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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **IMPROVED DIFFUSER FOR VENTILATION SYSTEMS**

(57) The present invention relates to a diffuser (100) for ventilation of a medium through a ventilation system. The diffuser according to the present invention comprises a stationary part (1) having a plurality of apertures (5), a damper (2) rotating with a circumferential movement over said stationary part (1) and having a plurality of apertures (6) corresponding to said apertures (5), and an actuator to move said damper (2). The stationary part (1) comprises a reservoir (3) and said stationary part (1) is adapted to be inclined towards the reservoir (3) in such a way that said reservoir (3) would stand at a lower level than the rest of said stationary part (1), and edges of said apertures (5) are adapted to protrude to form a plurality of particle channels (4) between said apertures (5) for the particles to flow through, wherein said particle channels (4) surround said reservoir (3) in order to allow said particles to accumulate within said reservoir (3) by way of gravity.

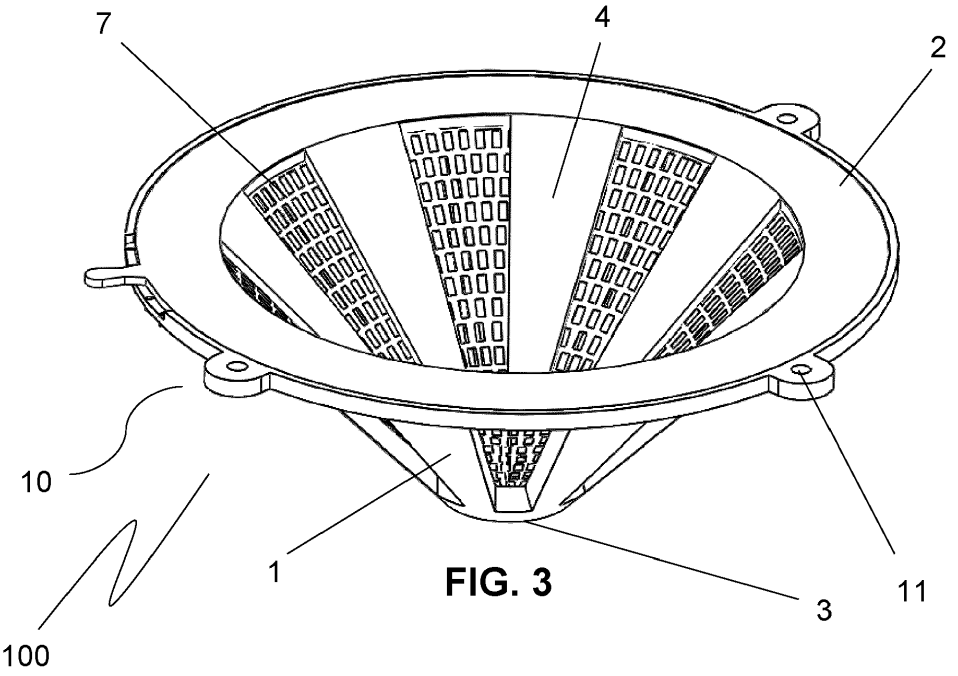

FIG. 3

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Description

Technical Field

[0001] The present invention relates to a diffuser for use in ventilation systems. More particularly, the present invention pertains to an improved diffuser with a stationary part having a plurality of apertures, a damper rotating with a circumferential movement over said stationary part and having a plurality of apertures corresponding to said apertures, and an actuator to move said damper. The present invention further relates to a novel range hood and a central ventilation system comprising the diffuser as mentioned hereinabove.

Background of the Invention

[0002] Common/central ventilation systems are increasingly used in multi-unit residential buildings for intake and exhaust of air in kitchens, rooms, bathrooms or any other area of the apartments. Central ventilation systems typically involve a high-power engine connected to a common exhaust line for sucking the internal dirty air of the apartments and discharging the same to the outside. The common exhaust line may be connected to the kitchen appliances such as range hoods for extracting smoke on a cooktop. In these kinds of range hoods, there is no need to employ a separate blow fan as in the classical range hoods because the vacuum necessary for extracting air is already supplied by the common exhaust system of the building.

[0003] However, diffusers are required in the foregoing systems in order to allow the air to flow through the common discharge line. These diffusers are typically integrated to the range hoods in the kitchens, or on the walls and ceilings of other rooms whereby the initial installation and the periodic maintenance of the system are carried out by skilled technicians. One common problem encountered with conventional diffusers of the exhaust systems mentioned above is that they tend to accumulate harmful substances on their surface such as dirt, dust and grease, which reduces their overall performance, causes hygiene related issues to come up and causes the diffuser to make more noise. This eventually requires the diffuser to be detached and thoroughly cleaned, which is cumbersome for users and technicians. Said requirement particularly becomes a greater burden as the diffuser requires cleaning up and maintenance more frequently due to the particles accumulated thereon.

[0004] EP 2379950 A1 relates to an air diffuser comprising at least one discharge that is hand manipulable to vary at least two of the airflow rates, the airflow pattern and the airflow direction, wherein the airflow pattern produced by the discharge element may be at least one of a substantially perpendicular axial swirl pattern relative to the discharge element surface or a substantially inclined swirl patten relative to the perpendicular axis of the discharge element surface. A dirt collecting basket with two chambers is also disclosed. However, this document discloses a floor diffuser, and this design is not applicable to wall type or ceiling type diffusers, as the dirt collecting basket of this document differs greatly from the reservoir and the structure described hereinbelow in the context of the present invention.

[0005] US 5180331 A discloses a device attachable to a suspended floor member for collecting materials which fall through grid openings in the floor member and for controlling the rate of airflow through the grid openings in an adjustable manner. The device includes a spill container for positioning under the grid openings of the floor member in a coordinated position such that a venting path is provided for permitting airflow past the spill container from above the floor member while retaining the capacity to collect liquids and particulate matter flowing through the grid openings. Adjustable dampening structure is coupled with the spill member to provide selection of differing vent openings to control rate of airflow through the structure. Similarly, this document also discloses a floor diffuser with a material retaining reservoir. However, this reservoir is only intended to retain particulate matter falling through the grid openings and this diffuser arrangement is not applicable to wall type or ceiling type diffusers. Hence, the diffuser provided in this document has limited usability in ventilation systems.

[0006] EP 3825621 A1 and EP 3825620 A1 relate to a diffuser for ventilation of a multi-unit residential building through a central ventilation system, comprising a stationary disc having a plurality of apertures, a damper rotating with a radial movement over said stationary disc and having a plurality of wings corresponding to said apertures (11) in order to open and close them, and a motor to move the damper. These arrangements, however, fail to provide a solution to the above-mentioned technical problems as they do not disclose a reservoir or any element for the accumulation of particles.

[0007] Therefore, there has been an unmet need in prior art to provide diffusers suitable for common exhaust systems as well as range hoods connected to these systems, which would facilitate the maintenance and cleaning up operations, increase overall performance by keeping the diffuser's surface cleaner for longer periods of time, and minimize complexity, friction within the diffuser and noise of the operation. This objective is currently achieved with a diffuser according to claim 1.

Brief Description of the Invention

[0008] The present invention relates to a novel diffuser (100) for achieving the foregoing objectives comprising a stationary part (1) having a plurality of apertures (5), a damper (2) rotating with a circumferential movement over said stationary part (1) and having a plurality of apertures (6) corresponding to said apertures (5), and an actuator to move said damper (2). The stationary part (1) according to the present invention comprises a reservoir (3) and said stationary part (1) is adapted to be inclined towards

the reservoir (3) in such a way that said reservoir (3) would stand at a lower level than the rest of said stationary part (1), and edges of said apertures (5) are adapted to protrude towards the outlet of the diffuser (100) in order to form a plurality of particle channels (4) between said apertures (5) for the particles to flow through, wherein said particle channels (4) surround said reservoir (3) in order to allow said particles to accumulate within said reservoir (3) by way of gravity.

[0009] Preferably, said protruding edges are configured in such a way in which a portion of an edge is protruding perpendicularly from its base and the rest thereof is protruding in an inclined manner.

[0010] In preferred embodiments of the present invention, the diffuser (100) further comprises a filter (7).

[0011] According to a further embodiment of the invention, said apertures (5) are adapted to be equal in shape and size, and said reservoir (3) is adapted to be at an equal distance to proximal ends of each said apertures (5).

[0012] Preferably, said stationary part (1) and said damper (2) comprise 8 apertures (5, 6), and hence said stationary part (1) comprises 8 particle channels.

[0013] In a preferred embodiment, the angle of said inclines is less than 45 degrees when said stationary part (1) and said damper (2) comprise 8 apertures (5, 6).

[0014] According to yet another embodiment, said damper (2) comprises indication means (8) coinciding with at least one predetermined indication point (9) on said stationary part (1) in order to show predetermined positions of the damper (2) corresponding to predetermined levels of airflow rate.

[0015] Further, said stationary part (1) preferably comprises mounting means (10) for the installation to and detachment from the ceiling or a wall.

[0016] In a preferred embodiment, said apertures (5, 6) are in the form of an isosceles trapezoid.

[0017] According to another embodiment, said filter (7) is mounted between said stationary part (1) and said damper (2).

[0018] In another aspect, the present invention relates to a central ventilation system for removing dirty air from a medium such as a multi-unit residential building comprising:

- a common discharge line having inlets in different units of the building,
- a common engine connected to said discharge line for the suction of dirty air from said inlets,
- a diffuser (100) according to the present invention connected to at least one of said inlets.

[0019] In further aspects, the present invention relates to the use of a diffuser (100) according to present invention in a central ventilation system of a multi-unit residential building or a range hood connected to said system.

[0020] Still in further aspects, the present invention pertains to a range hood (200) comprising the diffuser (100) according to the present invention.

[0021] According to an advantageous embodiment of said range hood (200), the range hood (200) further comprises an air-guiding structure (13) to prevent turbulent flow around the inlet of the diffuser (100).

Brief Description of the Figures

[0022] The preferred embodiments of the present invention are illustrated via non-limiting drawings wherein;

Figure 1 is a perspective view of the diffuser (100) according to the present invention.

Figure 2 is an exploded view of the diffuser (100) according to the present invention.

Figure 3 is a perspective view of the diffuser (100) with a filter (7) according to the present invention.

Figure 4 shows an exploded view of the diffuser (100) with a filter (7) according to the present invention.

Figure 5 shows a perspective view of the stationary part (1) according to the present invention.

Figure 6 is a perspective view of the range hood (200) according to the present invention.

Figure 7 is an exploded view of range hood (200) according to the present invention.

Detailed Description of the Invention

[0023] The present invention relates to a diffuser (100), comprising a stationary part (1) having a plurality of apertures (5), a damper (2) rotating with a circumferential movement over said stationary part (1) and having a plurality of apertures (6) corresponding to said apertures (5), and an actuator (not shown) to move said damper (2). Said actuator may for example be a servo motor. Such arrangements where an actuator is used to rotate the damper over the stationary part are known in the related technical field.

[0024] As shown in FIG. 1, FIG. 2 and FIG. 5, the stationary part (1) according to the present invention comprises a reservoir (3) and said stationary part (1) is adapted to be inclined towards the reservoir (3) in such a way that said reservoir (3) would stand at a lower level than the rest of said stationary part (1). Furthermore, edges of said apertures (5) are adapted to protrude in order to form a plurality of particle channels (4) between said apertures (5) for the particles to flow through, wherein said particle channels (4) surround said reservoir (3) in order to allow said particles to accumulate within said reservoir (3) by way of gravity. Here, the reservoir (3) being at a lower level shall be interpreted as the reservoir (3) being closer to the floor to facilitate the accumulation of particles

thereon, and the invention may be carried out via any shape of the diffuser (100) in compliance with the above-mentioned description, such as a cone. Lower ends of the particle channels (4) formed by the protrusions meet at the area designated for the reservoir (3) and accumulation of dirt particles inside the ventilation area is prevented, since they would naturally accumulate in the reservoir (3) instead of the particle channels (4) with the help of gravity during the operation, increasing overall performance of the diffuser (100) as it would take longer for the airflow area to become dirty. Moreover, the inclined structure of the diffuser (100) facilitates the movement of the damper (2), as the effect of vertical forces caused by the airflow on the damper (2) is thereby significantly reduced. In addition, cleaning up and maintenance of the diffuser (100) can effortlessly be performed.

[0025] According to an embodiment of the present invention, above-mentioned protruding edges are configured in such a way in which a portion of an edge is protruding perpendicularly from its base and the rest thereof is protruding in an inclined manner. In case said apertures (5) are in the form of a polygon, some of the edges may be configured to protrude perpendicularly while others are protruding in an inclined manner. It is discovered that this configuration causes small vortices to develop around the inlet of the diffuser (100), hence increasing the flow rate and allowing the reservoir (3) to accumulate more particles.

[0026] In preferred embodiments of the present invention, the diffuser (100) further comprises a filter (7) as shown in FIG. 3 and FIG. 4. Thus, a diffuser (100) with an improved separation of particles is obtained. Said filter (7) may preferably be a wire mesh filter, or any suitable filter that is known to a person skilled in the art. According to a further embodiment, said filter (7) may be mounted between said stationary part (1) and said damper (2). This improves the separation performance as larger particles would be collected on the filter (7) which normally wouldn't be able to reach the reservoir (3). This in turn slows down the accumulation process resulting the reservoir (3) and requires cleaning less frequently. Said filter (7) may be adapted to cover the entire inner surface of said stationary part (1).

[0027] According to a further embodiment of the invention, said apertures (5) are adapted to be equal in shape and size, and said reservoir (3) is adapted to be at an equal distance to proximal ends (proximal to the reservoir (3) itself) of each of said apertures (5). In other words, the reservoir (3) may be positioned at the centre as seen in FIG. 5. Said feature provides a uniform distribution of particles within the diffuser (100) and prevents particles from accumulating on a particular zone within the reservoir (3). Preferably, said apertures (5, 6) are in the form of an isosceles trapezoid and more preferably all of the apertures (5, 6) are in the form of an isosceles trapezoid with equal sizes, as shown in the FIGS 1, 2, 3, 4 and 5, ensuring that the surface area is utilized more efficiently, and ventilation performance is improved.

[0028] As seen in the aforementioned figures, said stationary part (1) and said damper (2) preferably comprise 8 apertures (5, 6), and hence said stationary part (1) comprises 8 particle channels (4). It is found during the experiments that when the stationary part (1) and the damper (2) comprise 8 apertures and the stationary part (1) comprises 8 particle channels (4), a higher performance in terms of ventilation is obtained, however said elements may also have a different number of apertures (5, 6) depending on their size and shape. It is found that when said stationary part and damper (1, 2) comprise 8 apertures (5, 6) and thus the stationary part (1) comprises 8 particle channels thereon, the flow rate of air is maximized and the amount of turbulent flow is minimized, contributing to an increase in the overall performance of the diffuser (100) according to the present invention. More specifically, it is found that when said embodiment is constructed with 8 apertures (5, 6) and 8 particle channels, the highest volumetric flow rate (332,9 m^3/h), the highest capture velocity (0,186 m/s) and the lowest turbulence kinetic energy (0,026 j/Kg) are obtained for the diffuser (100) while 2 apertures provided 300,2 m^3/h flow rate, 0,168 m/s capture velocity, 0,062 j/Kg turbulence kinetic energy; 4 apertures provided 326,9 m^3/h flow rate, 0,183 m/s capture velocity, 0,038 j/Kg turbulence kinetic energy; 6 apertures provided 331,1 m^3/h flow rate, 0,185 m/s capture velocity, 0,029 j/Kg turbulence kinetic energy; 12 apertures provided 331,0 m^3/h flow rate, 0,185 m/s capture velocity, 0,029 j/Kg turbulence kinetic energy and 18 apertures provided 319,8 m^3/h flow rate, 0,178 m/s capture velocity, 0,039 j/Kg turbulence kinetic energy, hence the best possible outcome is obtained for each parameter. This embodiment may be combined with the above-mentioned embodiments for a diffuser (100) comprising a stationary part (1) with 8 apertures (5) and a damper (2) with 8 apertures (6) wherein all of the apertures (5, 6) are in the form of an isosceles trapezoid with equal sizes, and the reservoir (3) is positioned at the centre to obtain a further advantageous embodiment. In a similar fashion, this embodiment may be combined with the above-mentioned embodiment regarding inclined protruding edges to obtain a further advantageous embodiment. According to the tests performed, it is found that this embodiment's performance depends on the incline angle of said protrusions wherein an incline angle of 15 degrees provided 336,8 m^3/h flow rate, 0,188 m/s capture velocity, 0,025 j/Kg turbulence kinetic energy; an incline angle of 30 degrees provided 340,6 m^3/h flow rate, 0,191 m/s capture velocity, 0,025 j/Kg turbulence kinetic energy; an incline angle of 45 degrees provided 332,9 m^3/h flow rate, 0,186 m/s capture velocity, 0,026 j/Kg turbulence kinetic energy, an incline angle of 60 degrees provided 323,2 m^3/h flow rate, 0,188 m/s capture velocity, 0,031 j/Kg turbulence kinetic energy and an incline angle of 75 degrees provided 306,8 m^3/h, 0,175 m/s capture velocity, 0,028 j/Kg, thus said incline angle is preferably less than 45 degrees, and more preferably is 15 degrees to 30 degrees for this embodiment in order to obtain a

high performance diffuser (100). It is to be understood that an incline angle of 0 degrees means that the protrusion is perpendicular to its base and an incline angle of 15 degrees means that the angle between the protrusion and its base is 75 degrees.

[0029] According to yet another embodiment, said damper (2) comprises indication means (8) coinciding with at least one predetermined indication point (9) on said stationary part (1) in order to show predetermined positions of the damper (2) corresponding to predetermined levels of airflow rate as shown in FIGS 1, 2, 4 and 5. Said indication means (8) are preferably provided in the form of written indications, grooves, or a combination thereof, and more preferably at least three of said predetermined indication points (9) are provided for at least three predetermined levels of airflow rate. The position of the damper (2), hence the airflow rate may be manually or automatically controlled by means of a control system (not shown, e.g., a control system based on differential pressure which is well-known in the related technical field) in order to ensure that the instantaneous airflow rate matches the desired airflow rate at all times.

[0030] Further, said stationary part (1) preferably comprises mounting means (10) for the installation to and detachment from the ceiling or a wall to provide a facilitated installation and detachment of the diffuser (100) for cleaning up and maintenance purposes. For example, said mounting means (10) may be provided in the form of mounting holes (11) as can be seen in FIGS 1, 2, 3, 4 and 5, and screws (12) corresponding thereto as can be seen in FIG. 7 in order to allow the stationary part (1) to be screwed to the ceiling or a wall. The installation may also be carried out by other mounting means known to a person skilled in the art.

[0031] In another aspect, the present invention relates to a central ventilation system for removing dirty air from a medium such as a multi-unit residential building comprising:

- a common discharge line having inlets in different units of the building,
- a common engine connected to said discharge line for the suction of dirty air from said inlets,
- a diffuser (100) as defined hereinabove connected to at least one of said inlets.

[0032] In further aspects, the present invention relates to the use of a diffuser (100) according to present invention in a central ventilation system of a multi-unit residential building or a range hood (200) connected to said system.

[0033] Still in a further aspect, the present invention relates to a novel range hood (200) comprising the diffuser (100) according to the present invention as shown in FIG. 6 and FIG. 7. Said range hood (200) may be connected to a common discharge/ventilation line of a building and the diffuser (100) is preferably connected to an exhaust duct of said range hood (200).

[0034] According to an advantageous embodiment of said range hood (200), the range hood (200) further comprises an air-guiding structure (13) to prevent turbulent flow around the inlet of the diffuser (100) as shown in FIG. 6 and FIG. 7. This is particularly advantageous as turbulent flow tend to occur within low-pressure areas around the inlets of ventilation devices and with the reduction or elimination of turbulent flow, the noise caused by the airflow is reduced and the efficiency of the ventilation operation is increased. Said air-guiding structure (13) preferably comprises a curved, differentiable surface and/or a planar surface surrounding the inlet of the range hood (200).

[0035] The stationary part (1) and the damper (2) of the diffuser (100) according to the present invention may conveniently be produced from plastics, metal or a combination of metal and plastics such that one of them is metal and the other is plastics, or any material that is suitable for the application. More preferably, both components are made of a metal.

[0036] Further aspects and embodiments of the present invention will be apparent for those skilled in the art in view of the appended claims. It is to be noted that the preferred embodiments disclosed in the specification and the accompanying drawings are not intended to limit the invention except insofar as it is limited by the claims.

Claims

1. A diffuser (100) for ventilation of a medium through a ventilation system, comprising a stationary part (1) having a plurality of apertures (5), a damper (2) rotating with a circumferential movement over said stationary part (1) and having a plurality of apertures (6) corresponding to said apertures (5), and an actuator to move said damper (2), **characterized in that**;

   - the stationary part (1) comprises a reservoir (3) and said stationary part (1) is adapted to be inclined towards the reservoir (3) in such a way that said reservoir (3) would stand at a lower level than the rest of said stationary part (1), and
   - edges of said apertures (5) are adapted to protrude to form a plurality of particle channels (4) between said apertures (5) for the particles to flow through, wherein said particle channels (4) surround said reservoir (3) in order to allow said particles to accumulate within said reservoir (3) by way of gravity.

2. A diffuser (100) according to claim 1, wherein said protruding edges are configured in such a way in which a portion of an edge is protruding perpendicularly from its base and the rest thereof is protruding in an inclined manner.

3. A diffuser (100) according to claim 1 or 2, wherein the diffuser (100) further comprises a filter (7).

4. A diffuser (100) according to any of the preceding claims, wherein said apertures (5) are adapted to be equal in shape and size, and said reservoir (3) is adapted to be at an equal distance to proximal ends of each said apertures (5).

5. A diffuser (100) according to any of the preceding claims, wherein said stationary part (1) and said damper (2) comprise 8 apertures (5, 6), and hence said stationary part (1) comprises 8 particle channels.

6. A diffuser (100) according to claim 2 and 5, wherein the angle of said inclines is less than 45 degrees.

7. A diffuser (100) according to any of the preceding claims, wherein said damper (2) comprises indication means (8) coinciding with at least one predetermined indication point (9) on said stationary part (1) in order to show predetermined positions of the damper (2) corresponding to predetermined levels of airflow rate.

8. A diffuser (100) according to any of the preceding claims, wherein said stationary part (1) comprises mounting means (10) for the installation to and detachment from a ceiling or a wall.

9. A diffuser (100) according to any of the preceding claims, wherein said apertures (5, 6) are in the form of an isosceles trapezoid.

10. A diffuser (100) according to claim 3, wherein said filter (7) is mounted between said stationary part (1) and said damper (2).

11. A central ventilation system for removing dirty air from a medium such as a multi-unit residential building comprising:

- a common discharge line having inlets in different units of the building,
- a common engine connected to said discharge line for the suction of dirty air from said inlets,
- a diffuser (100) according to any of the preceding claims 1 to 10 connected to at least one of said inlets.

12. Use of a diffuser (100) according to any of the preceding claims 1 to 10 in a central ventilation system of a multi-unit residential building or a range hood connected to said system.

13. A range hood (200) comprising the diffuser (100) according to any of the preceding claims 1 to 10.

14. A range hood (200) according to claim 13, wherein the range hood (200) further comprises an air-guiding structure (13) to prevent turbulent flow around the inlet of the diffuser (100).

Amended claims in accordance with Rule 137(2) EPC.

1. A diffuser (100) for ventilation of a medium through a ventilation system, comprising a stationary part (1) having a plurality of first apertures (5), a damper (2) arranged for rotating with a circumferential movement over said stationary part (1) and having a plurality of second apertures (6) corresponding to said first apertures (5), and an actuator to move said damper (2), **characterized in that**;

- the stationary part (1) comprises a reservoir (3) and said stationary part (1) is adapted to be inclined towards the reservoir (3) in such a way that said reservoir (3) would stand at a lower level than the rest of said stationary part (1), and
- edges of said first apertures (5) are adapted to protrude to form a plurality of particle channels (4) between said first apertures (5) for the particles to flow through, wherein said particle channels (4) surround said reservoir (3) in order to allow said particles to accumulate within said reservoir (3) by way of gravity.

2. A diffuser (100) according to claim 1, wherein said protruding edges are configured in such a way in which a portion of an edge is protruding perpendicularly from its base and the rest thereof is protruding in an inclined manner.

3. A diffuser (100) according to claim 1 or 2, wherein the diffuser (100) further comprises a filter (7).

4. A diffuser (100) according to any of the preceding claims, wherein said first apertures (5) are adapted to be equal in shape and size, and said reservoir (3) is adapted to be at an equal distance to proximal ends of each said first apertures (5).

5. A diffuser (100) according to any of the preceding claims, wherein said stationary part (1) and said damper (2) comprise 8 first apertures (5) and 8 second apertures (6) respectively, and hence said stationary part (1) comprises 8 particle channels.

6. A diffuser (100) according to claim 2 and 5, wherein the angle of said inclines is less than 45 degrees.

7. A diffuser (100) according to any of the preceding claims, wherein said damper (2) comprises indication means (8) coinciding with at least one predeter-

mined indication point (9) on said stationary part (1) in order to show predetermined positions of the damper (2) corresponding to predetermined levels of airflow rate.

8. A diffuser (100) according to any of the preceding claims, wherein said stationary part (1) comprises mounting means (10) for the installation to and detachment from a ceiling or a wall.

9. A diffuser (100) according to any of the preceding claims, wherein said first and second apertures (5, 6) are in the form of an isosceles trapezoid.

10. A diffuser (100) according to claim 3, wherein said filter (7) is mounted between said stationary part (1) and said damper (2).

11. A central ventilation system for removing dirty air from a medium such as a multi-unit residential building comprising:

- a common discharge line having inlets for different units of the building,
- a common engine connected to said discharge line for the suction of dirty air from said inlets,
- a diffuser (100) according to any of the preceding claims 1 to 10 connected to at least one of said inlets.

12. Use of a diffuser (100) according to any of the preceding claims 1 to 10 in a central ventilation system of a multi-unit residential building or a range hood connected to said system.

13. A range hood (200) comprising the diffuser (100) according to any of the preceding claims 1 to 10.

14. A range hood (200) according to claim 13, wherein the range hood (200) further comprises an air-guiding structure (13) to prevent turbulent flow around the inlet of the diffuser (100).

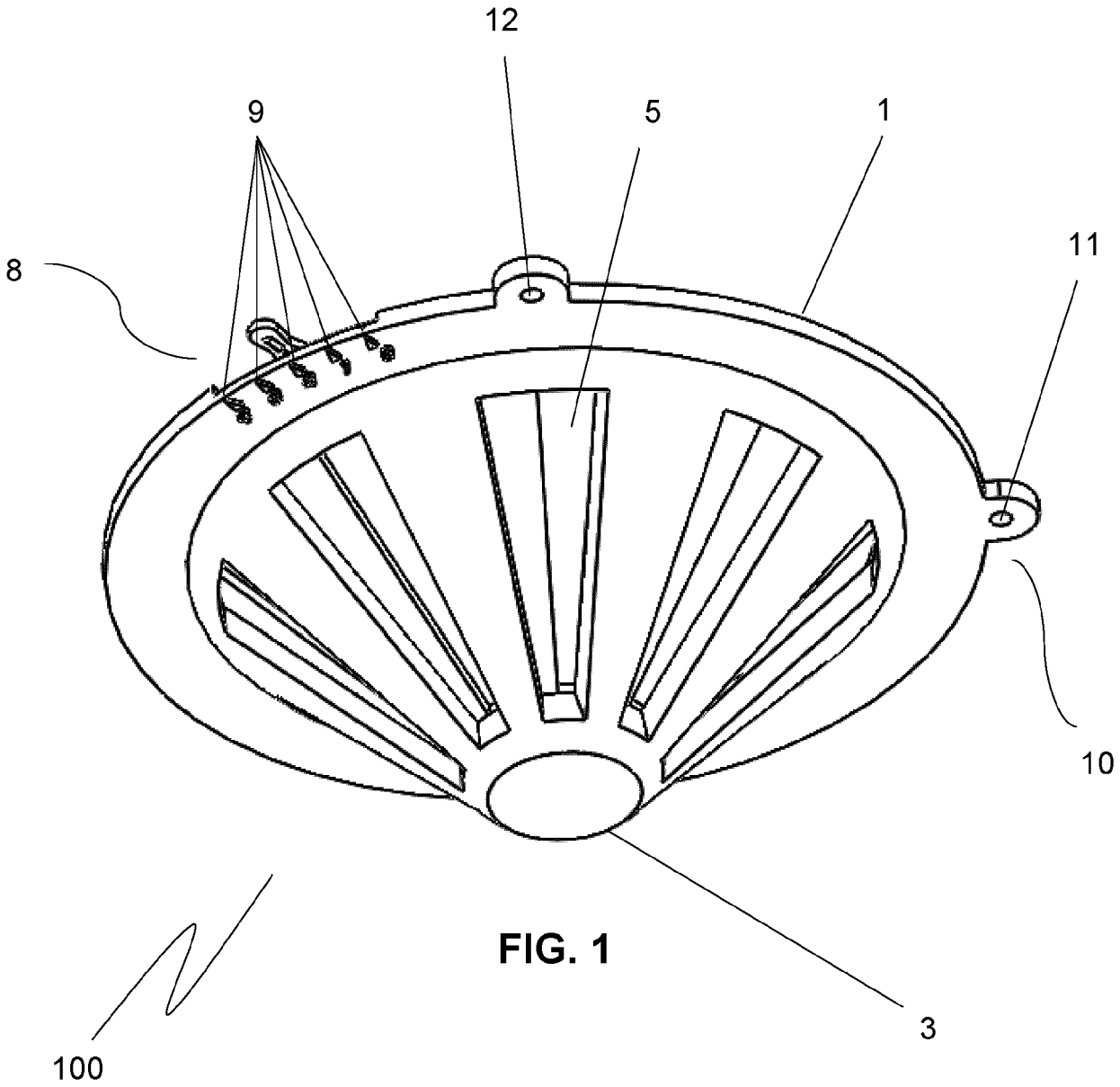

FIG. 1

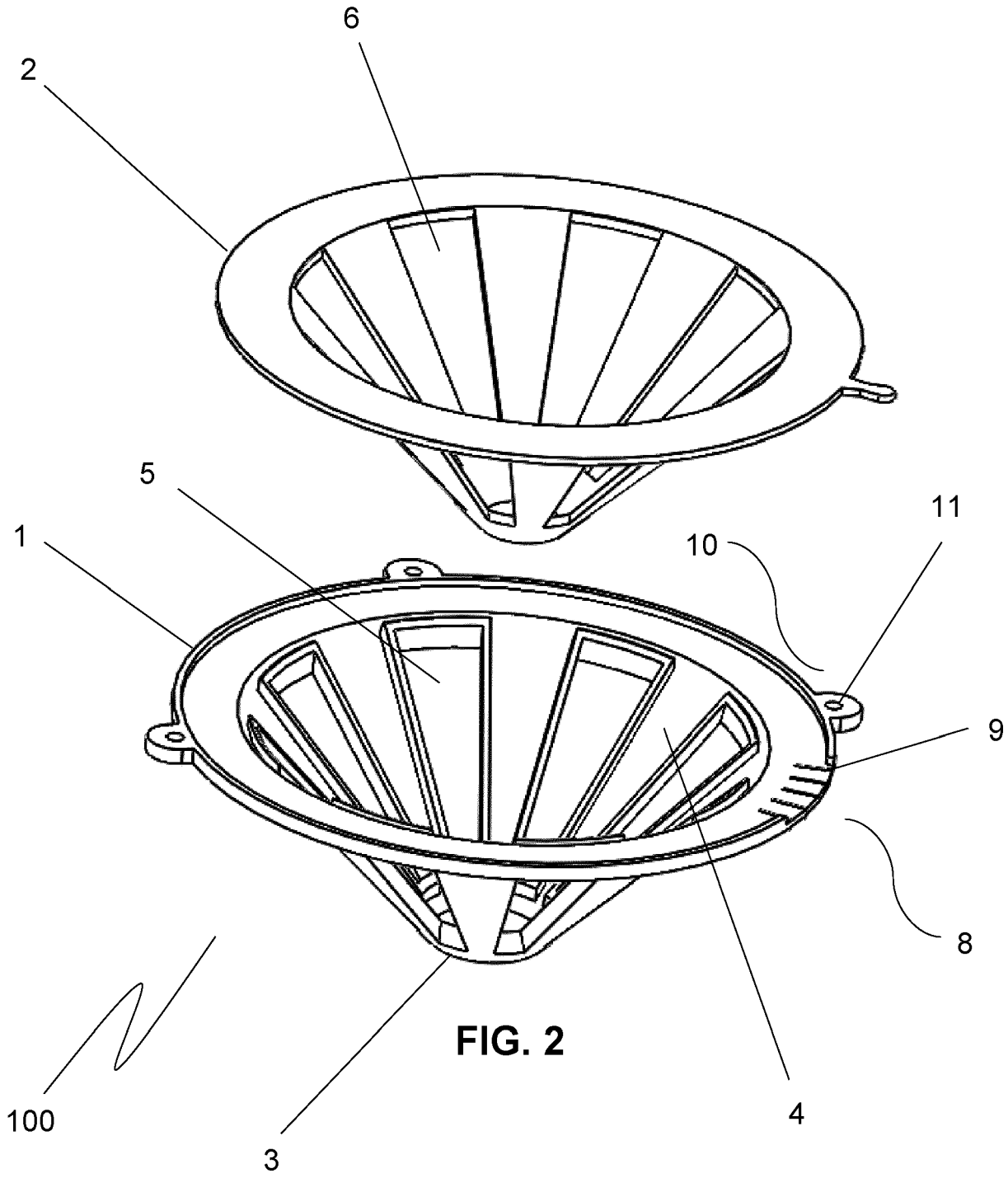

FIG. 2

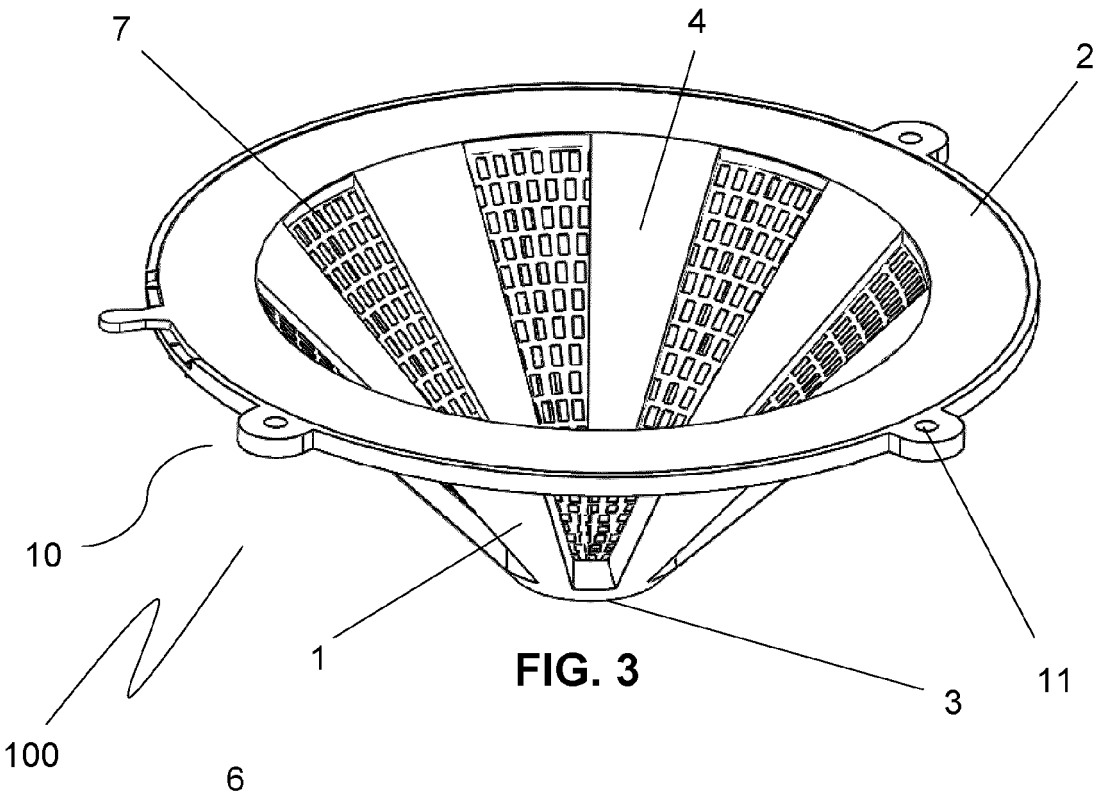

FIG. 3

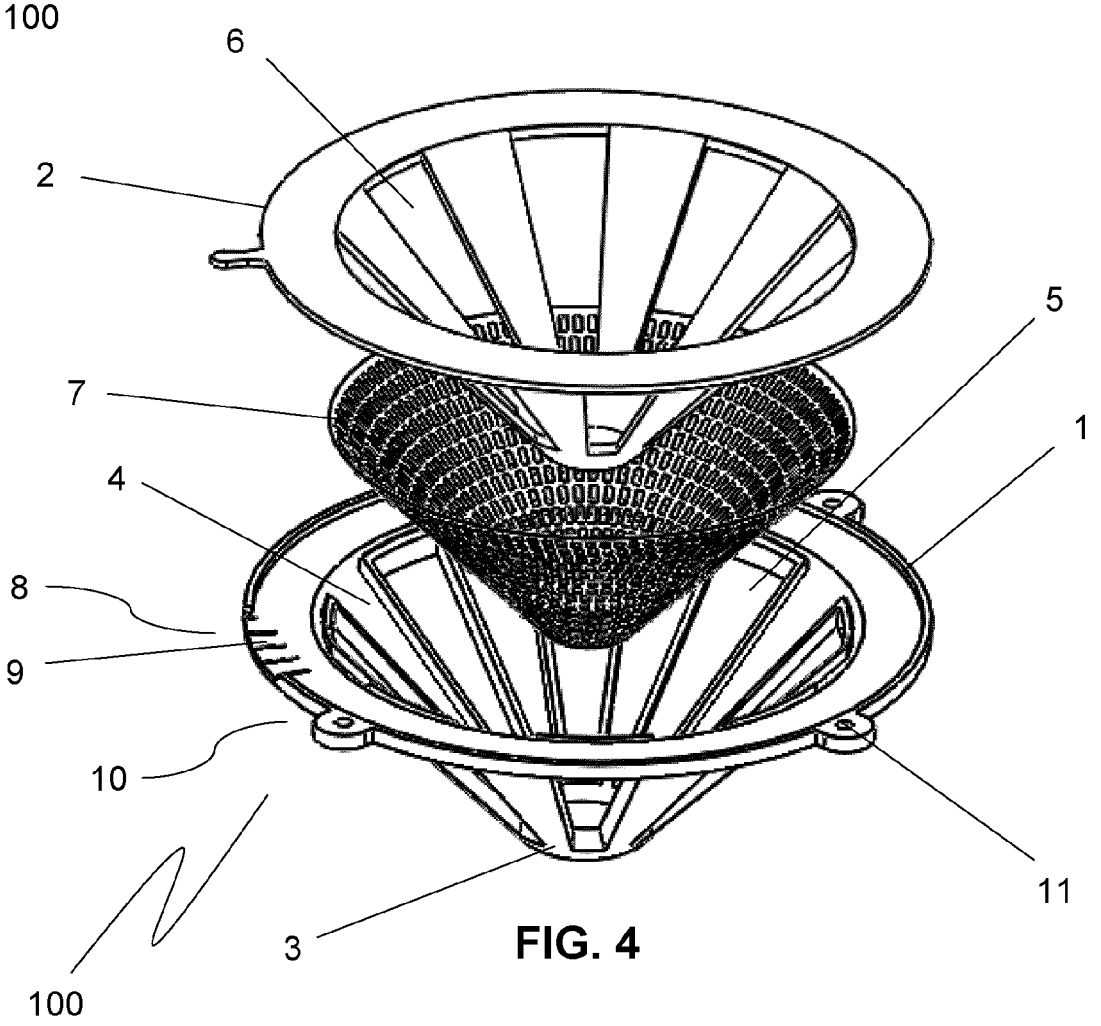

FIG. 4

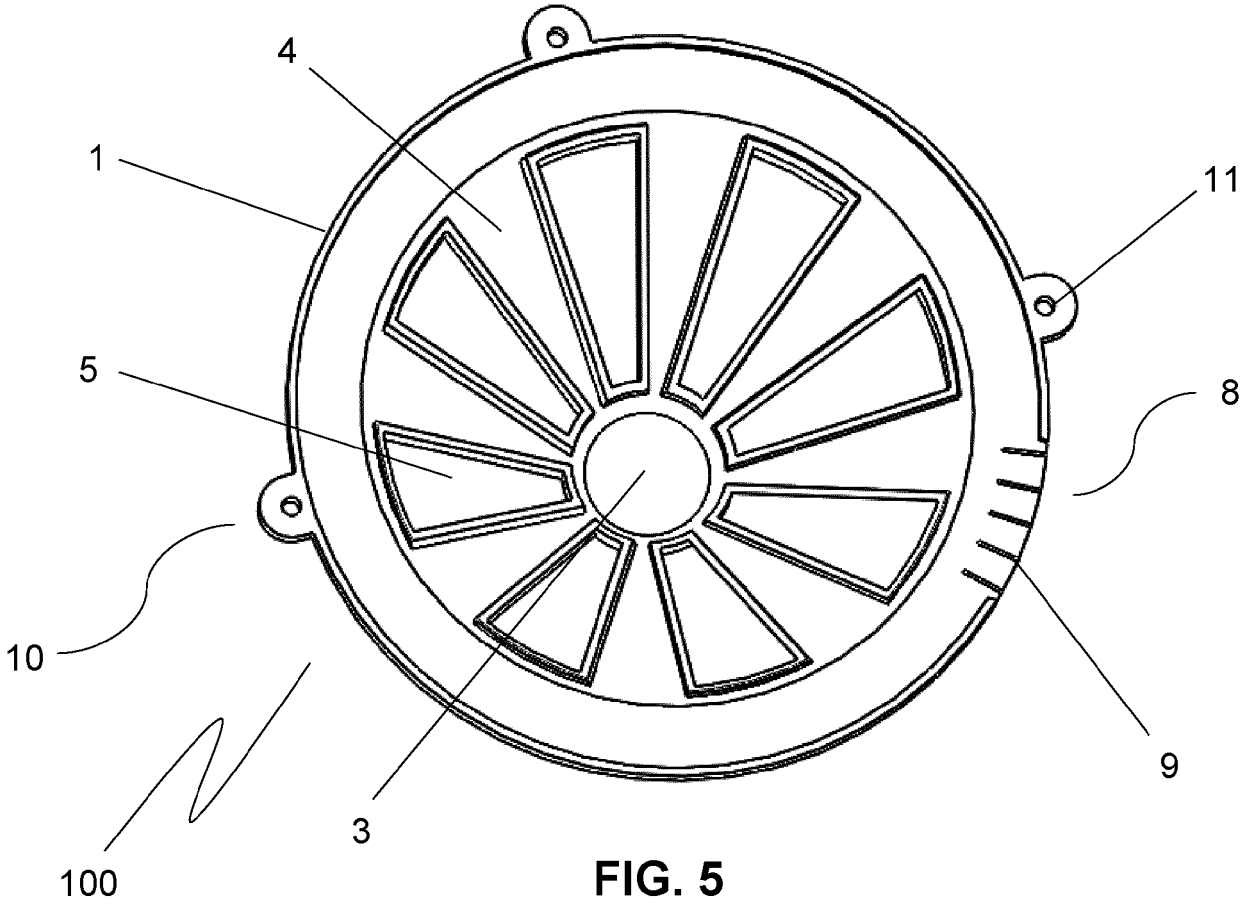

FIG. 5

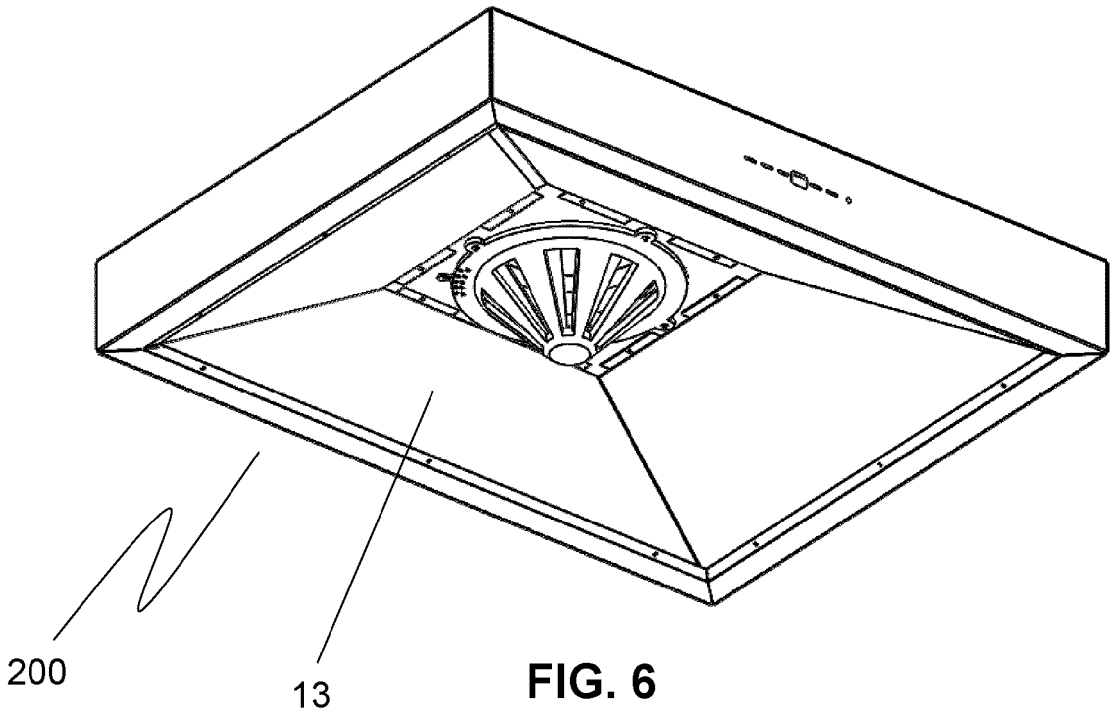

FIG. 6

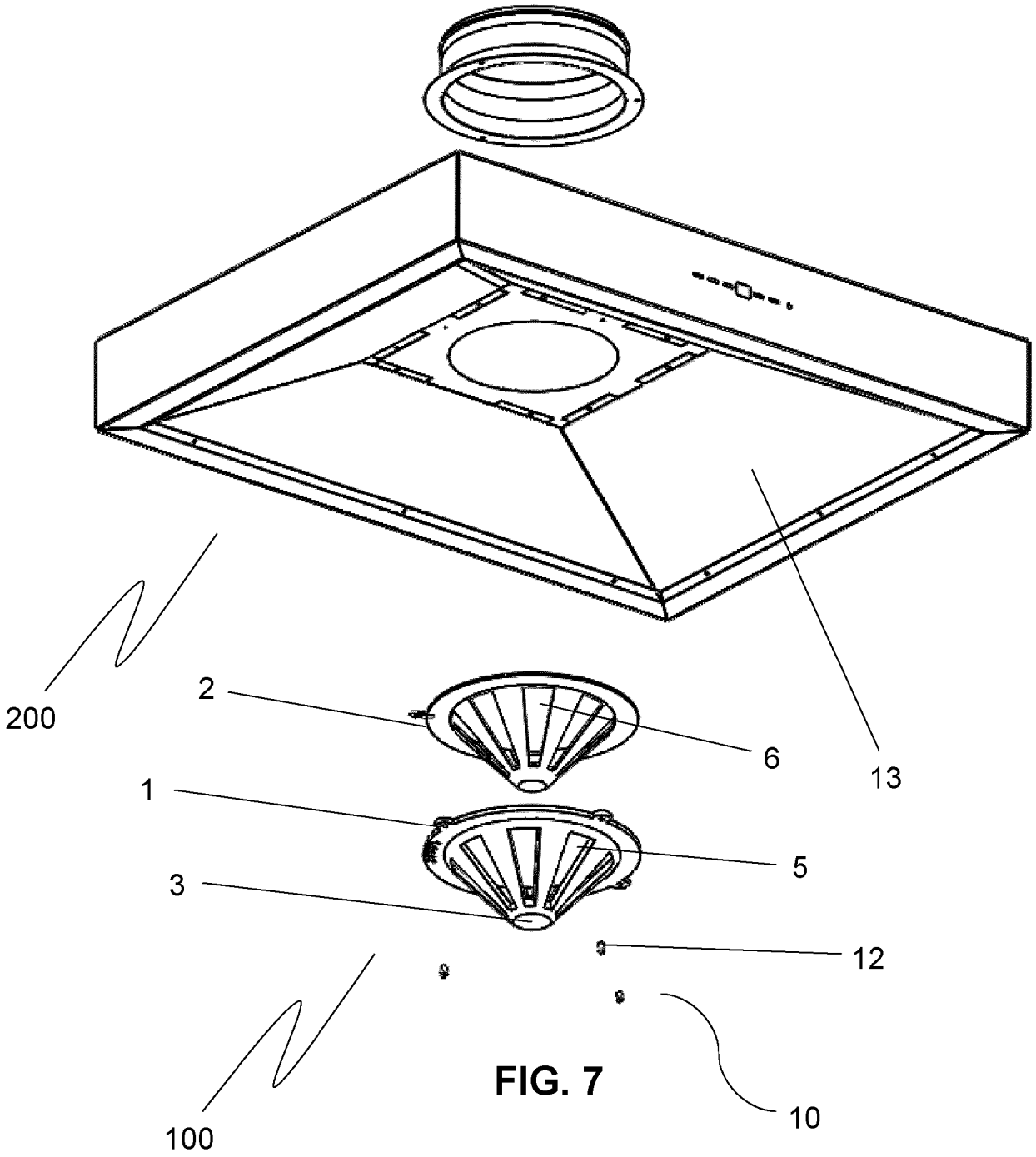

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
Munich	24 January 2022	Schwaiger, Bernd

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