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(71) Applicant: **DENSO THERMAL SYSTEMS S.p.A.**
10046 Poirino (Torino) (IT)

(72) Inventors:
- **MERCOGLIANO, Francesco**
  I-10046 POIRINO (Torino) (IT)
- **BAIANO SVIZZERO, Antonio**
  I-10046 POIRINO (Torino) (IT)

(74) Representative: **Vanzini, Christian et al**
Jacobacci & Partners S.p.A.
Corso Emilia 8
10152 Torino (IT)

(54) CENTRIFUGAL BLOWER WITH SOUND ABSORPTION STRUCTURE FOR AUTOMOTIVE HVAC SYSTEMS

(57) Housing of plastics material for a centrifugal blower for automotive HVAC systems, comprising a base half shell (20) and a cover half shell (30) joined to each other, and a sound absorption structure comprising a chamber side panel (40) fitted into a seat (23) formed in the base half shell (20) and facing an impeller chamber (3a), and an outlet side panel (50) fitted into a seat (33) formed in the cover half shell (30) and facing an air outlet duct (3b).

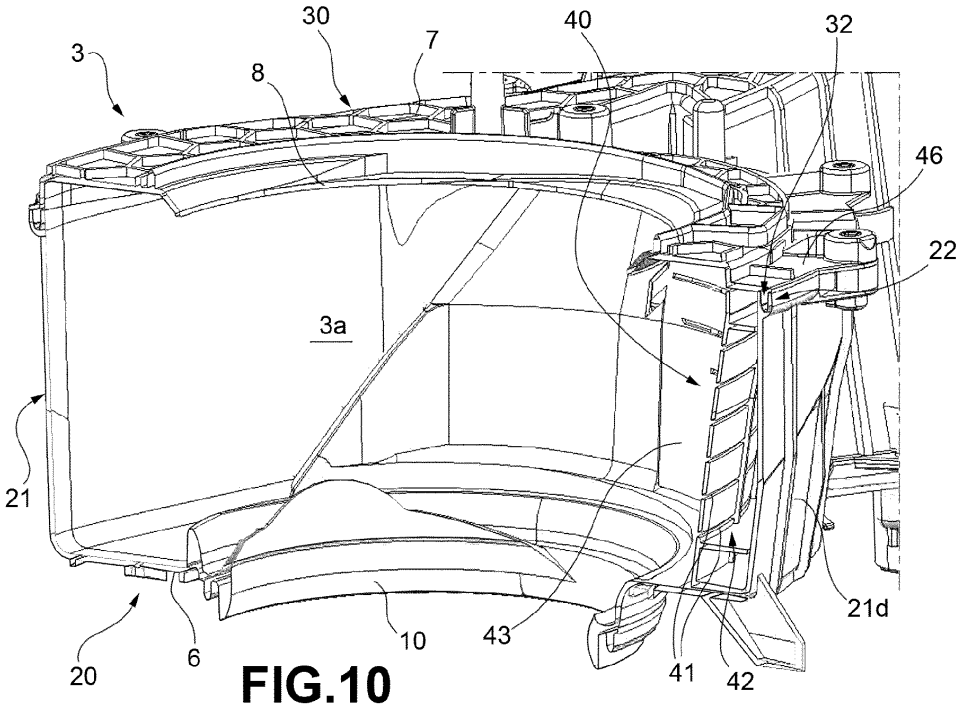

FIG.10

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Description

[0001] The present invention relates to a housing of plastics material for a centrifugal blower for automotive HVAC systems, having a base end wall, a cover end wall and a side wall extending between the base end wall and the cover end wall, in said housing there being defined an impeller chamber and an air outlet duct, wherein on the cover end wall there is formed an air inlet opening facing the impeller chamber, and on the side wall there is formed an air outlet opening facing the air outlet duct, wherein a sound absorption structure is arranged on said side wall, said sound absorption structure comprising at least one resonant cavity fluidically connected to the impeller chamber and the air outlet duct through a plurality of slits arranged on the side wall and facing at least one of said impeller chamber and air outlet duct.

[0002] In centrifugal blowers, the air drawn into the blower by the rotation of the impeller enters the inlet opening formed in one of the end walls of the housing of the blower with a direction parallel to the axis of rotation of the impeller and is subsequently expelled through the outlet opening formed in the side wall of the housing with a direction perpendicular to the inlet direction.

[0003] The use of a sound absorption structure makes it possible to reduce the noise generated by the air inside the housing of the blower. The resonant cavity/cavities and the communication openings thereof with the impeller chamber and air outlet duct are sized to create a Helmholtz resonance with the air being pushed by the impeller acting as a dynamic damper for sound waves. To increase the sound absorption effect, it may be envisaged for the resonant cavity to be at least partially filled with a porous sound absorption material.

[0004] An embodiment of a housing equipped with a sound absorption structure is described at the general concept level in the Applicant's Italian Patent Application No. 102019000006861.

[0005] One object of the present invention is to provide a solution to make the concept described in the Italian Patent Application No. 102019000006861 producible on an industrial scale.

[0006] For this object, the subject matter of the invention is a housing for centrifugal blowers of the type defined above, comprising

a base half shell formed by the base end wall and by a first portion of the side wall, protruding from the base end wall, said first portion of the side wall surrounding the impeller chamber and delimiting on a radially outer side the air outlet duct,

a cover half shell formed by the cover end wall and by a second portion of the side wall, protruding from the cover end wall, said second portion of the side wall delimiting on a radially inner side the air outlet duct, and

at least one of:

- a chamber side panel fitted into a seat formed in the base half shell and facing said impeller chamber, wherein said at least one resonant cavity is formed between the chamber side panel and said first portion of the side wall, and wherein said slits are formed on the chamber side panel, and
- an outlet side panel fitted into a seat formed in the cover half shell and facing said air outlet duct, wherein said at least one resonant cavity is formed between the outlet side panel and said second portion of the side wall, and wherein said slits are formed on the outlet side panel,

wherein the base half shell and the cover half shell are joined to each other.

[0007] The housing according to the invention may be made from three, or at most four, pieces of plastics material which are assembled together, and have relatively simple shapes and are thus easily made through conventional injection molding techniques. It therefore lends itself to economic implementation on an industrial scale.

[0008] Preferred embodiments of the invention are defined in the dependent claims, which are to be understood as an integral part of the present description.

[0009] Further features and advantages of the housing according to the invention will become clearer from the following detailed description of an embodiment of the invention, made in reference to the accompanying drawings, provided purely for illustrative and non-limiting purposes, wherein:

- Fig. 1 is a perspective view of a housing for a centrifugal blower according to the invention;
- Fig. 2 is an exploded view, showing the housing split into a base half shell and a cover half shell;
- Fig. 3 and 4 are perspective views of the base half shell from the outer and inner sides of the shell, respectively;
- Fig. 5 is a view of a chamber side panel configured to be fitted into the base half shell;
- Fig. 6 is a perspective view of the base half shell from which the chamber side panel has been removed;
- Fig. 7 and 8 are further perspective views of the base half shell;
- Fig. 9 is a sectional view of a detail of the base half shell, taken at the impeller chamber;
- Fig. 10 is a sectional view of the complete housing, taken at the impeller chamber;
- Fig. 11 is a perspective view of the cover half shell, taken from the inner side of the housing;
- Fig. 12 is a perspective view of the cover half shell, from which an outlet side panel has been removed;
- Fig. 13 and 14 are perspective views of the outlet side panel from the side facing the air outlet duct and from the rear side, respectively;

- Fig. 15 is a sectional view of a detail of the cover half shell, taken at the air outlet duct; and
- Fig. 16 is a sectional view of the complete housing, taken at the air outlet duct.

[0010] Fig. 1 shows a housing or volute made of plastics material for a centrifugal blower, denoted as a whole with 3.

[0011] The housing 3 is configured to accommodate an impeller I of the centrifugal blower, lightly depicted with dashed lines in Fig. 1. The housing 3 is also configured to be coupled to an electric motor (not shown) to drive the impeller I, which electric motor is arranged outside of the housing 3.

[0012] From the point of view of its overall shape/geometry, the housing or volute 3 comprises a pair of end walls 6 and 7, which hereinafter will be called "base end wall" and "cover end wall", respectively, and a side wall 9 extending between the end walls 6, 7. An air inlet opening 8 is formed on the cover end wall 7, and a passage opening 10 is formed on the base end wall 6, through which opening the shaft (not shown) passes, connecting the electric motor to the impeller I of the blower. An air outlet opening 11 is formed on the side wall 9 of the housing 3.

[0013] The end walls 6, 7 and the side wall 9 of the housing 3 cooperate to define an impeller chamber 3a, within which the impeller I is housed, and an air outlet duct 3b, which connects the impeller chamber 3a to the air outlet opening 11 and is configured to convey the air flow pushed in a centrifugal direction from the impeller I to the air outlet opening 11.

[0014] A sound absorption structure is arranged on the side wall 9, which will be described hereinafter.

[0015] In terms of its construction, the housing 3 comprises four pieces of plastics material assembled together. More specifically, the housing 3 comprises a base half shell 20, a cover half shell 30, a chamber side panel 40, and an outlet side panel 50.

[0016] The base half shell 20 is shown separately in Fig. 2-4 and 6-9. The base half shell 20 is essentially formed by the base end wall 6 and by a first portion 21 of the side wall 9, which protrudes from the base end wall 6. The first portion 21 of the side wall 9, which will also be referred to as the first wall portion 21 hereinafter, extends along part of the perimeter of the base end wall 6. More specifically, the first portion 21 extends so as to surround the impeller chamber 3a and delimit on a radially outer side the air outlet duct 3b. In this description, the radial positions are defined with respect to the central axis x of the impeller chamber 3b (shown in Fig. 6; the central axis x here defined corresponds to the position of the axis of rotation of the impeller I). Therefore, the radially outer side of the outlet duct 3b is the side of the outlet duct 3b furthest from the axis x.

[0017] In particular, the first portion 21 of the side wall 9 extends between an end area 21a thereof at the air outlet opening 11 and a rostrum-shaped end area 21b thereof at the junction of the impeller chamber 3a and the radially inner side of the air outlet duct 3b.

[0018] The base half shell 20 therefore comprises a peripheral edge 22 that partly extends along the entire first portion 21 of the side wall 9 and partly extends along the radially inner side of a portion 6a of the base end wall 6 that delimits the outlet duct 3b.

[0019] The cover half shell 30 is shown separately in Fig. 2, 11-12 and 15. The cover half shell 30 is essentially formed by the cover end wall 70 and by a second portion 31 of the side wall 9 that protrudes from the cover end wall 70. The second portion 31 of the side wall 9, which will also be referred to as the second wall portion 31 hereinafter, extends along part of the perimeter of the cover end wall 7. More specifically, the second portion 31 extends so as to delimit on a radially inner side the air outlet duct 3b.

[0020] In particular, the second portion 31 of the side wall 9 extends between an end area 31a thereof at the air outlet opening 11 and an end area 31b thereof adjacent to the junction between the impeller chamber 3a and the radially inner side of the air outlet duct 3b.

[0021] The cover half shell 30 therefore comprises a peripheral edge 32 that extends partly along the perimeter of the cover end wall 7 and partly along the second portion 31 of the side wall 9.

[0022] The base half shell 20 and the cover half shell 30 are joined to each other. More specifically, the peripheral edge 22 of the base half shell 20 and the peripheral edge 32 of the cover half shell 30 are joined to each other in a relationship of abutment against each other in a manner known per se in the industry, such as by screws or snap fasteners arranged along these peripheral edges, or by means of adhesives or welding.

[0023] When the base half shell 20 and the cover half shell 30 are joined to each other to make the housing 3, the side wall 9 of the housing 3 is formed by the union between the first portion 21 and the second portion 31. In particular, near the junction between the impeller chamber 3a and the radially inner side of the air outlet duct 3b there is a coupling between an edge of the end area 21b of the first wall portion 21 and the end area 31b of the second wall portion 31. In the assembled housing 3, the impeller chamber 3a is enclosed between the base end wall 6 and the first wall portion 21 of the cover half shell 20 on one side, and the cover end wall 7 of the cover half shell 30 on the other side, as may be seen in Fig. 10. In contrast, the air outlet duct 3b, for most of its length, and the air outlet opening 11 are enclosed between the base end wall 6 and the first wall portion 21 (radially outer side of the duct) of the cover half shell 20 on the one side, and the cover end wall 7 and the wall portion 31 (radially inner side of the duct) of the cover half shell 30 on the other, as may be seen in Fig. 1 and 16. At the junction between the impeller chamber 3a and the air outlet duct 3b, the air outlet duct 3b is initially enclosed between the base end wall 6 (radially outer side and radially inner side of the duct) and the first wall portion 21 of the cover half

shell 20 on one side, and the cover end wall 7. Moving toward the air outlet opening 11, the height of the first wall portion 21 of the base half shell 20 on the radially inner side of the duct decreases, giving way to the second wall portion 31 of the cover half shell 30, the height of which increases accordingly. However, this transition is limited in a short segment of the air outlet duct 3b near the junction with the impeller chamber 3a.

[0024] The sound absorption structure of the blower is obtained by the chamber side panel 40 and the outlet side panel 50.

[0025] The chamber side panel 40 is shown in Fig. 2, 4-5 and 7-10. The chamber side panel 40 is fitted into a seat 23 formed in the base half shell 20, whereby it faces the impeller chamber 3a at a given distance from the first wall portion 21. This creates at least one resonant cavity 42 between the chamber side panel 40 and the first wall portion 21, which cavity is fluidically connected with the impeller chamber 3a. This fluidic connection is made through a plurality of slits 41 formed on (or rather, through) the chamber side panel 40. In the example shown, these slits 41 are formed as an array of parallel slits extending approximately along the main direction of the airflow in the impeller chamber 3a. However, the shape and arrangement of the slits may be designed differently from those depicted in the figures, depending on the conditions under which the blower is expected to operate.

[0026] A porous sound absorption material (not shown) may be placed inside the resonant chamber 42.

[0027] The chamber side panel 40 is arch-shaped (see in particular Fig. 5). The seat 23 that receives the chamber side panel 40 is formed as a recess in the first wall portion 21, facing the impeller chamber 3a (see in particular Fig. 6). When fitted into the relative seat 23, the chamber side panel 40 has a surface 43 facing the impeller chamber 3a that is flush with a surface 21c, facing the impeller chamber 3a, of an area of the first wall portion 21 adjacent to the seat 23.

[0028] The chamber side panel 40 and the relative seat 23 have an angular extension α, with respect to the central axis x of the impeller chamber 3a, of less than 180°. The chamber side panel 40 and the seat 23 extend along a segment of the perimeter of the impeller chamber 3a from the end area 21b of the first portion of the wall at the junction between the impeller chamber 3a and the radially inner side of the air outlet duct 3b. This arrangement makes it possible to limit the sound absorption structure where the effects of the turbulence created by the airflow in the impeller chamber are most significant.

[0029] As may be seen in Fig. 5-7, the chamber side panel 40 has side ends 40a, 40b that are coupled to respective side ends 23a, 23b of the relative seat 23. In particular, the insertion of the chamber side panel 40 into the seat 23 is done through ribs 44 fitted onto the side ends 40a, 40b of the chamber side panel 40, which are fitted into respective guide grooves 24 formed in the ends 23a, 23b of the seat (the arrangement of ribs and grooves may be reversed from that described above, if necessary). Thus, the insertion of the chamber side panel 40 occurs substantially in the direction of the height of the first wall portion 21.

[0030] The chamber side panel 40 also has terminal ends 40c, 40d coupled to the base end wall 6 and to the cover end wall 7, respectively. This coupling is achieved by means of alignment pins 45 fitted onto the terminal ends 40c, 40d of the chamber side panel 40, which are fitted into respective holes 6b, 7b formed in the base end wall 6 and in the cover end wall 7 (the arrangement of pins and holes may be reversed from that described above, if necessary).

[0031] The chamber side panel 40 has rearwardly at least one ledge protrusion 46 that extends within the seat 23 up to the lowered part 21d of the first wall portion 21 surrounding the seat 23. This achieves a complete closure of the seat 23 by the chamber side panel 40.

[0032] The outlet side panel 50 is shown in Fig. 2, and 11-16. The outlet side panel 50 is fitted into a seat 33 formed in the cover half shell 30 so that it faces the air outlet duct 3b, at a given distance from the second wall portion 31. This creates at least one resonant cavity 52 between the outlet side panel 50 and the second wall portion 31, which cavity is fluidically connected with the air outlet duct 3b. This fluidic connection is made by means of a plurality of slits 51 formed on (or rather, through) the outlet side panel 50. In the example shown, these slits 51 are formed as an array of parallel slits extending approximately along the main direction of the airflow in the air outlet duct 3b. However, the shape and arrangement of the slits may be designed differently from those shown in the figures, according to the conditions under which the blower is expected to operate.

[0033] A porous sound absorption material (not shown) may be placed inside the resonant chamber 52.

[0034] The seat 33 that receives the outlet side panel 50 is formed as a recess in the second wall portion 31, facing the air outlet duct 3b (see in particular Fig. 12). When fitted into the relative seat 33, the outlet side panel 50 has a surface 53 facing the air outlet duct 3b that is flush with a surface 31c, facing the air outlet duct 3b, of an area of the second wall portion 31 adjacent to the seat 33.

[0035] The outlet side panel 50 and the seat 33 extend for a partial segment of the length of the air outlet duct 3b from the end area 31b of the second wall portion 31 adjacent to the junction between the impeller chamber 3a and the radially inner side of the air outlet duct 3b. This arrangement makes it possible to limit the sound absorption structure where the effects of the turbulence created by the airflow in the impeller chamber are most significant.

[0036] As may be seen in Fig. 12-14, the outlet side panel 50 has side ends 50a, 50b that are coupled to respective side ends 33a, 33b of the relative seat 33. In particular, the insertion of the outlet side panel 50 into the seat 33 is done through ribs 54 fitted onto the side

ends 50a, 50b of the outlet side panel 50, which are fitted into respective guide grooves 34 formed in the ends 33a, 33b of the seat (the arrangement of ribs and grooves may be different from that described above, e.g., reversed therefrom). Thus, the insertion of the outlet side panel 50 occurs substantially in the direction of the height of the second wall portion 31.

[0037] The outlet side panel 50 also has terminal ends 50c, 50d coupled to the cover end wall 7 and to the base end wall 6, respectively. This coupling is done by means of alignment holes/pins 55 formed on the terminal ends 50c, 50d of the outlet side panel 50, which are coupled to respective alignment pins/holes 7c, 6c formed in the cover end wall 7 and in the base end wall 6 (the arrangement of pins and holes may be different from that described above, e.g. reversed therefrom).

[0038] The outlet side panel 50 has rearwardly at least one ledge projection 56 that extends within the seat 33 to the lowered part 31d of the first wall portion 31 surrounding the seat 33. In this way, a complete closure of the seat 33 by the outlet side panel 50 is obtained.

[0039] According to alternative embodiments that are not shown, the sound absorption structure may be provided only in the impeller chamber 3a or only in the air outlet duct 3b. In which case, only the impeller side panel 40 or, respectively, the outlet side panel 50 will be provided.

Claims

1. A housing of plastics material for a centrifugal blower for automotive HVAC systems, having a base end wall (6), a cover end wall (7) and a side wall (9) extending between the base end wall (6) and the cover end wall (7), in said housing there being defined an impeller chamber (3a) and an air outlet duct (3b), wherein on the cover end wall (7) there is formed an air inlet opening (8) facing the impeller chamber (3a), and on the side wall (9) there is formed an air outlet opening (11) facing the air outlet duct (3b),

wherein a sound absorption structure is arranged on said side wall, said sound absorption structure comprising at least one resonant cavity (42, 52) fluidically connected to the impeller chamber (3a) and the air outlet duct (3b) through a plurality of slits (41, 51) arranged on the side wall (9) and facing at least one of said impeller chamber and air outlet duct,

characterized by comprising

a base half shell (20) formed by the base end wall (6) and by a first portion (21) of the side wall (9), protruding from the base end wall (6), said first portion of the side wall surrounding the impeller chamber (3a) and delimiting on a radially outer side the air outlet duct (3b),

a cover half shell (30) formed by the cover end wall (7) and by a second portion (31) of the side wall (9), protruding from the cover end wall (7), said second portion of the side wall delimiting on a radially inner side the air outlet duct (3b), and

at least one of:

- a chamber side panel (40) fitted in a seat (23) formed in the base half shell (20) and facing said impeller chamber (3a), wherein said at least one resonant cavity (42) is formed between the chamber side panel (40) and said first portion (21) of the side wall (9), and wherein said slits (41) are formed on the chamber side panel (40), and
- an outlet side panel (50) fitted in a seat (33) formed in the cover half shell (30) and facing said air outlet duct (3b), wherein said at least one resonant cavity (52) is formed between the outlet side panel (50) and said second portion (31) of the side wall (9), and wherein said slits (51) are formed on the outlet side panel (50),

wherein the base half shell (20) and the cover half shell (30) are joined to each other.

2. The housing according to claim 1, wherein the base half shell (20) comprises a peripheral edge (22) extending along said first portion (21) of the side wall (9) and along a portion (6a) of the base end wall (6) delimiting the outlet duct (3b), wherein the cover half shell (30) comprises a peripheral edge (32) extending along the perimeter of the cover end wall (7) and along said second portion (31) of the side wall (9), the peripheral edge (22) of the base half shell (20) and the peripheral edge (32) of the cover half shell (30) being joined to each other.

3. The housing according to any of the preceding claims, wherein the chamber side panel (40) is arch-shaped, and the seat (23) in which the chamber side panel is fitted is formed as a recess in the first portion (21) of the side wall (9), facing the impeller chamber (3a), wherein the chamber side panel (40) has a surface (43) facing the impeller chamber (3a) which is flush with a surface (21c), facing the impeller chamber (3a), of an area of the first portion (21) of the side wall (9) adjacent to the seat (23).

4. The housing according to claim 3, wherein the chamber side panel (40) and the respective seat (23) have an angular span, with respect to the central axis (x) of the impeller chamber (3a), smaller than 180°, said chamber side panel and seat extending from an end area (21b) of the first portion (21) of the side wall (9) at the junction between the impeller chamber (3a) and the radially inner side of the air outlet duct (3b).

5. The housing according to claim 3 or 4, wherein the chamber side panel (40) has lateral ends (40a, 40b) coupled to respective lateral ends (23a, 23b) of the respective seat (23) through ribs (44) fitted into respective guide grooves (24), and wherein the chamber side panel (40) has terminal ends (40c, 40d) coupled to the base end wall (6) and to the cover end wall (7), respectively, through alignment pins (45) fitted into respective holes (6b, 7b).

6. The housing according to any of claims 3 to 5, wherein the chamber side panel (40) has rearwardly at least one ledge protrusion (46) extending within the seat (23) of the chamber side panel (40) up to the first portion (21) of the side wall (9).

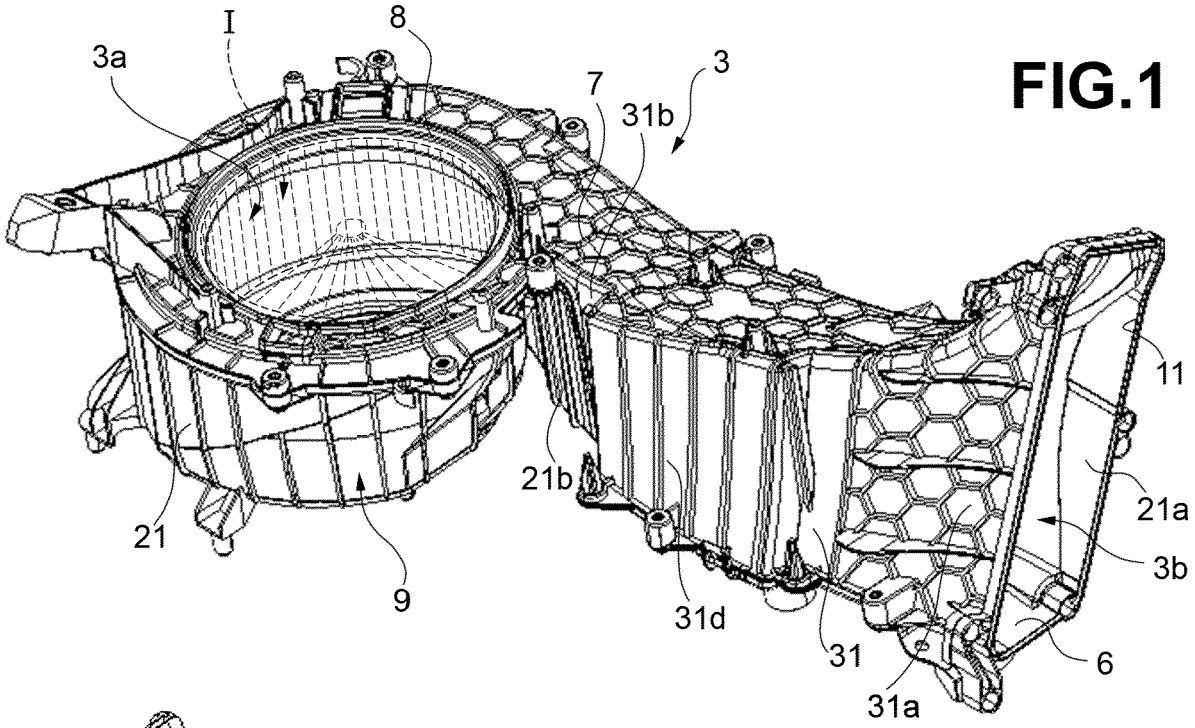
7. The housing according to any of the preceding claims, wherein the seat (33) in which the outlet side panel (50) is fitted is formed as a recess in the second portion (31) of the side wall (9), facing the air outlet duct (3b), wherein the outlet side panel (50) has a surface (53) facing the air outlet duct (3b) which is flush with a surface (31c), facing the air outlet duct (3b), of an area of the second portion (31) of the side wall (9) adjacent to the seat (33).

8. The housing according to claim 7, wherein the outlet side panel (50) and the respective seat (33) have a longitudinal span smaller than the length of the air outlet duct (3b), said outlet side panel and seat extending from an end area (31b) of the second portion (31) of the side wall (9) adjacent to the junction between the impeller chamber (3a) and the radially inner side of the air outlet duct (3b).

9. The housing according to claim 7 or 8, wherein the outlet side panel (50) has lateral ends (50a, 50b) coupled to respective lateral ends (33a, 33b) of the respective seat (33) through ribs (54) fitted into respective guide grooves (34), and wherein the outlet side panel (50) has terminal ends (50c, 50d) coupled to the cover end wall (7) and to the base end wall (6), respectively, through alignment pins (55, 7c) fitted into respective holes (6c, 55).

10. The housing according to any of claims 7 to 9, wherein the outlet side panel (50) has rearwardly at least one ledge projection (56) extending within the seat (33) of the outlet side panel (50) up to the second portion (31) of the side wall (9).

11. The housing according to any of the preceding claims, wherein said at least one resonant cavity (42, 52) is at least partially filled with a sound adsorbing porous material.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3a
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31b
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21b
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3b
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31d
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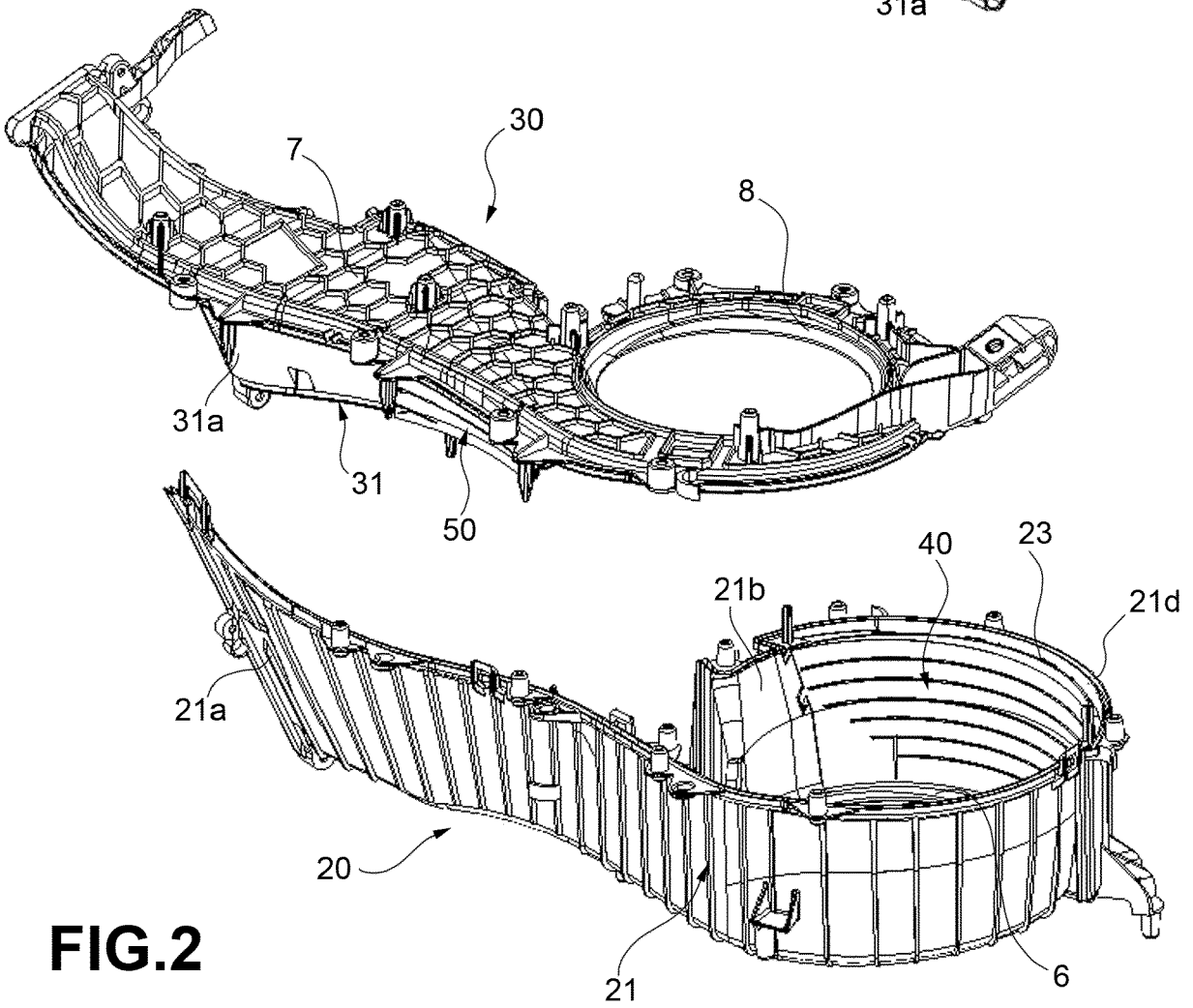
31a

FIG.1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21b
21d
21a
20
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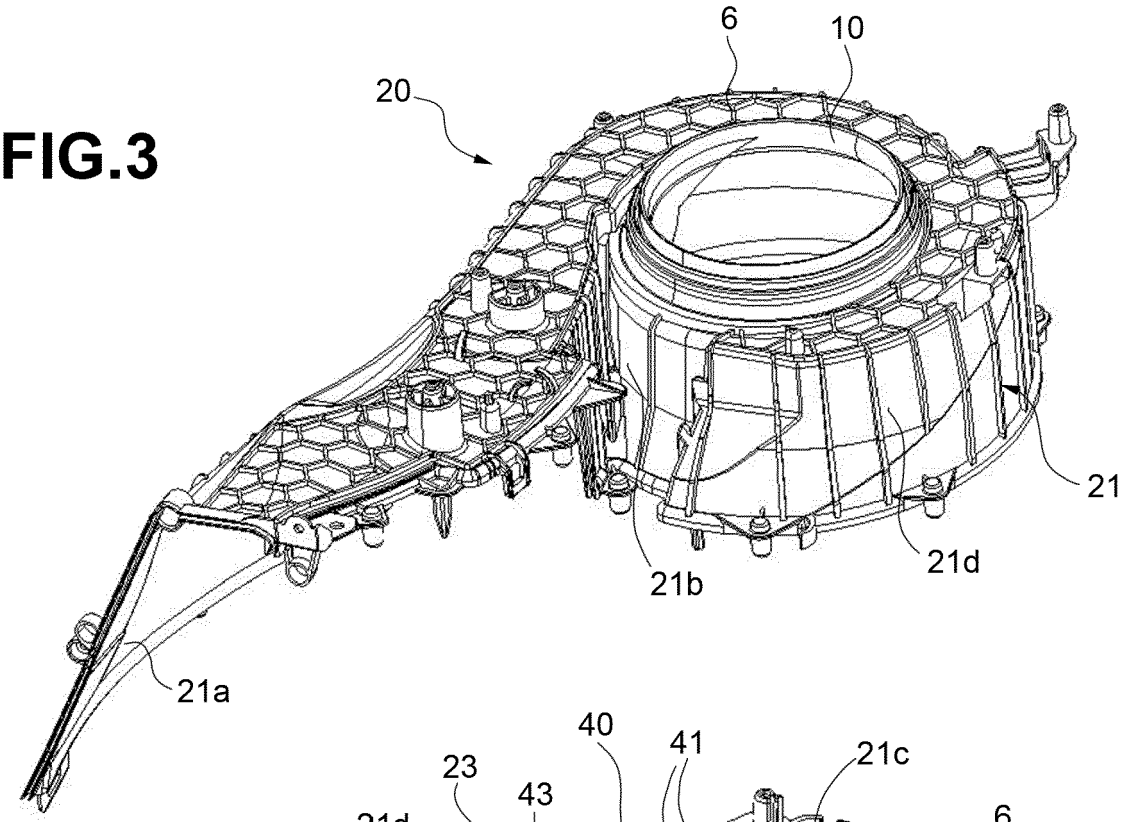
6

FIG.2

FIG.3



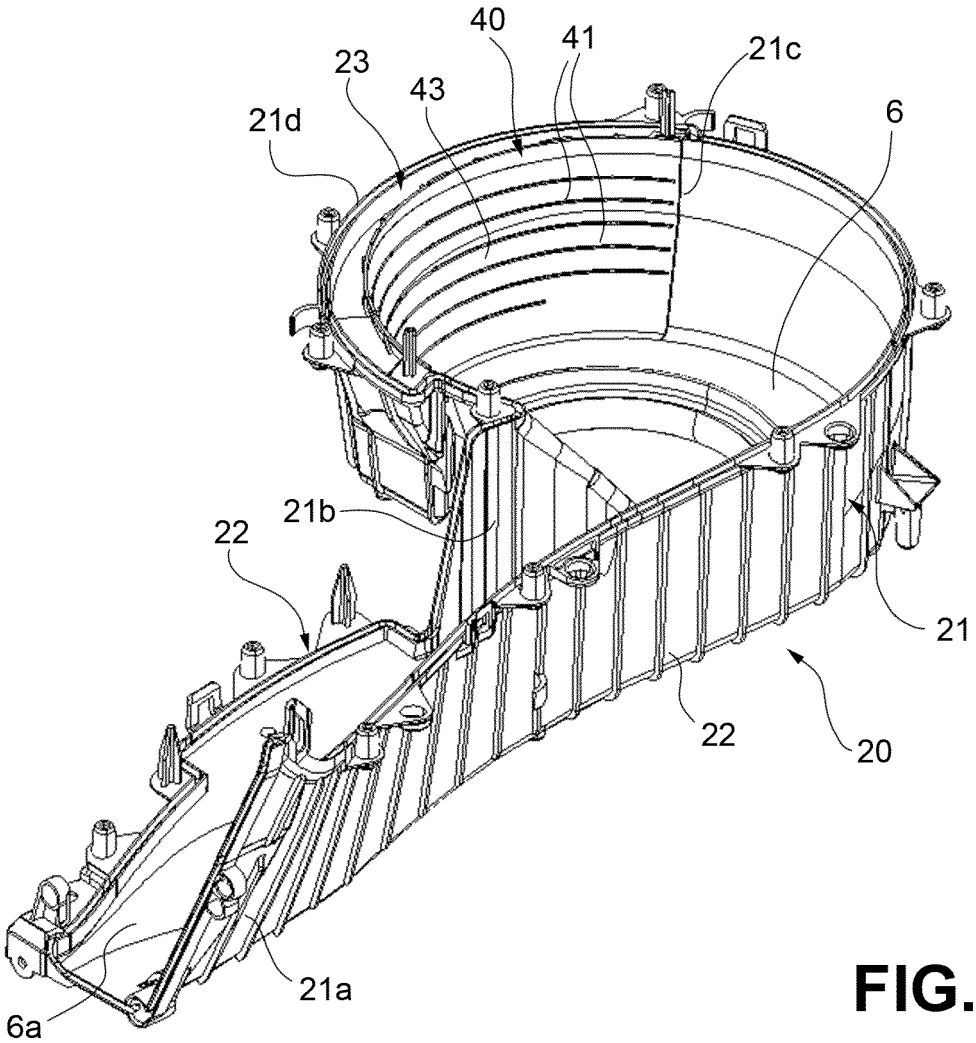
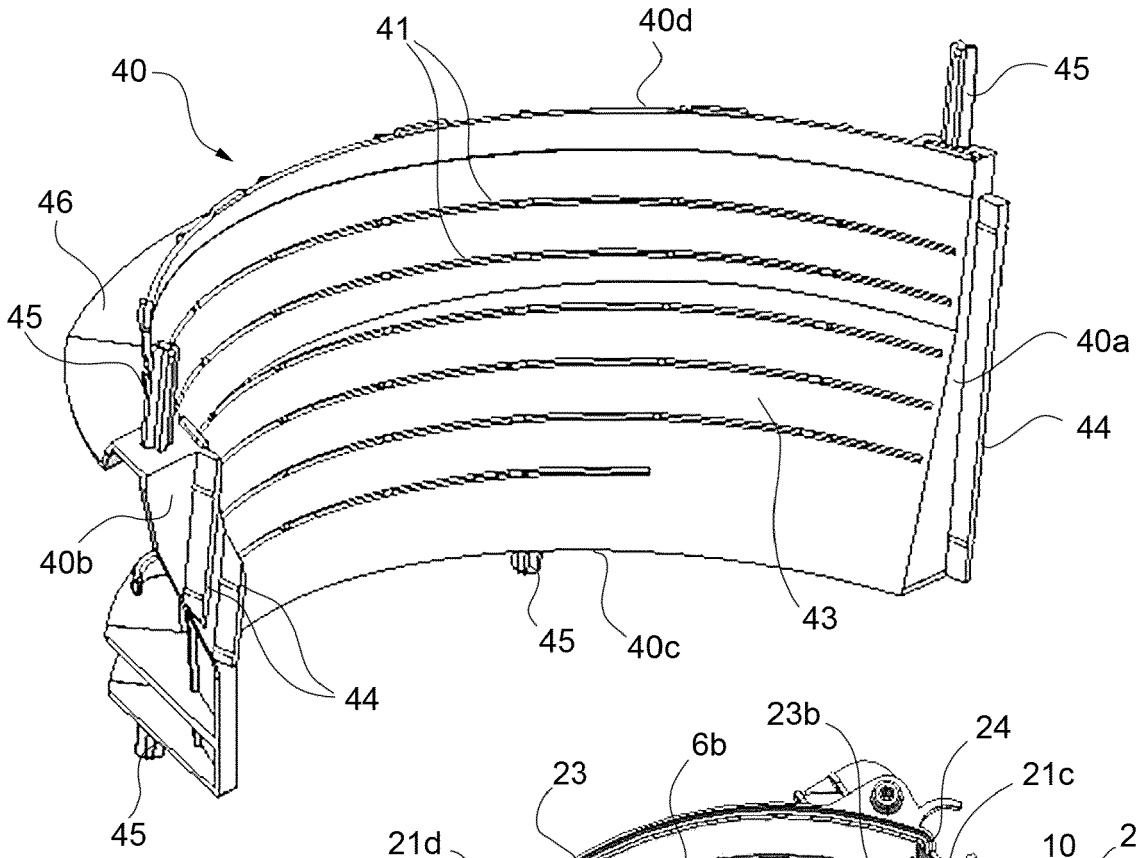


FIG.4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40d
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46
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40a
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40b
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40c
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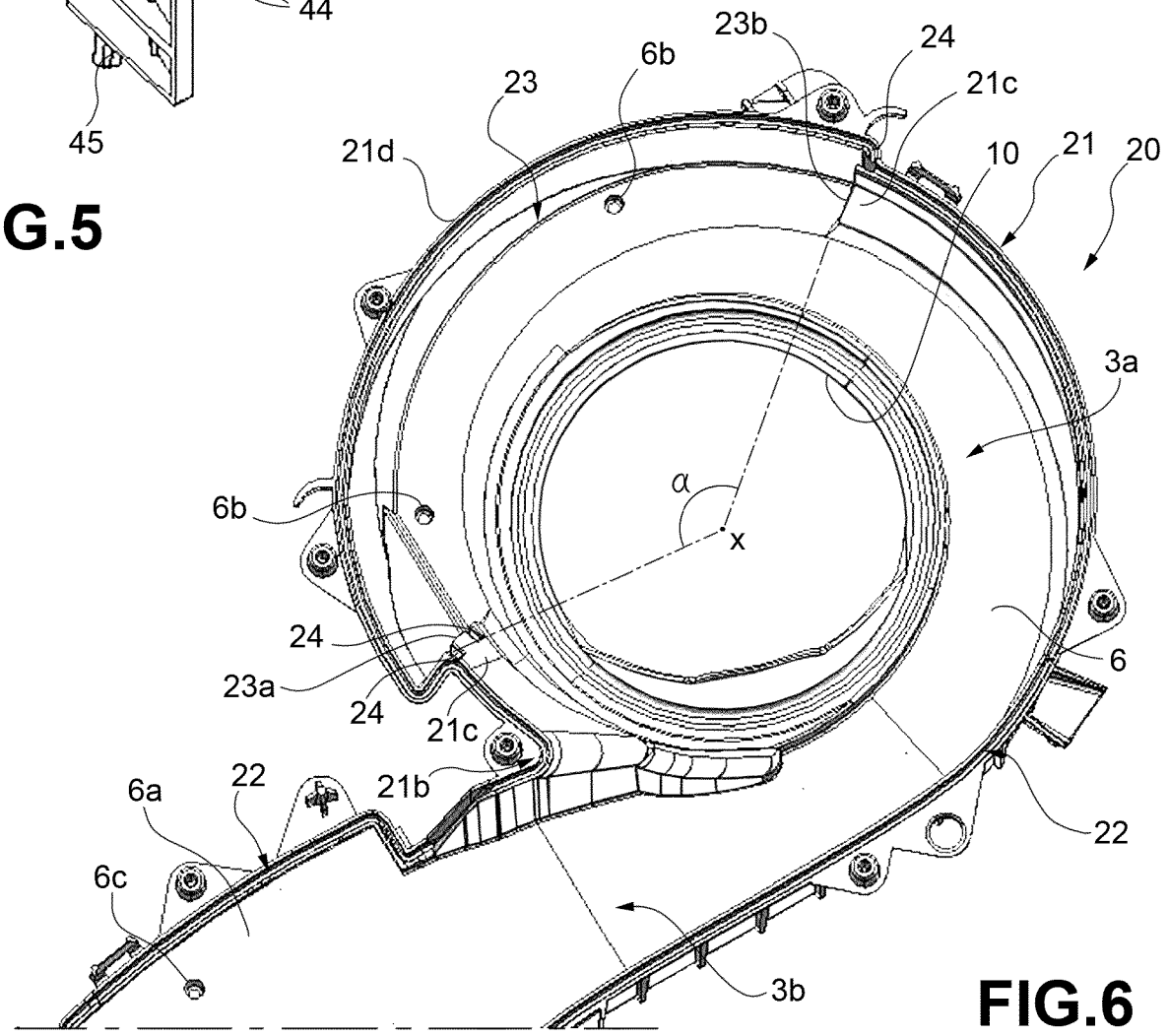
44
45

FIG.5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6a
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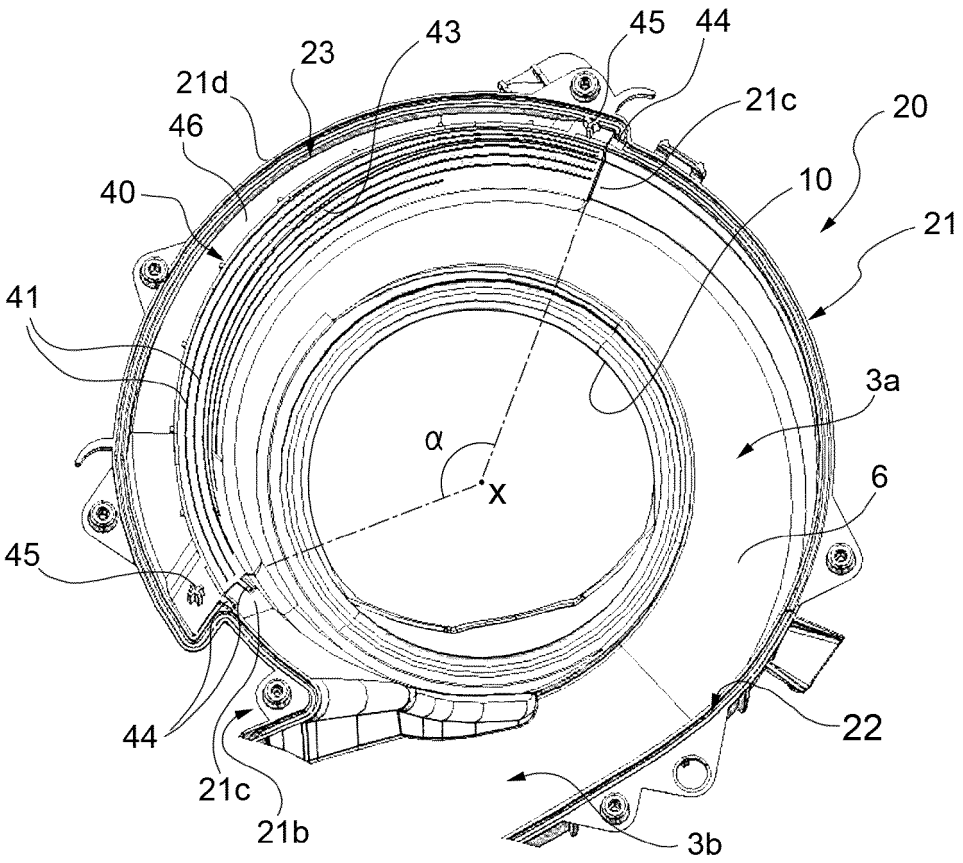
22
6c
3b

FIG.6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3b

FIG.7

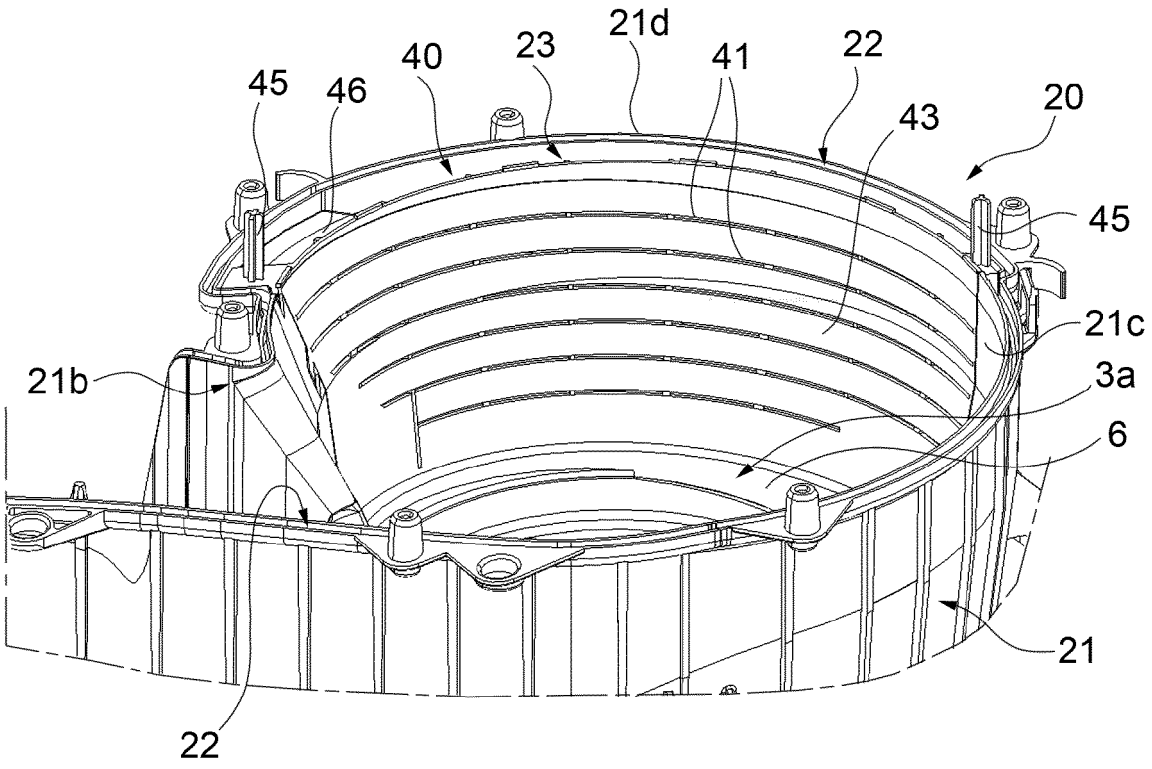
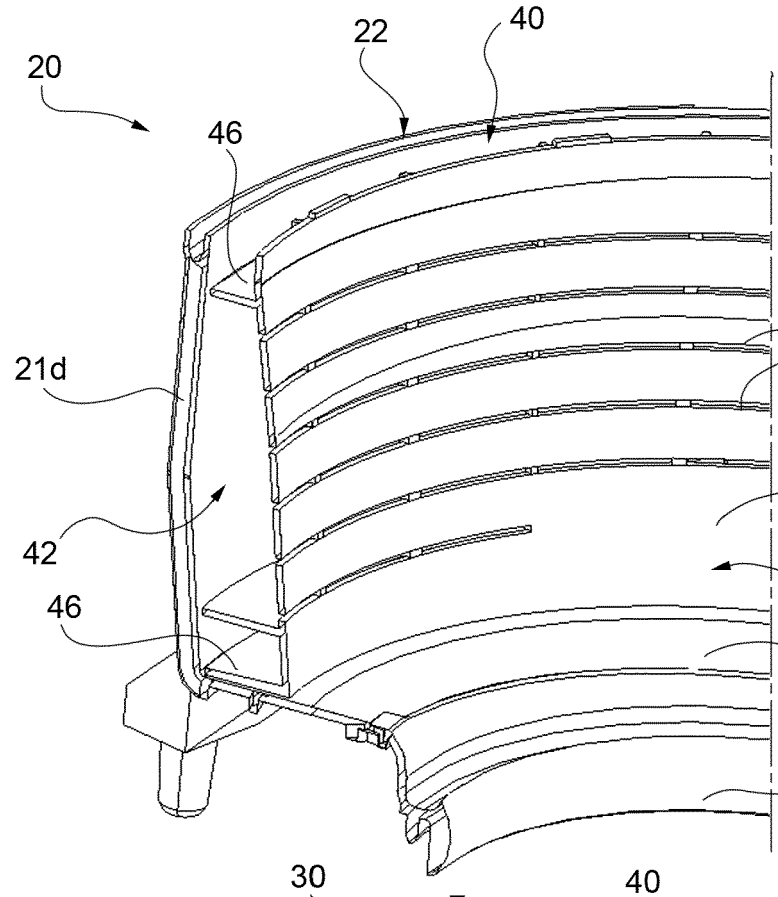

21d
40
23
41
22
45
46
43
20
45
21c
21b
3a
6
21
22

FIG.8

FIG.9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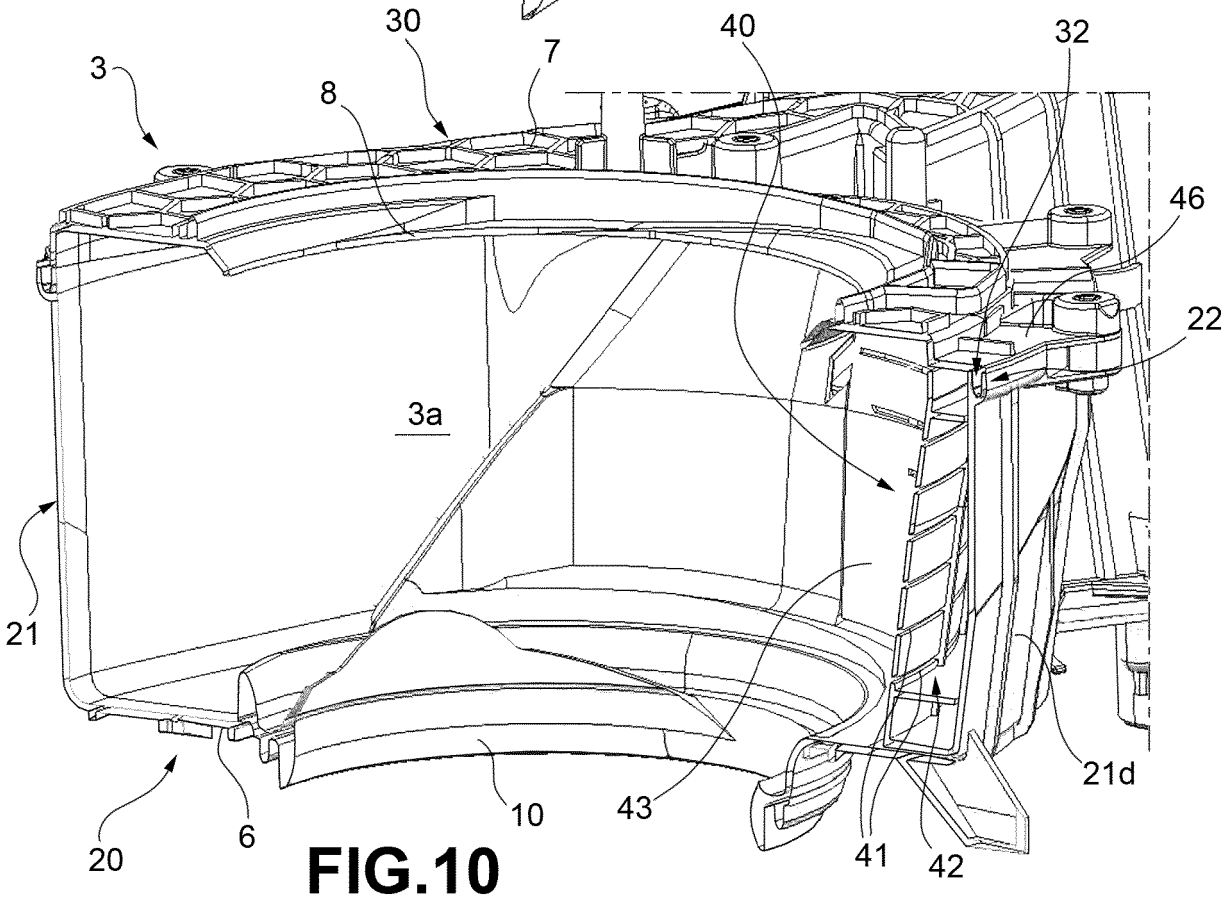
46
41
21d
43
42
3a
46
6
10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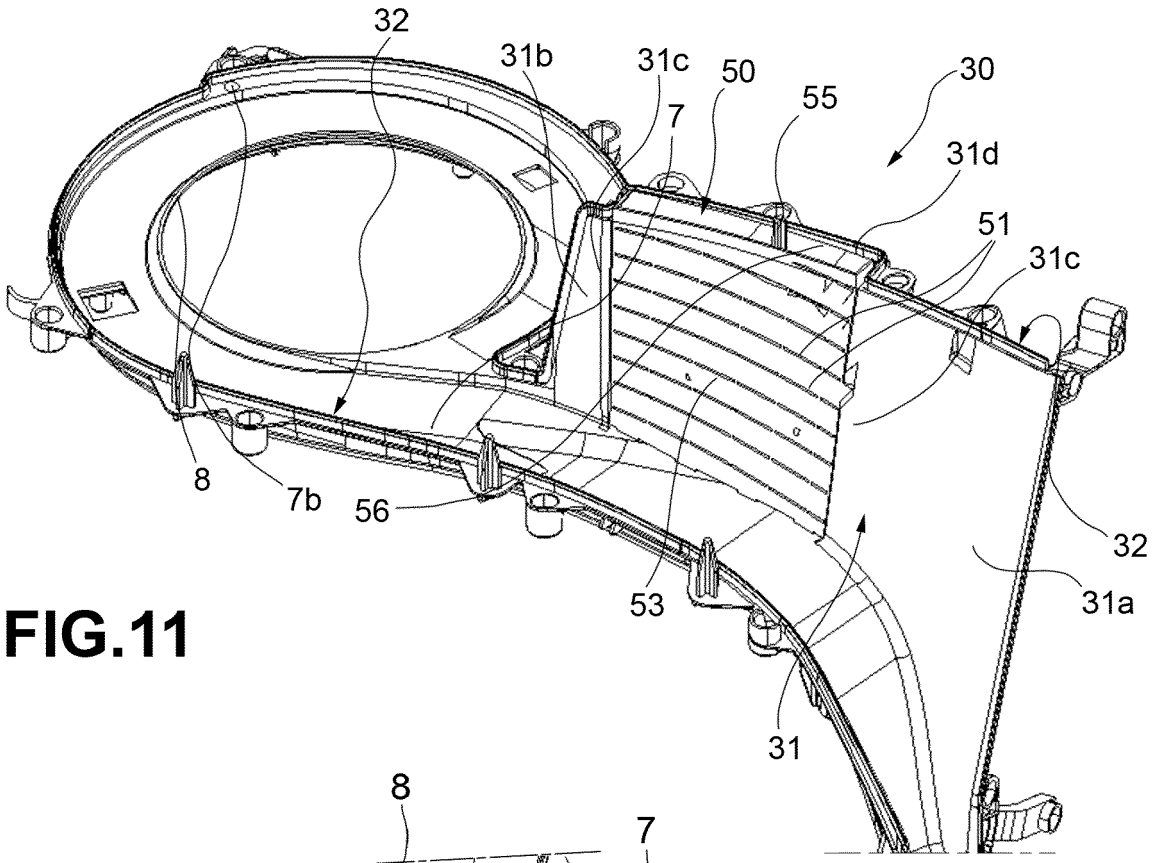
32
46
22
3a
21
20
6
10
43
41
42
21d

FIG.10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31c
50
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30
7
31d
51
31c
8
7b
56
32
53
31a
31

FIG.11

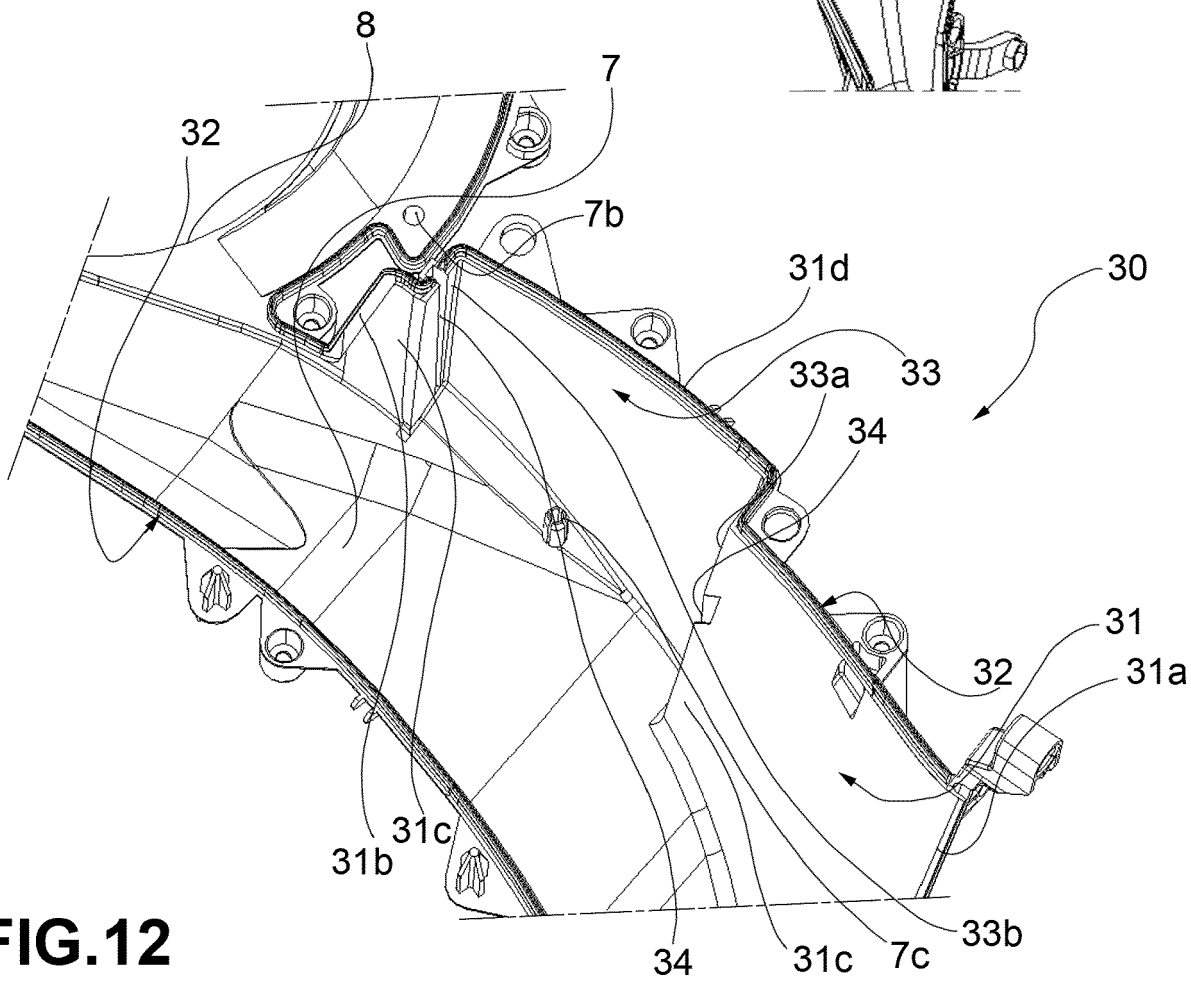

8
7
32
7b
31d
30
33a
33
34
31
32
31a
31c
31b
34
31c
7c
33b

FIG.12

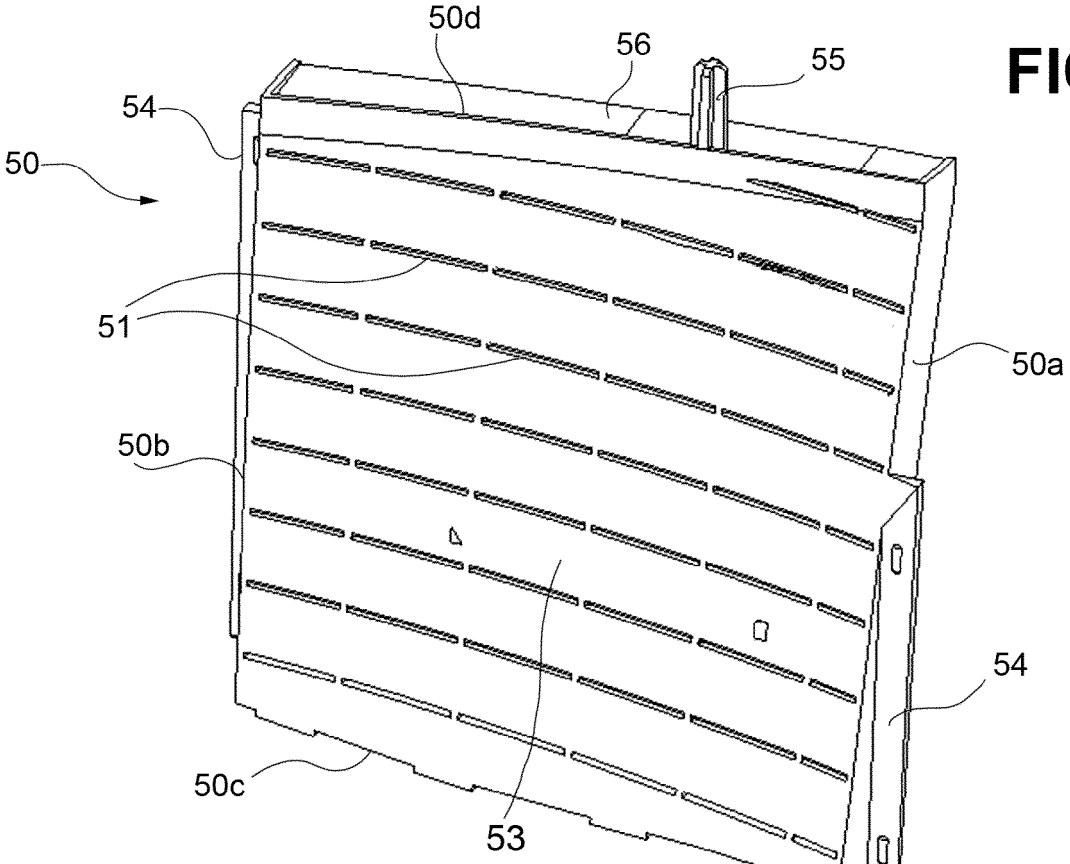


FIG.13

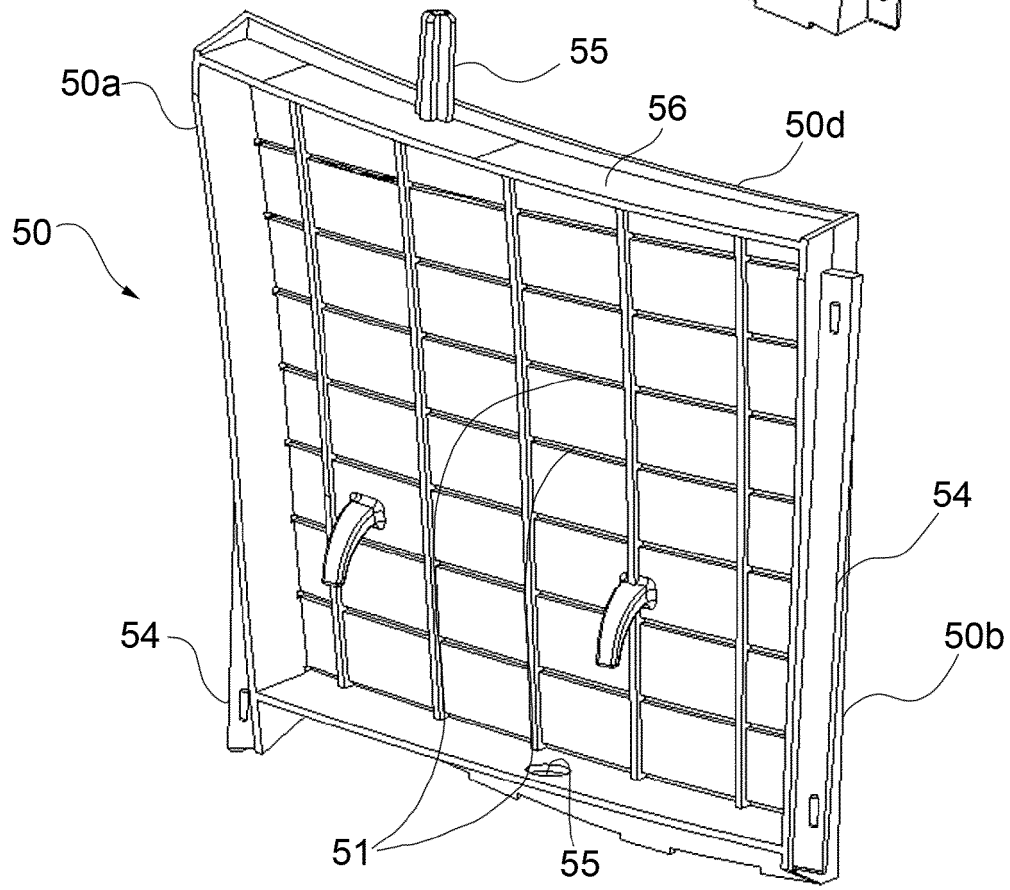
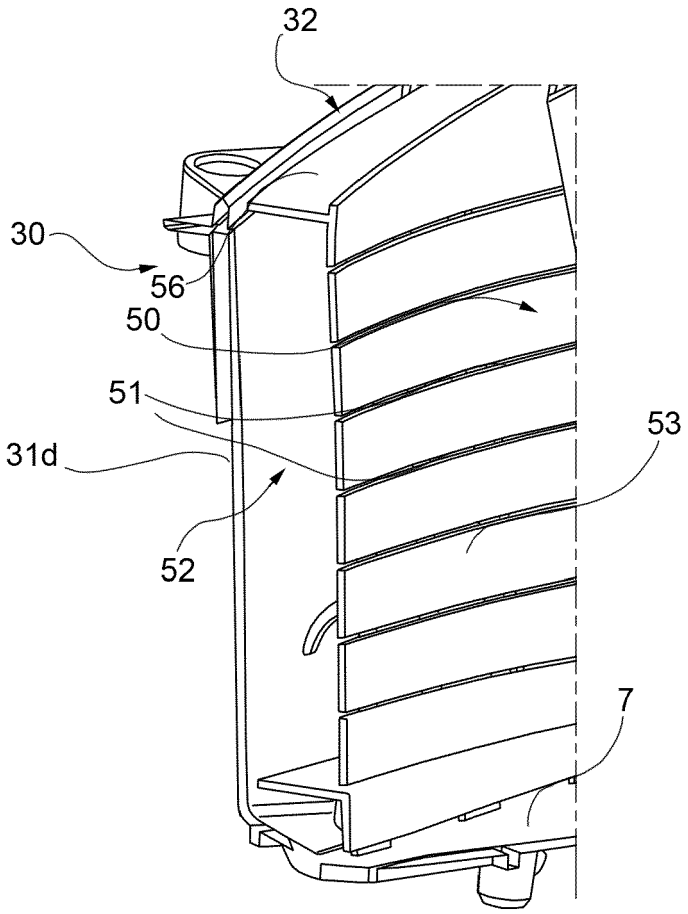


FIG.14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30
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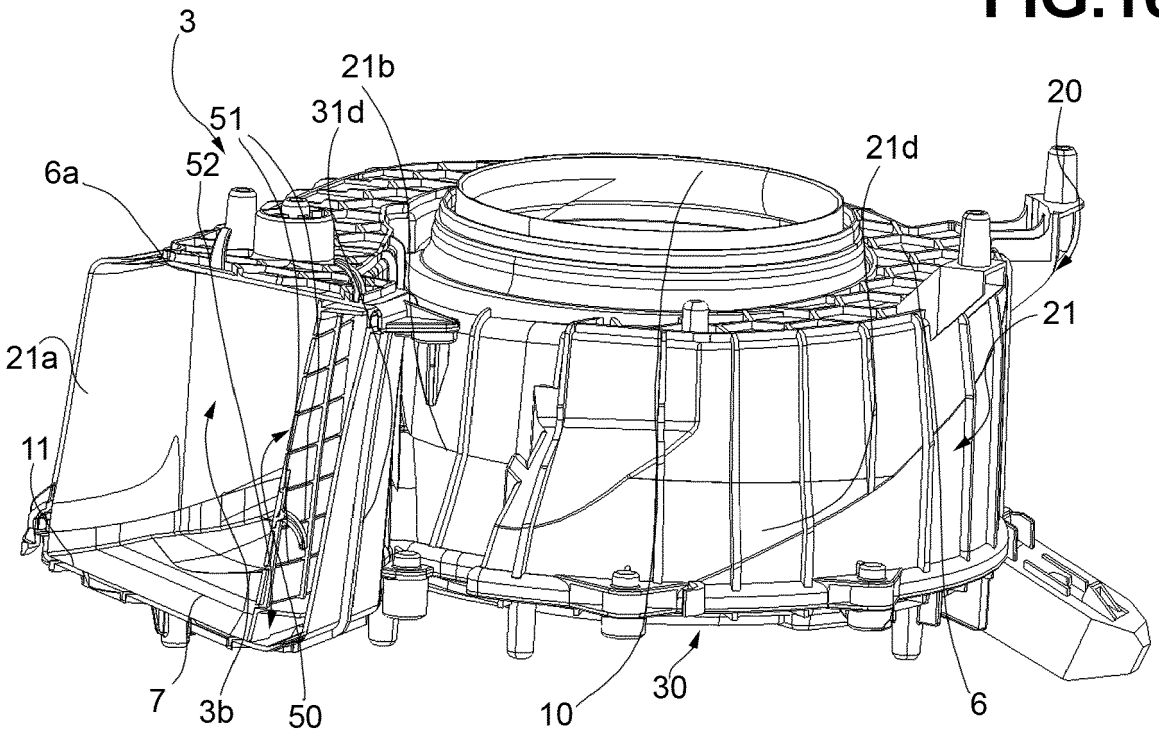
51
53
31d
52
7

FIG.15

FIG.16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21b
31d
51
52
6a
20
21d
21
21a
11
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3b
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10
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6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 4752

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A	IT 2019 0000 6861 A1 (DENSO THERMAL SYSTEMS SPA [IT]) 15 November 2020 (2020-11-15) * the whole document * * figures 1,5a-5d *	1-11	INV. F04D29/66 F04D29/42 F04D29/62
A	US 2021/095679 A1 (UCHINO TAKASHI [JP] ET AL) 1 April 2021 (2021-04-01) * paragraph [0014] - paragraph [0017] * * figure 1 *	1-11	
A	US 10 473 120 B2 (DENSO INT AMERICA INC [US]; DENSO CORP [JP]) 12 November 2019 (2019-11-12) * column 2, line 59 - column 6, line 19 * * figures 1-6 *	1-11	

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F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 September 2023	Lovergine, A

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14-09-2023

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