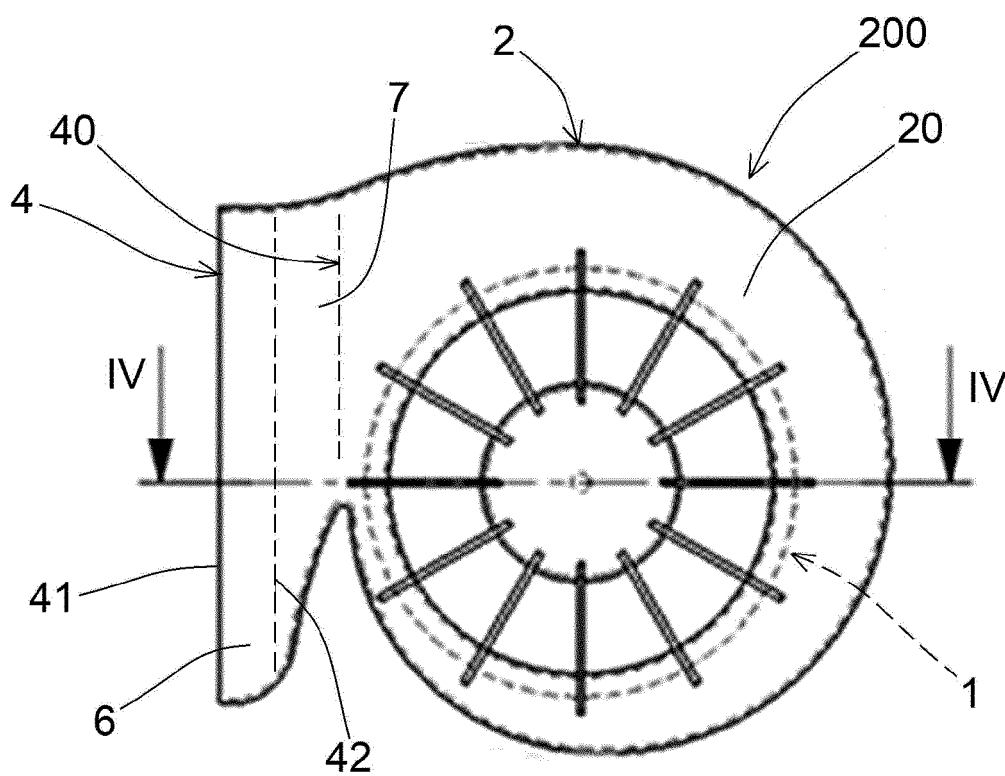


FIG. 2

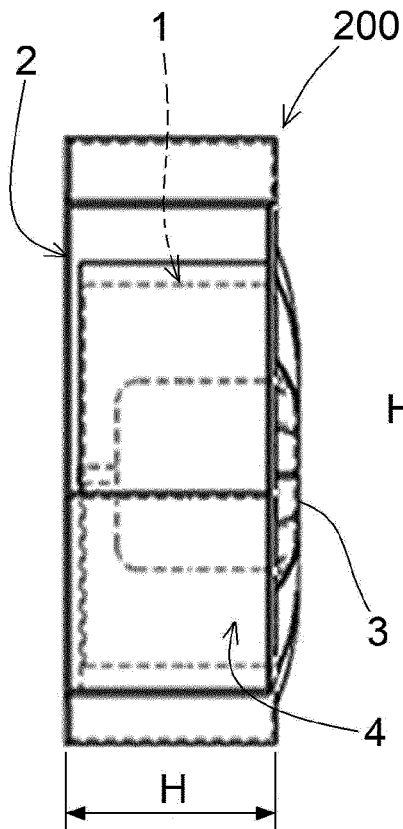


FIG. 3
PRIOR ART

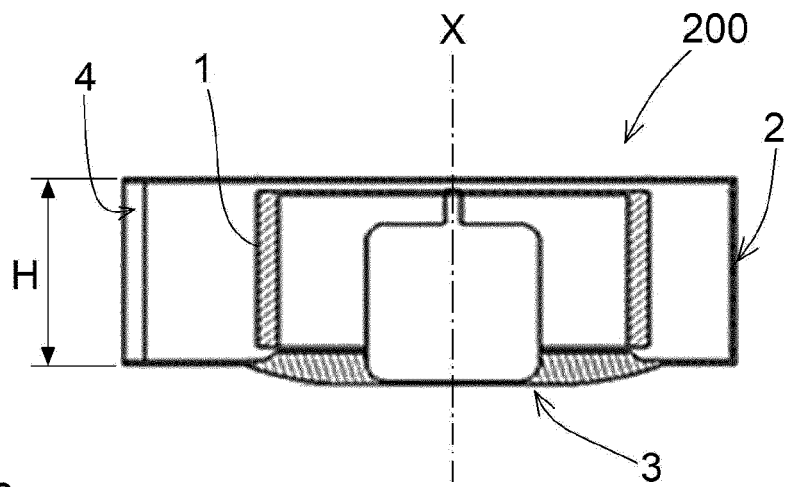


FIG. 4
PRIOR ART

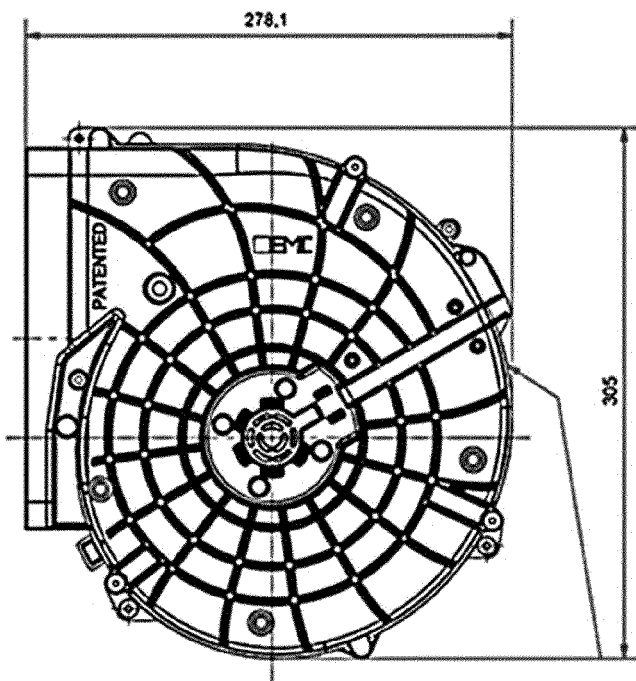
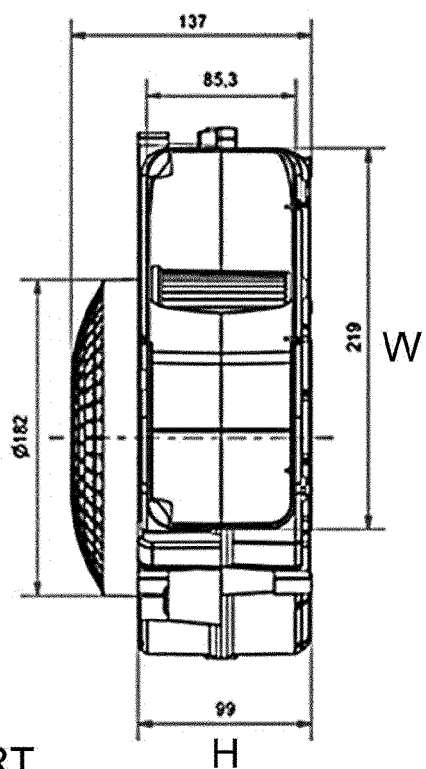
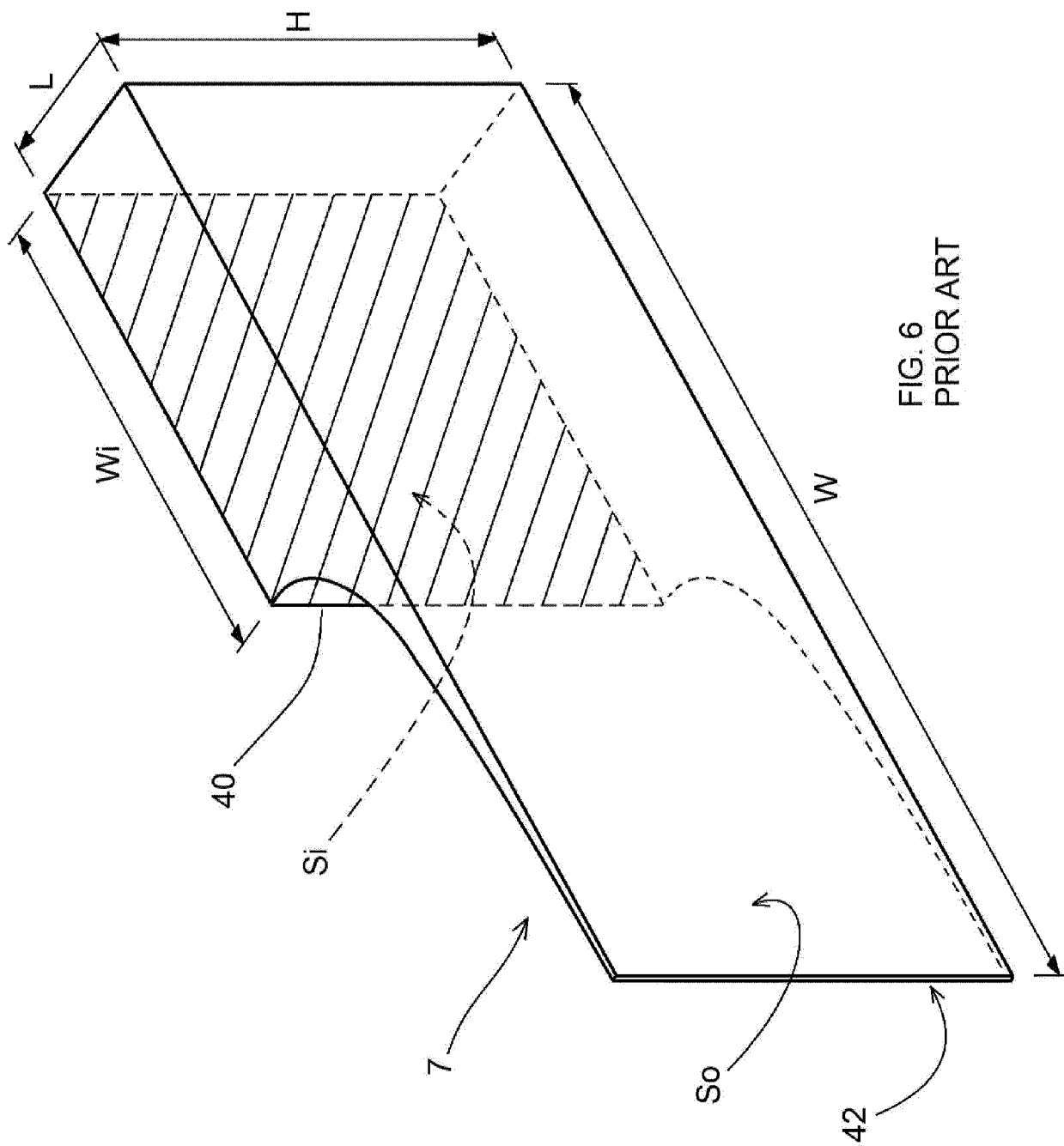


FIG. 5
PRIOR ART





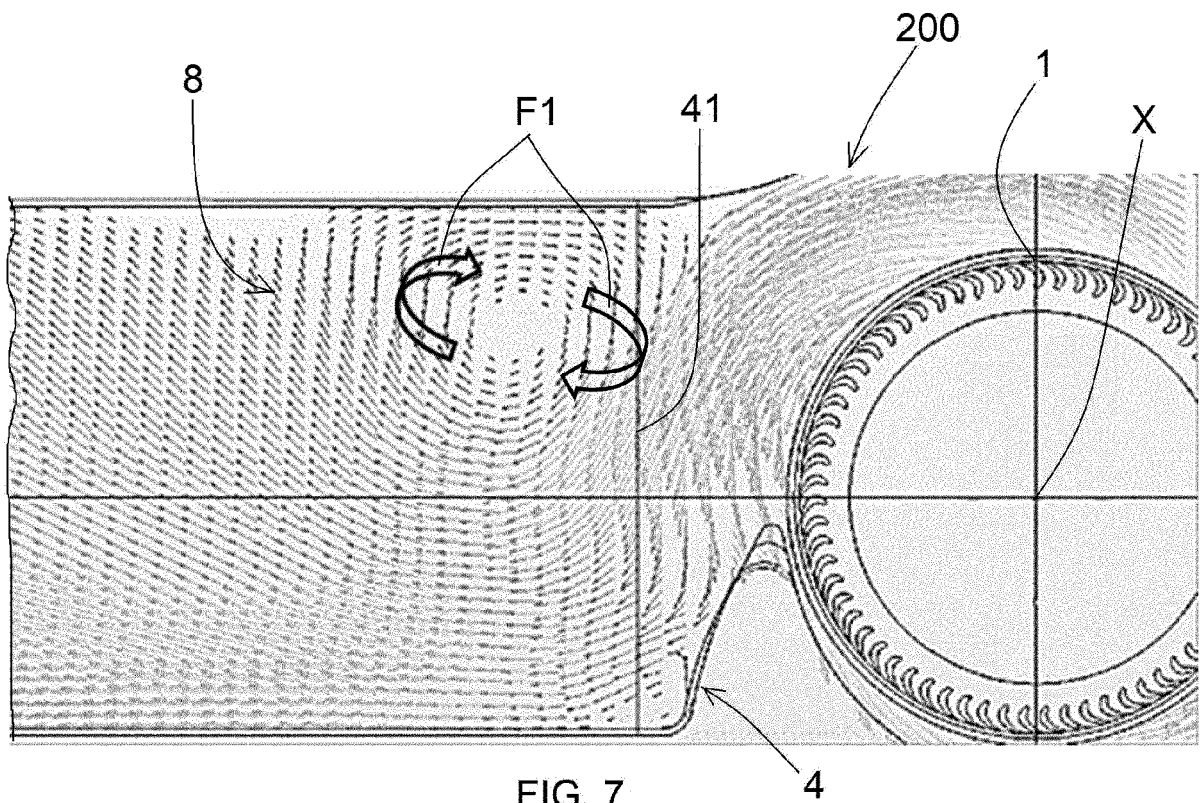


FIG. 7
PRIOR ART

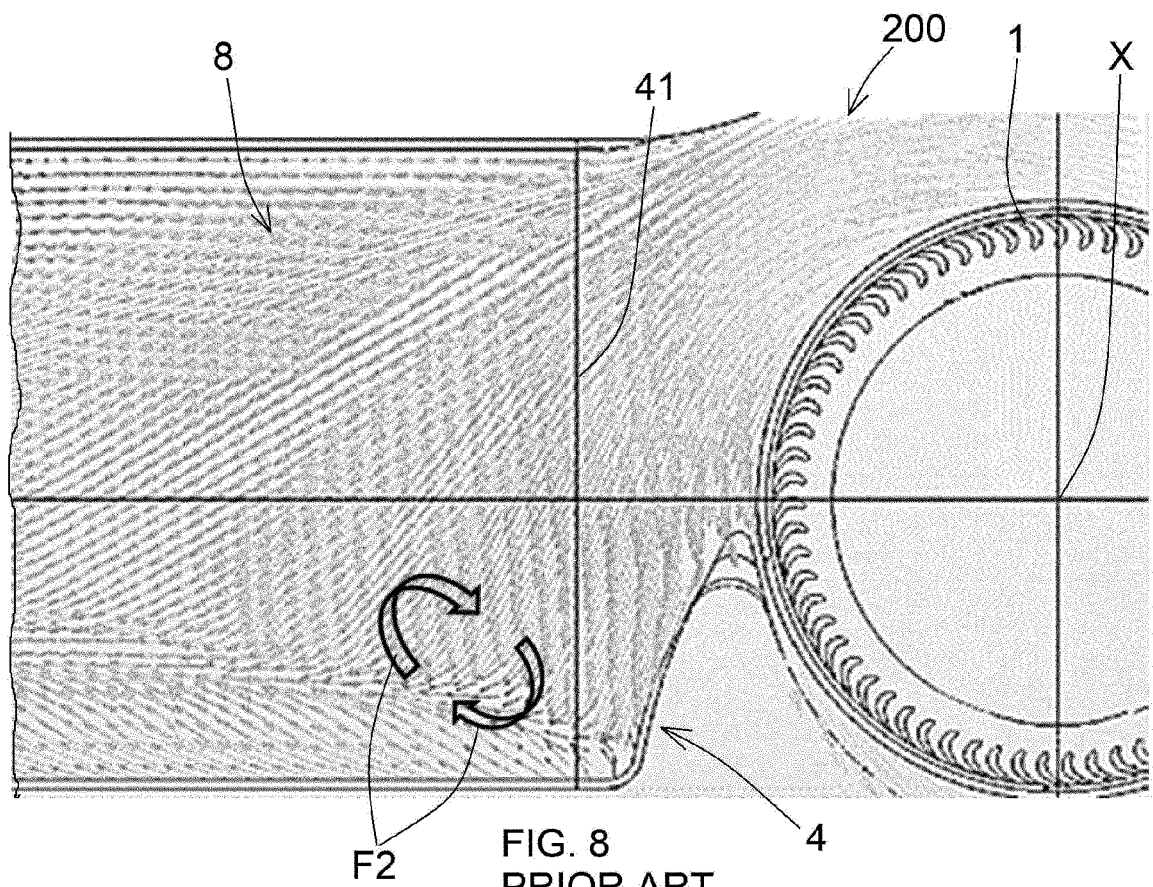


FIG. 8
PRIOR ART

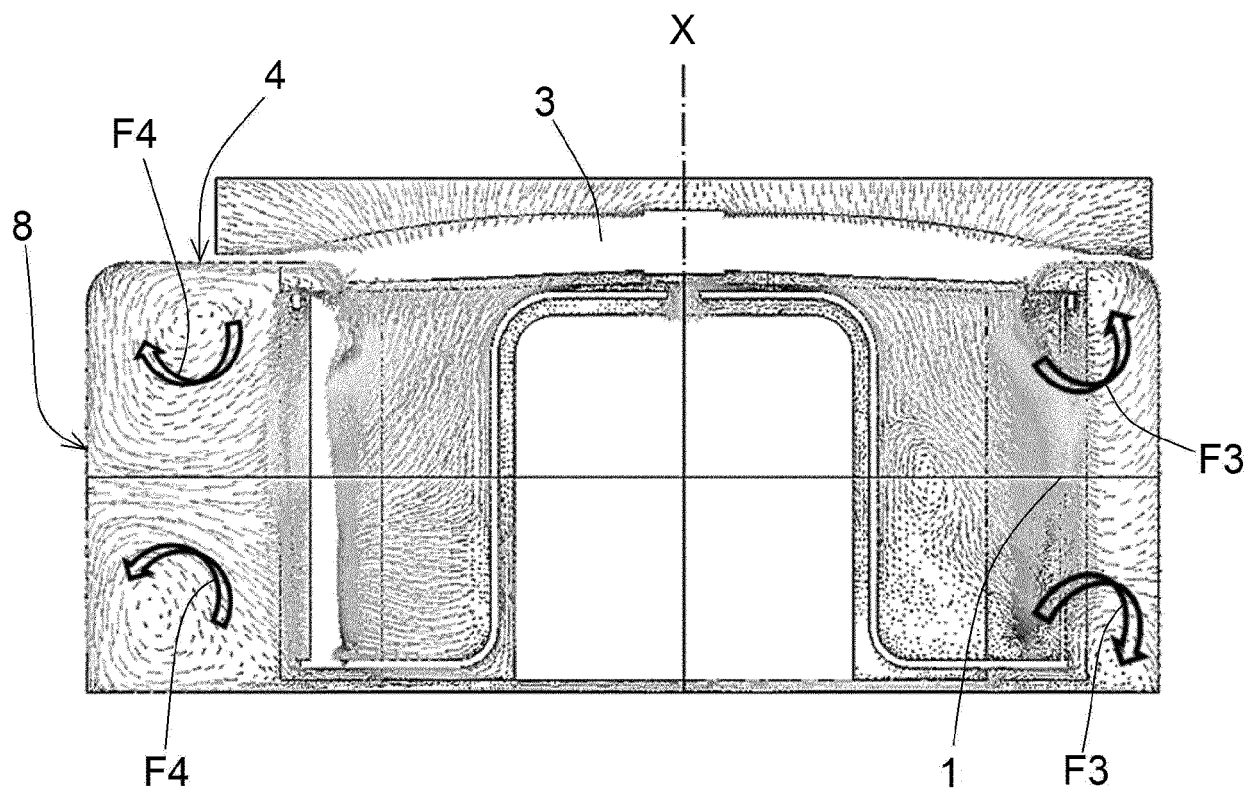


FIG. 9
PRIOR ART

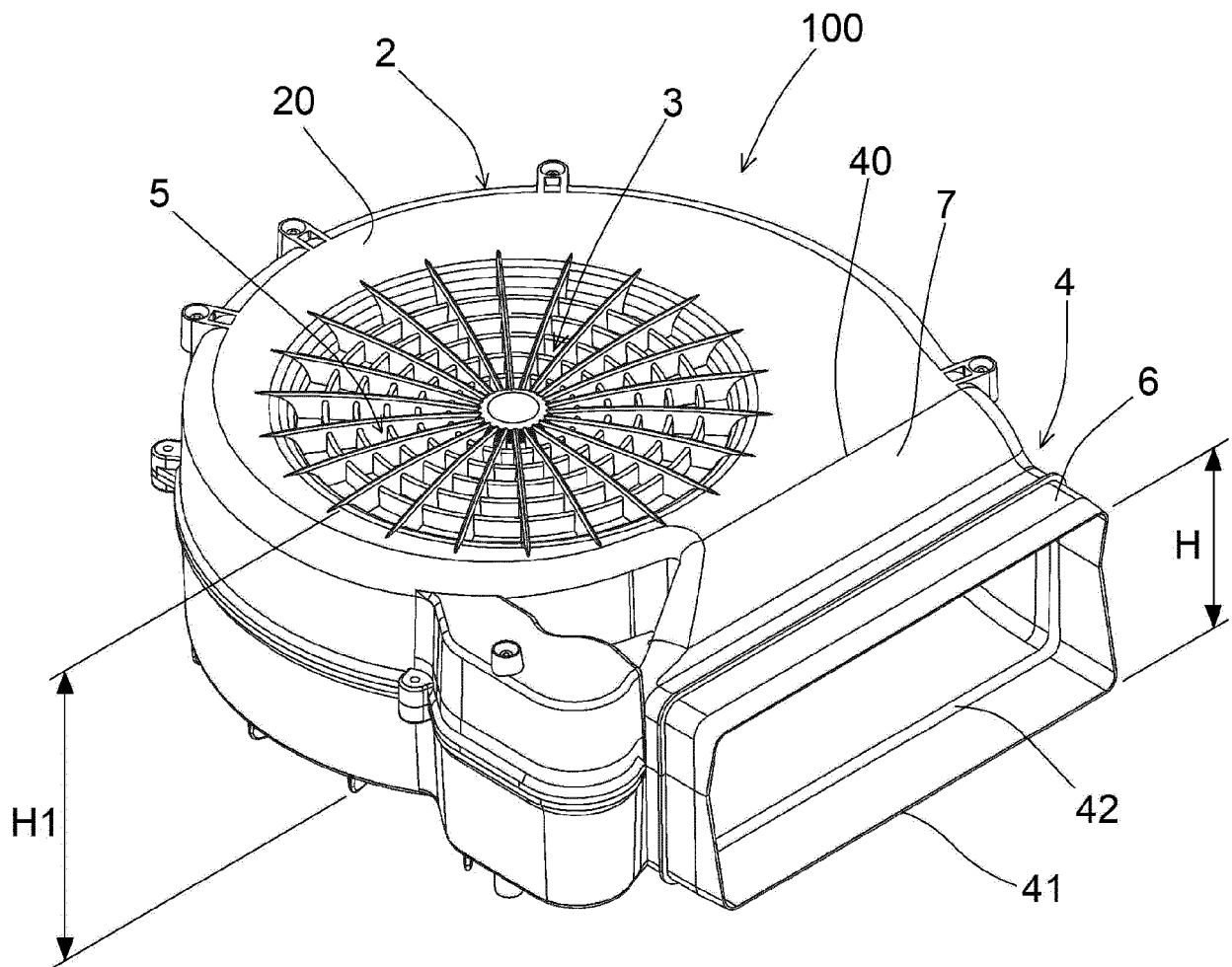


FIG. 10

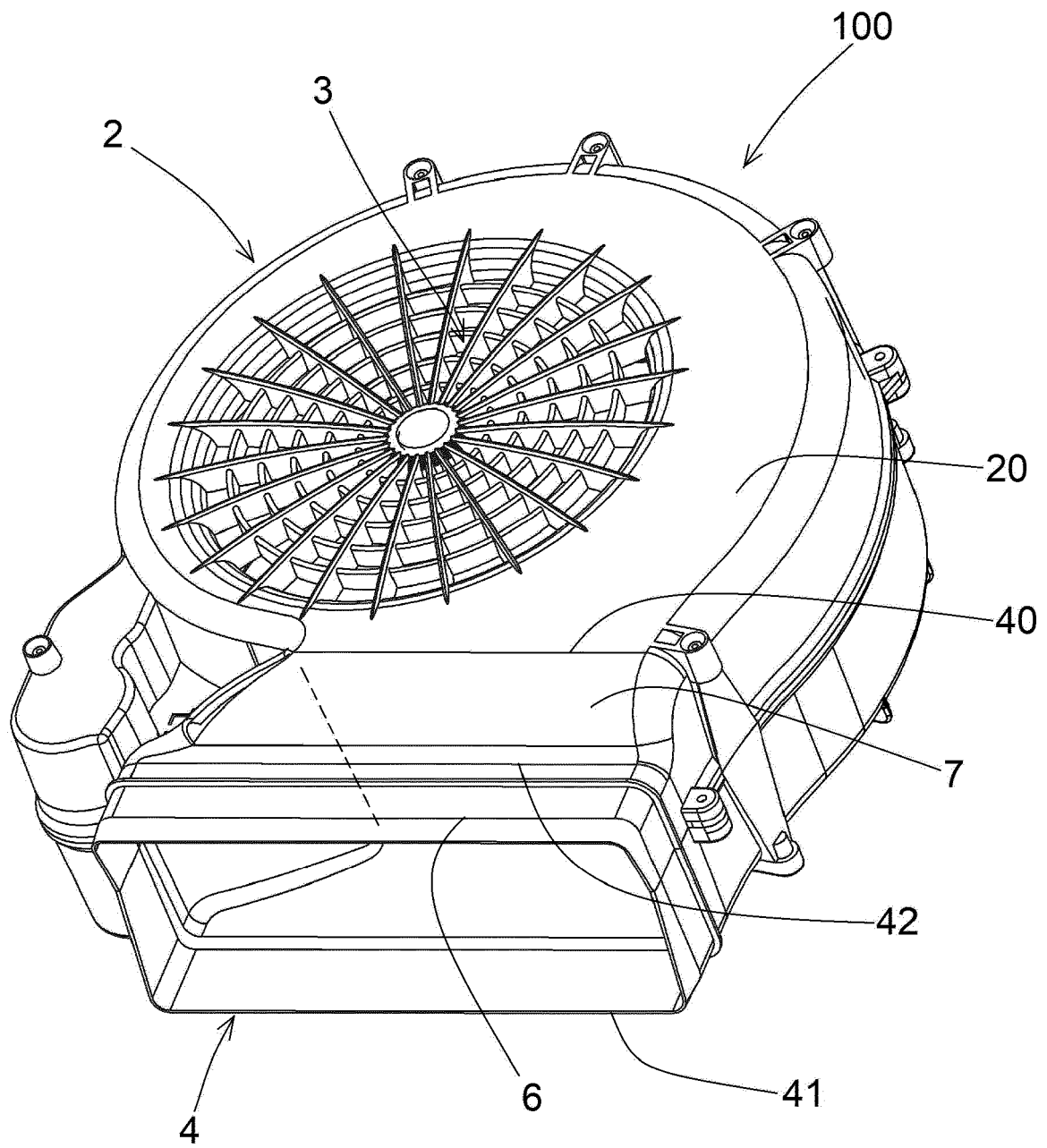


FIG. 11

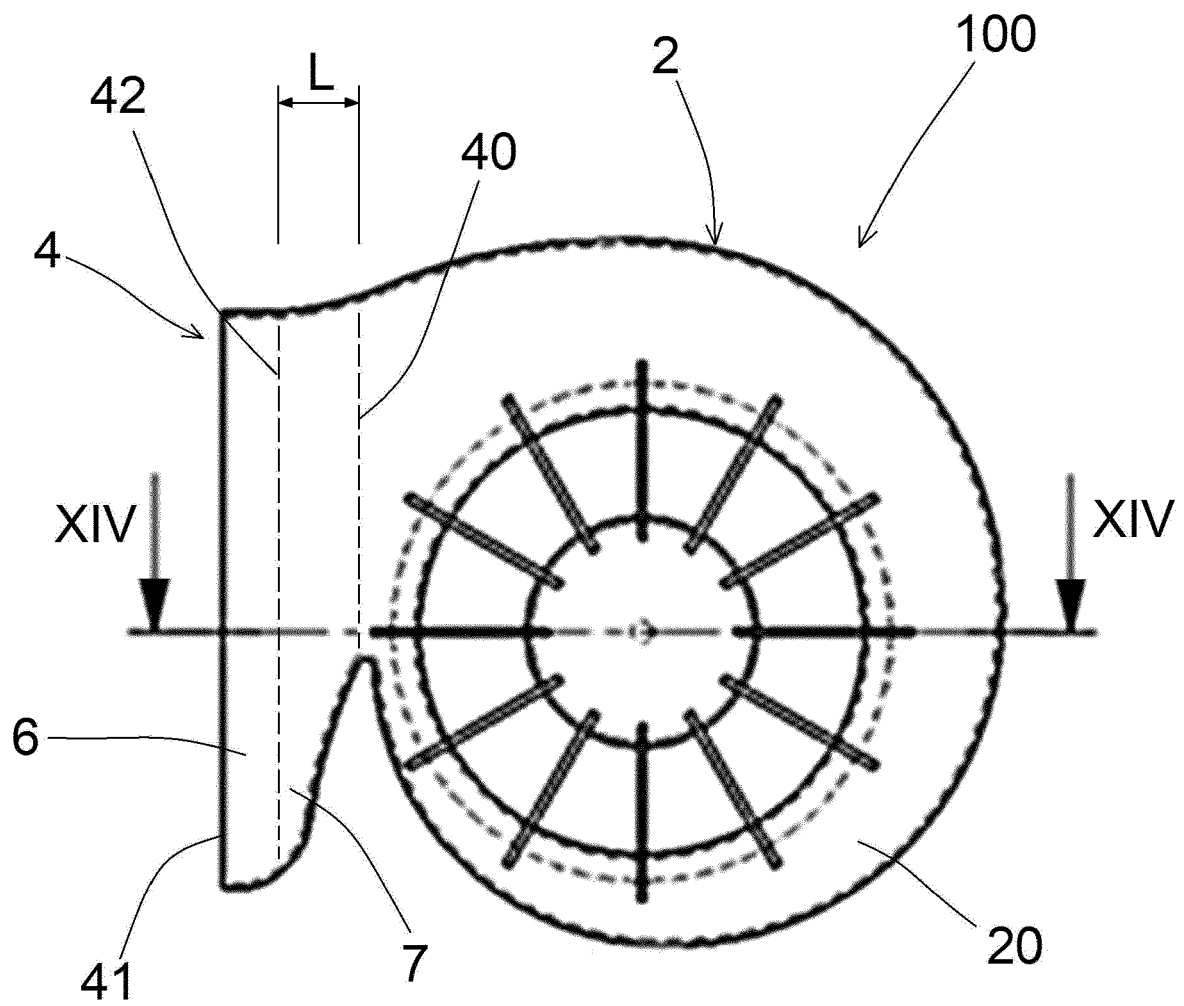


FIG. 12

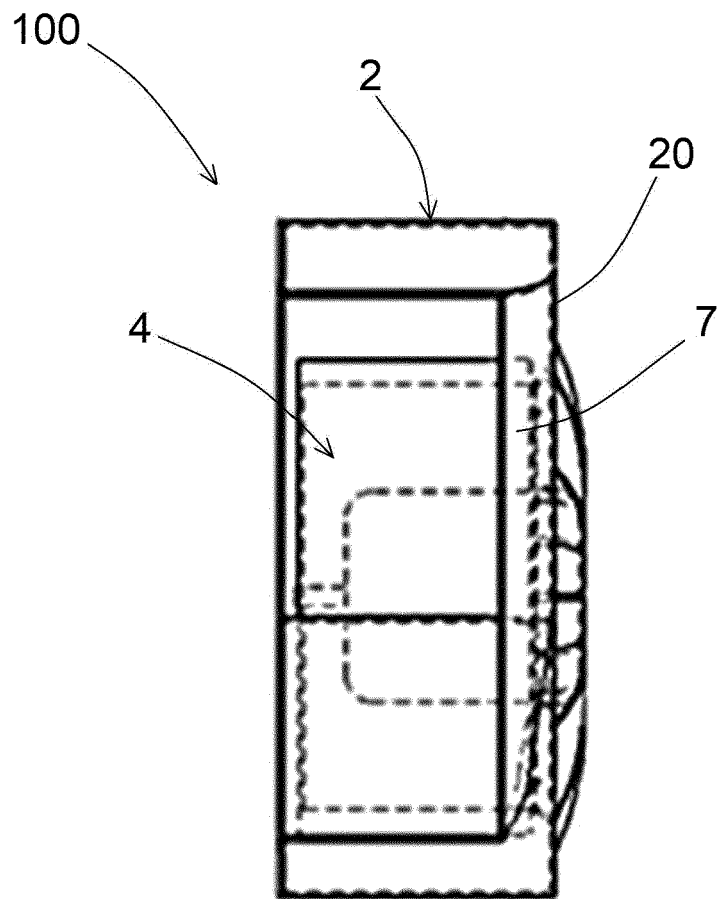


FIG. 13

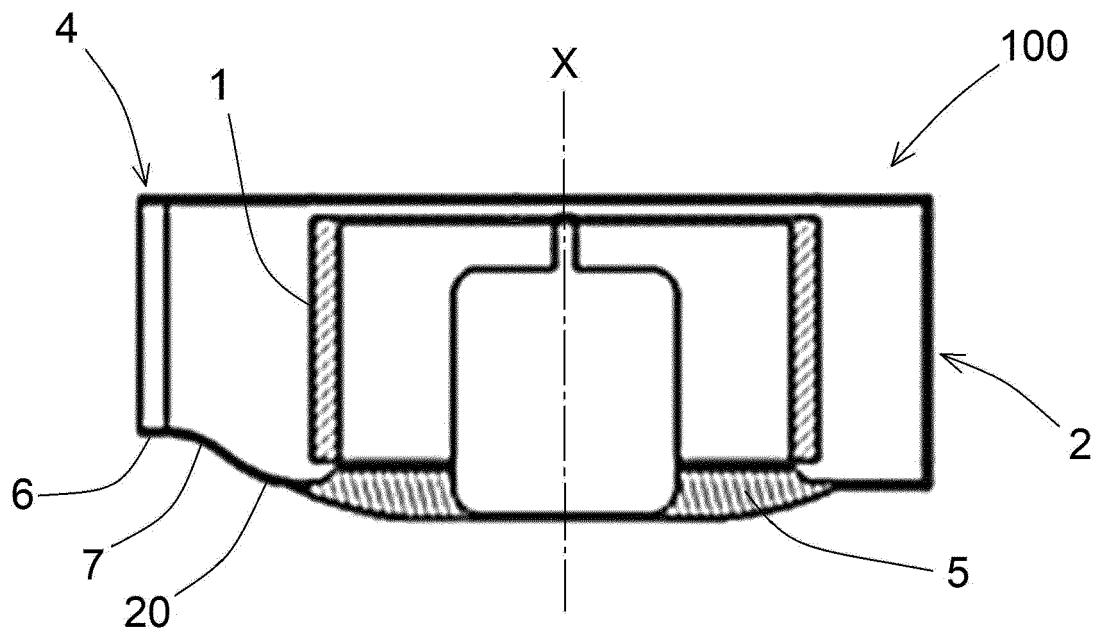


FIG. 14

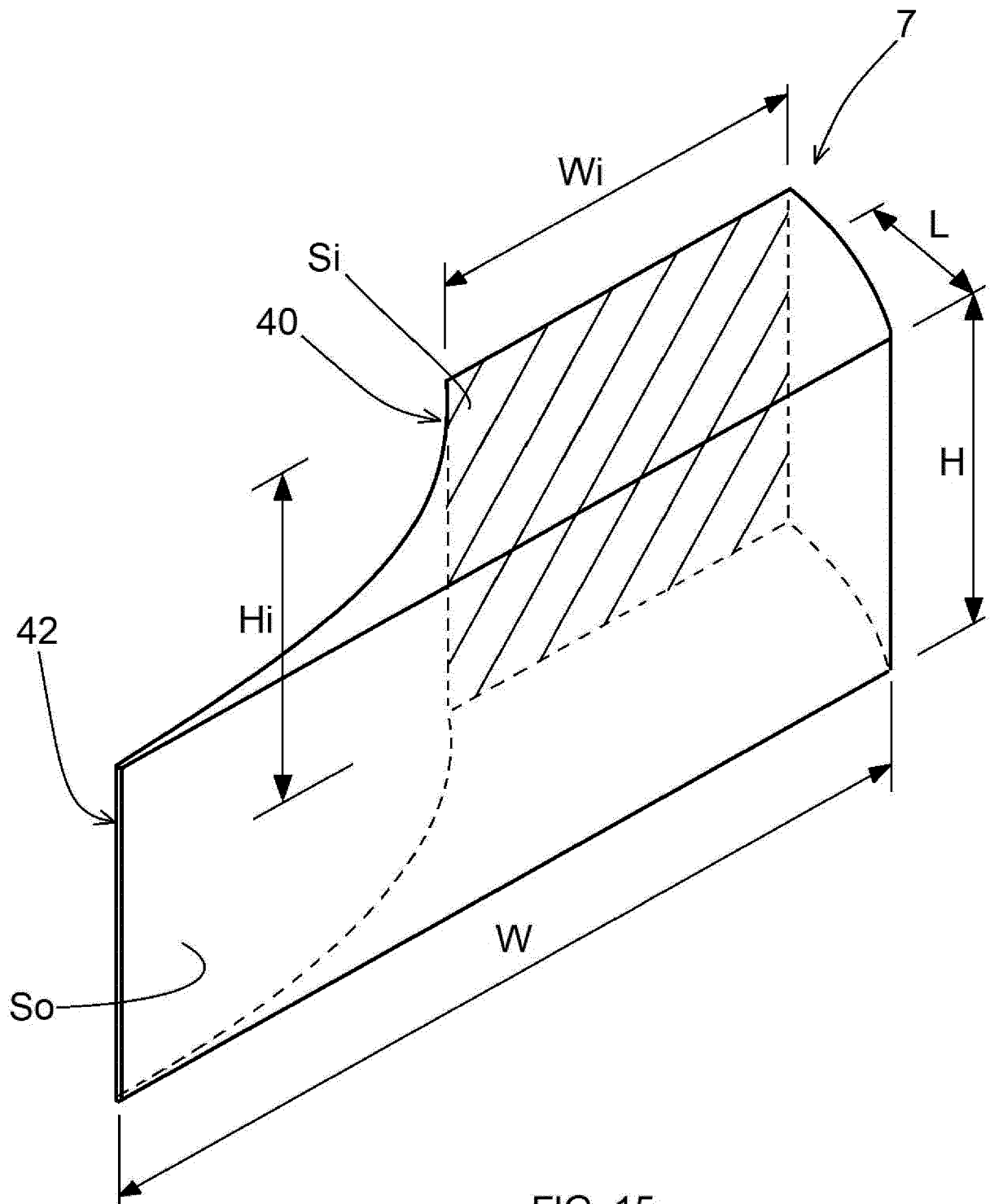


FIG. 15

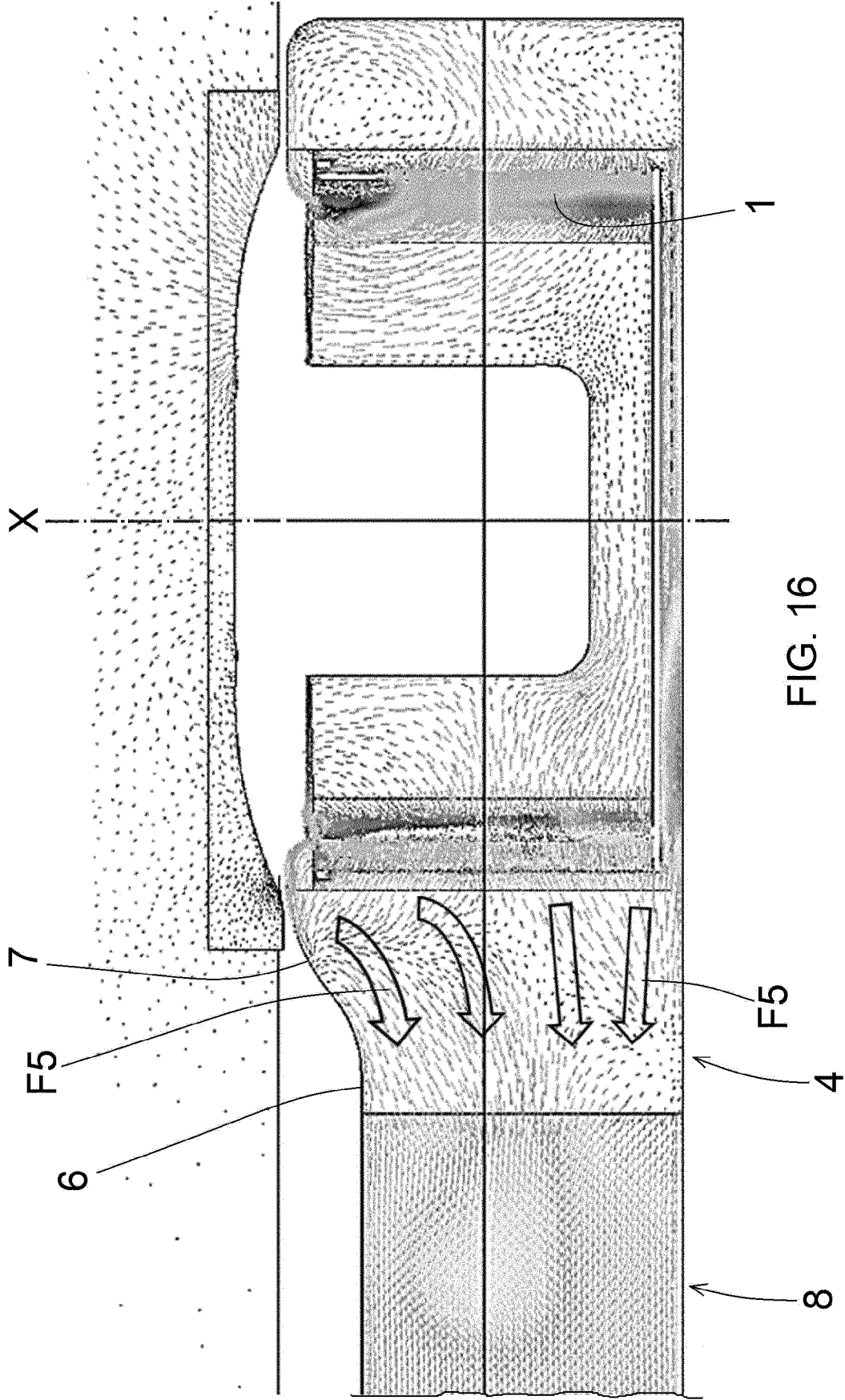


FIG. 16



EUROPEAN SEARCH REPORT

Application Number

EP 22 20 7719

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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