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(54) **VALVE FOR AN EXHAUST DUCT**

VENTIL FÜR EINE ABGASLEITUNG

SOUPAPE POUR CONDUIT D'ÉCHAPPEMENT

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Description

FIELD OF TECHNOLOGY

[0001] The present invention relates to building technology. In particular, the invention relates to ventilation technology. More specifically, the invention relates to an exhaust-air duct valve according to the preamble to claim 1 for creating an essentially laminar exhaust-air flow.

PRIOR ART

[0002] Particularly in the design of ventilation ducts of buildings equipped with mechanical ventilation, the conventional aim is the most laminar air flow possible, to minimize air resistance, i.e. pressure loss. To assist in achieving a laminar air flow sharp corners are avoided when shaping the ventilation ducts. The same applies to the valve to be installed on the end of exhaust-air duct opening outside the building, the task of which is, on the one hand to release exhaust air from the building and, on the other, to prevent rain, snow, rubbish, small animals, and other external factors from entering the ventilation duct. Valves, i.e. "hats" are indeed known, in which horns are used, which connect to the end of the exhaust-air duct and extend in the direction of flow, above which is an insert, which spreads rainwater past the horn and towards a water-removal opening in the casing of the valve. One such valve is the VILPE® Hattu-160, by which the exhaust-air pipe is reliably protected without compromising the flow properties of the ventilation duct. However, it would be advantageous to reduce the pressure losses in the ventilation duct even further, to allow ventilation machinery to be run on lower power to improve energy efficiency.

[0003] AU 436202 B2 discloses a valve for an exhaust duct with a casing enclosing the outer end of the duct. The casing encloses a collar downstream from the duct and a conical insert downstream from the collar to control air flow out through a top opening around the insert.

SUMMARY

[0004] One solution is a new type of valve, which has optimized flow properties. Inside the valve's casing, which is equipped with an exhaust-air opening, an outwardly-opening horn is located, which is arranged to be connected through a flow connection with the outer end of the exhaust-air duct and to lead the air in the flow direction towards the exhaust-air opening in the casing. At least part of the insert located inside the casing, at a distance in the flow direction from the outer end of the exhaust-air duct, comprises an impingement surface widening in the flow direction and a narrowing exit surface. The ratio of the distance between the insert and the outer end of the exhaust-air duct, and the internal diameter of the casing is 0,4 or more.

[0005] According to the present invention there is proposed an exhaust-duct valve as defined in claim 1. Preferred embodiments are defined in the dependent claims.

[0006] By means of the new type of exhaust-duct valve, a lower pressure loss, which has a favourable effect on the energy efficiency of the ventilation system, is achieved without compromising the protection of the duct. Because the ventilation machinery can be run at a lower power than previously, there is also the additional advantage of reduced noise in the ventilation system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] In the following, some examples of embodiments of the invention are examined in greater detail with reference to the accompanying drawings, in which:

FIGURE 1 shows a side cross-section of an exhaust-duct valve according to one embodiment,
FIGURE 2 shows a side cross-section, with supplementary reference numbers, of the exhaust-duct valve according to FIGURE 1, and
FIGURE 3 shows a perspective cross-sectional view of the exhaust-duct valve according to FIGURE 1.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0008] As can be seen from FIGURES 1 - 3, the exhaust duct valve 100 is intended to the installed on the outer end of an exhaust-air duct 200 outside a building. The exhaust-duct valve 100 has a casing 10, which is arranged to connect to the outer end of the exhaust duct 200. The casing 10 can be made from one or more parts. In the example of Figure 1, the casing 10 comprises two parts 11, 12 connected to each other by a shape joint, to facilitate installation. Alternatively, the parts 11, 12 can be joined together, for example, by gluing, with screws, rivets, or some other joint. If it is possible

in terms of manufacturing technique, a one-part valve can also be envisaged (not shown). The seating part 11 connects to the outer end of the exhaust duct 200 by a shape, screw, or other joint and can comprise a covering 14 extending around the exhaust duct 200. The seating 11 comprises at its lower end a group of water-removal openings 50, which are shaped to lead rainwater that has entered the casing 10 out of the casing 10 without water collecting inside the casing. Especially the lower surface of the seating 11 is made to run outwards and downwards from the centre line of the exhaust-duct valve 100, in order to guide rainwater out of the exhaust-duct valve's casing 10. In the example according to the figures, the lower surface is, in addition, curved, particularly being convex upwards.

[0009] The seating 11 also comprises a horn 40, which is located inside the casing 10 and arranged to be connected to a flowing connection with the outer end of the exhaust duct 200. In the embodiment shown in FIGURES 1 - 3, the horn 40 is a separate component, connected to the seating 11 by shape-jointing. Alternatively, the horn 40 could be secured in the cover 14 by a shape or other joint, or in the seam between the seating 11 and the cover 14, or the horn 40 could be integrated with the seating 11 or the cover 14. The horn 40 is shaped to open in the direction of flow. Thus the free upper end of the horn 40 is wider than its lower end connected to the exhaust duct 200. In this context, the direction of flow is defined as the normal to the opening connecting the horn 40 to the exhaust duct 200, which is the vertical direction in the embodiment shown in the figures. Due to the installation tolerances, the flow direction Y may deviate from the vertical direction.

[0010] The jacket 12 connected to the seating 11 of the casing 10 is designed to protect the horn 40 from environmental factors, such as rain, rubbish, and small animals. The jacket 12 encloses the horn 40 and comprises an insert 30 located above the horn 40. More specifically, the insert 30 is located at a distance Y2 in the flow direction Y from the horn 40 and at a distance Y1 from the outer end of the exhaust duct 200, to which the horn 40 is connected. The insert 30 can be entirely inside the casing 10, as shown in FIGURES 1 - 3, or it can extend above the casing 10 in order to induce an air flow (not shown). The insert 30 is shaped on the one hand to protect the horn 40 from environmental factors and on the other to promote a laminar flow. Thus the insert 30 comprises an impingement surface 31 widening in the flow direction Y, which receives the air coming from the exhaust duct 200 and forwarded by the horn 40. According to one embodiment, the impingement surface 31 is convex in the flow direction Y, being, for example, spherical, or it can have a shape with a changing radius (not shown). In other words, the lower part of the insert 30 is convex. The impingement surface 31 spreads the arriving air flow towards the jacket 12 of the casing 10. More specifically, the impingement surface 31 is shaped to guide the exhaust-air flow transversely to the flow direction Y towards the gap between the inner surface of the casing 10 and the insert 30, which has a width X3 in the transverse direction to the flow direction Y. On the other hand, in the flow direction Y the insert 30 has a narrowing exit surface 32. In other words, the insert 30 has a narrowing upper part. According to the embodiment shown in the figures, the exit surface 32 is a cone with a rounded point, but also other narrowing shapes, such as domes can be envisaged. The incidence and exit surfaces 31, 32 meet in the circumferential outer edge of the insert. The outer edge is preferably shaped as a saw-shaped drip edge 33, the sharp points of which separate the flowing water mass into controlled drip flows, which helps to avoid the water flowing from curving towards the centre line of the valve 10 and thus towards the horn 40. In other words, thanks to the drip edge 33 the flowing water is guided in trickles towards the inner surface of the casing 10.

[0011] The upper end of the casing 10 is shaped to be such that an exhaust openings 20 is formed between the jacket 12 and the insert 30. The exhaust opening 20 is thus located at the outer end of the casing 10, in the flow direction Y. In other words, the casing 10 is open at the top. The exhaust opening 20 is annular, to prevent rainwater from entering the horn 40. The casing 10 also encloses a guide 13, which surrounds the exit surface 32 of the insert 30, between the insert 30 and the casing 10. According to the embodiment shown in the figures, the guide 13 is a cylinder 13, which extends and narrows in the flow direction Y. The guide 13 is comparatively short and is placed to surround the insert 30 from above, thus causing the least possible pressure loss. The guide 13 helps to guide rainwater away from the horn 40.

[0012] In the shaping of the exhaust-duct valve 100 special attention has be paid to the behaviour of a compressible and flowing substance in the duct. Thus the mutual ratios of the dimensions of the exhaust-duct valve 100 have been developed to minimize turbulence, without, however, compromising the protection of the horn 40. According to one embodiment, for example, the ratio of the distance Y1 between the insert 10 and the outer end of the exhaust duct 200 to the internal diameter X2 is 0,4 or more. If, for example, the exhaust-duct valve 100 is dimensioned for a 125-millimetre exhaust duct 200, the X4 of which is 125 mm, the ratio Y1/X2 is in the order of 0,6. If the exhaust-duct valve 100 is dimensioned for a 160-millimetre exhaust duct 200, the X4 of which is 160 mm, the ratio Y1/X2 is in the order of 0,5. As the ratio grows, the distance of the insert 30 from the exhaust duct 200 becomes long, so that the exhaust-air flow can only progress in the exhaust-duct valve 100 by gently flowing around the insert 30. For the same purpose, the insert 30 is, according to one embodiment, placed at a distance Y2 in the flow direction from the horn 40 in such a way that the ratio of the distance Y2 between the insert 30 and the horn 40 to the internal diameter X2 of the casing 10 is 0,1 or more, preferably 0,2 or more. If, for example, the exhaust-duct valve 100 is dimensioned for a 125-millimetre exhaust duct 200, the X4 of which is 125 mm, the ratio Y2/X2 is in the order of 0,2. If the exhaust-duct valve 100 is dimensioned for 160-millimetre exhaust duct 200, the X4 of which is 160 mm, the ratio Y2/X2 is in the order of 0,13. Thus the flow remains fluent. It should be understood that the dimensions of real pieces may differ from the nominal dimensions referred to above.

[0013] On the other hand, it is advantageous to take the protection properties of the insert into account. Thus the external diameter X1 of the insert 30, particularly the largest external diameter at the drip edge 32, is considerable relative to the internal diameter X5 of the horn 40. According to one embodiment, the ratio X1/X5 is 1 or more, preferably 1,2 or more. If, for example, the exhaust-duct valve 100 is dimensioned for a 125-millimetre exhaust duct 200, X4 of which is 125 mm, or for a 160-millimetre exhaust duct 200, X4 of which is 160 mm, the ratio X1/X5 is in the order of 1,2. Thus the insert 30 is sufficiently wide relative to the size of the horn 40. As can be seen from the above examples, the insert 30 need not be considerably wider than the internal diameter X5 of the horn 40.

[0014] Similarly, it is advantageous to ensure a sufficiently wide gap between the insert 30 and the inner surface of the casing. According to one embodiment, the ratio of the width X3 of the gap between the insert 30 and the casing 10 to the internal diameter X4 of the exhaust duct 200 is 0,1 or more, preferably 0,2 or more. On the other hand, the ratio of the gap X3 between the insert 30 and the inner surface of the casing 10 to the internal diameter X2 of the casing 10 is 0,05 or more, preferably 0,1 or more.

INDUSTRIAL APPLICABILITY

[0015] A conventional valve was compared with a valve implemented according to one embodiment in a flow simulation, in which the flow properties of the conventional valve and the valve according to one embodiment, designed for a 125-millimetre exhaust duct, were compared to each other at a flow velocity of 5 m/s and the results of which are shown in the table below:

Parameter	Conventional valve	Valve according to one embodiment
Y2/X1 [mm]	-	0,2
Y2/X2	-	0,13
Y2/Y1	-	0,3
Y1/X2	-	0,5
X3/X4	0,3	0,2
X3/X2	0,15	0,1
X1/X5	1,44	1,5
pressure loss [Pa]	14,3	10,1

[0016] The parameters Y2/X1, Y2/X2, Y2/Y1, and Y1/X2 are missing from the table's column Conventional valve, because it lacks the insert equipped with a convex impingement surface. The insert had, however, an exit surface narrowing in the flow direction, as did the comparable valve according to an embodiment. As can be seen from the above table, by means of the new type of exhaust-duct valve a pressure loss nearly 30 % smaller than when using a convention valve can be achieved.

LIST OF REFERENCE NUMBERS

10	casing
11	seating
12	jacket
13	guide
20	air-exhaust opening
30	insert
31	impingement surface
32	exit surface
33	drip edge
40	horn
50	water-removal opening

(continued)

100	exhaust-duct valve
200	exhaust-air duct
X1	external diameter of insert
X2	internal diameter of the casing
X3	width of the gap between the casing's inner surface and the insert
X4	internal diameter of exhaust duct
X5	internal diameter of outer end of horn
Y	flow direction
Y1	distance between insert and outer end of exhaust-air duct
Y2	distance between insert and horn

Claims

1. An exhaust-duct valve (100) for an exhaust duct, which exhaust-duct valve is arranged to connect to the outer end of the exhaust duct (200), and which valve comprises:

   - a casing (10), which has an internal diameter (X2) and an exhaust-air opening (20),
   - an opening horn (40), which is located inside the casing (10) and is arranged to be connected to the outer end of the exhaust duct (200) in a flowing connection and to lead air in a flow direction (Y) towards the exhaust-air opening (20) of the casing (10), and
   - an insert (30), which:

     ◦ is located at least partly inside the casing (10) at a distance (Y1) in the flow direction (Y) from the outer end of the exhaust duct (200),
     ◦ comprises an impingement surface (31) widening in the flow direction (Y), and which insert
     ◦ comprises an exit surface (32) narrowing in the flow direction (Y),

   whereby the ratio of the distance (Y1) between the insert (10) and the outer end of the exhaust duct (200) to the internal diameter (X2) of the casing is 0,4 or more.

2. The exhaust-duct valve (100) according to claim 1, in which the ratio of the distance (Y1) between the insert (10) and the outer end of the exhaust duct (200) to the internal diameter (X2) of the casing is 0,5 or more.

3. The exhaust-duct valve (100) according to claim 1 or 2, in which the casing (10) has an open top.

4. The exhaust-duct valve (100) according to claim 1, 2, or 3, in which the impingement surface (31) is convex in the flow direction (Y).

5. The exhaust-duct valve (100) according to any of the above claims, in which the insert (30) is located at a distance (Y2) in the flow direction (Y) from the horn (40), wherein the ratio of the distance (Y2) between the insert (30) and the horn (40) to the internal diameter (X2) of the casing (10) is 0,1 or more, preferably 0,2 or more.

6. The exhaust-duct valve (100) according to any of the above claims, in which the insert (30) has an external diameter (X1) transverse to the flow direction, wherein the ratio of the external diameter (X1) on the insert (30) to the internal diameter (X5) of the outer end of the horn (40) is 1 or more, particularly 1,2 or more.

7. The exhaust-duct valve (100) according to any of the above claims, in which the greatest external diameter (X1) of the insert (30) is larger than the diameter of the mouth of the horn, in order to prevent rainwater from entering the horn.

8. The exhaust-duct valve (100) according to any of the above claims, in which the impingement surface (31) is shaped to guide the exhaust-air flow in a direction transverse to the flow direction towards a gap between the inner surface

of the casing (10) and the insert (30), which gap has a width (X3) in the direction transverse to the flow direction (Y).

9. The exhaust-duct valve (100) according to any of the above claims, in which the ratio of the width (X3) of the gap to the internal diameter (X4) of the exhaust duct (200) is 0,1 or more, preferably 0,2.

10. The exhaust-duct valve (100) according to any of the above claims, in which the ratio of the width (X3) of the gap to the internal diameter (X2) of the casing (10) is 0,05 or more, preferably 0,1 or more.

11. The exhaust-duct valve (100) according to any of the above claims, in which the insert (30) comprises a saw-edged drip edge (33) between the impingement surface (31) and the exit surface (32) in the flow direction (Y).

12. The exhaust-duct valve (100) according to any of the above claims, in which, in the installed assembly, the flow direction (Y) is vertical or essentially vertical.

Patentansprüche

1. Abgasleitungsventil (100) für eine Abgasleitung, wobei das Abgasleitungsventil angeordnet ist, um mit dem äußeren Ende der Abgasleitung (200) verbunden zu sein, und wobei das Ventil Folgendes umfasst

- ein Gehäuse (10), das einen internen Durchmesser (X2) und eine Abluftöffnung (20) aufweist,
- einen Öffnungstrichter (40), der sich im Innern des Gehäuses (10) befindet und angeordnet ist, um mit dem äußeren Ende der Abgasleitung (200) in einer Fließverbindung verbunden zu sein, und um Luft in einer Strömungsrichtung (Y) zu der Abluftöffnung des Gehäuses (10) hin zu leiten, und
- ein Einsatzteil (30), das:

  ◦ sich mindestens teilweise im Innern des Gehäuses (10) in einem Abstand (Y1) in der Strömungsrichtung (Y) von dem äußeren Ende der Abgasleitung (200) befindet,
  ◦ eine Aufprallfläche (31) umfasst, die in der Strömungsrichtung (Y) breiter wird, und wobei das Einsatzteil
  ◦ eine Austrittsfläche (32) umfasst, die in der Strömungsrichtung (Y) schmaler wird,

wodurch das Verhältnis des Abstands (Y1) zwischen dem Einsatzteil (10) und dem äußeren Ende der Abgasleitung (200) zum internen Durchmesser (X2) des Gehäuses 0,4 oder mehr beträgt.

2. Abgasleitungsventil (100) nach Anspruch 1, bei dem das Verhältnis des Abstands (Y1) zwischen dem Einsatzteil (10) und dem äußeren Ende der Abgasleitung (200) zum internen Durchmesser (X2) des Gehäuses 0,5 oder mehr beträgt.

3. Abgasleitungsventil (100) nach Anspruch 1 oder 2, wobei das Gehäuse (10) ein offenes Oberteil aufweist.

4. Abgasleitungsventil (100) nach Anspruch 1, 2 oder 3, wobei die Aufprallfläche (31) in der Strömungsrichtung (Y) konvex ist.

5. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, wobei sich das Einsatzteil (30) in einem Abstand (Y2) in der Strömungsrichtung (Y) von dem Trichter (40) befindet, wobei das Verhältnis des Abstands (Y2) zwischen dem Einsatzteil (30) und dem Trichter (40) zu dem internen Durchmesser (X2) des Gehäuses (10) 0,1 oder mehr, bevorzugt 0,2 oder mehr beträgt.

6. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, wobei das Einsatzteil (30) einen externen Durchmesser (X1) quer zur Strömungsrichtung aufweist, wobei das Verhältnis des externen Durchmessers (X1) auf dem Einsatzteil (30) zu dem internen Durchmesser (X5) des äußeren Endes des Trichters (40) 1 oder mehr, insbesondere 1,2 oder mehr beträgt.

7. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, bei dem der größte externe Durchmesser (X1) des Einsatzteils (30) größer als der Durchmesser der Mündung des Trichters ist, um zu verhindern, dass Regenwasser in den Trichter fließt.

8. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, bei dem die Aufprallfläche (31) gestaltet ist,

um die Abluftströmung in einer Richtung quer zu der Strömungsrichtung zu einer Lücke zwischen der Innenfläche des Gehäuses (10) und dem Einsatzteil (30) hin zu führen, wobei die Lücke eine Breite (X3) in der Richtung quer zur Strömungsrichtung (Y) aufweist.

9. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, bei dem das Verhältnis der Breite (X3) der Lücke zu dem internen Durchmesser (X4) der Abgasleitung (200) 0,1 oder mehr, bevorzugt 0,2 beträgt.

10. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, bei dem das Verhältnis der Breite (X3) der Lücke zu dem internen Durchmesser (X2) des Gehäuses (10) 0,05 oder mehr, bevorzugt 0,1 oder mehr beträgt.

11. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, bei dem das Einsatzteil (30) eine sägezahnförmige Tropfkante (33) zwischen der Aufprallfläche (31) und der Austrittsfläche (32) in der Strömungsrichtung (Y) umfasst.

12. Abgasleitungsventil (100) nach einem der vorhergehenden Ansprüche, bei dem bei der installierten Baugruppe die Strömungsrichtung (Y) senkrecht oder im Wesentlichen senkrecht ist.

Revendications

1. Soupape pour conduit d'échappement (100) pour un conduit d'échappement, ladite soupape pour conduit d'échappement étant agencée pour connecter l'extrémité externe du conduit d'échappement (200), et ladite soupape comprenant :

- un boîtier (10), qui présente un diamètre interne (X2) et une ouverture d'air d'échappement (20),
- une corne d'ouverture (40), qui est située à l'intérieur du boitier (10) et est agencée pour être connectée à l'extrémité externe du conduit d'échappement (200) dans une connexion d'écoulement et pour diriger l'air dans une direction d'écoulement (Y) vers l'ouverture d'air d'échappement (20) du boîtier (10), et
- un insert (30), qui

  ◦ est situé au moins en partie à l'intérieur du boîtier (10) à une distance (Y1) dans la direction d'écoulement (Y) depuis l'extrémité externe du conduit d'échappement (200),
  ◦ comprend une surface d'impact (31) s'élargissement dans la direction d'écoulement (Y), et ledit insert
  ◦ comprend une surface de sortie (32) se rétrécissant dans la direction d'écoulement (Y),

moyennant quoi le rapport de la distance (Y1) entre l'insert (10) et l'extrémité externe du conduit d'échappement (200) sur le diamètre interne (X2) du boîtier est de 0,4 ou plus.

2. Soupape pour conduit d'échappement (100) selon la revendication 1, dans laquelle le rapport de la distance (Y1) entre l'insert (10) et l'extrémité externe du conduit d'échappement (200) sur le diamètre interne (X2) du boîtier est de 0,5 ou plus.

3. Soupape pour conduit d'échappement (100) selon la revendication 1 ou 2, dans laquelle le boîtier (10) présente une partie supérieure ouverte.

4. Soupape pour conduit d'échappement (100) selon la revendication 1, 2 ou 3, dans laquelle la surface d'impact (31) est convexe dans la direction d'écoulement (Y).

5. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle l'insert (30) est situé à une distance (Y2) dans la direction d'écoulement (Y) depuis la corne (40), dans laquelle le rapport de la distance (Y2) entre l'insert (30) et la corne (40) sur le diamètre interne (X2) du boîtier (10) est de 0,1 ou plus, de préférence de 0,2 ou plus.

6. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle l'insert (30) présente un diamètre externe (X1) transversal par rapport à la direction d'écoulement, dans laquelle le rapport du diamètre externe (X1) sur l'insert (30) sur le diamètre interne (X5) de l'extrémité externe de la corne (40) est de 1 ou plus, en particulier de 1,2 ou plus.

7. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle le diamètre externe le plus grand (X1) de l'insert (30) est plus grand que le diamètre de l'embouchure de la corne, afin d'empêcher l'eau de pluie de pénétrer dans la corne.

8. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle la surface d'impact (31) est formée pour guider le flux d'air d'échappement dans une direction transversale par rapport à la direction d'écoulement vers un espace entre la surface interne du boîtier (10) et l'insert (30), ledit espace présentant une largeur (X3) dans la direction transversale à la direction d'écoulement (Y).

9. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle le rapport de la largeur (X3) de l'espace sur le diamètre interne (X4) du conduit d'échappement (200) est de 0,1 ou plus, de préférence de 0,2.

10. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle le rapport de la largeur (X3) de l'espace sur le diamètre interne (X2) du boîtier (10) est de 0,05 ou plus, de préférence de 0,1 ou plus.

11. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle l'insert (30) comprend un bord d'égouttement en scie (33) entre la surface d'impact (31) et la surface de sortie (32) dans la direction d'écoulement (Y).

12. Soupape pour conduit d'échappement (100) selon l'une quelconque des revendications précédentes, dans laquelle, dans l'ensemble installé, la direction d'écoulement (Y) est verticale ou essentiellement verticale.

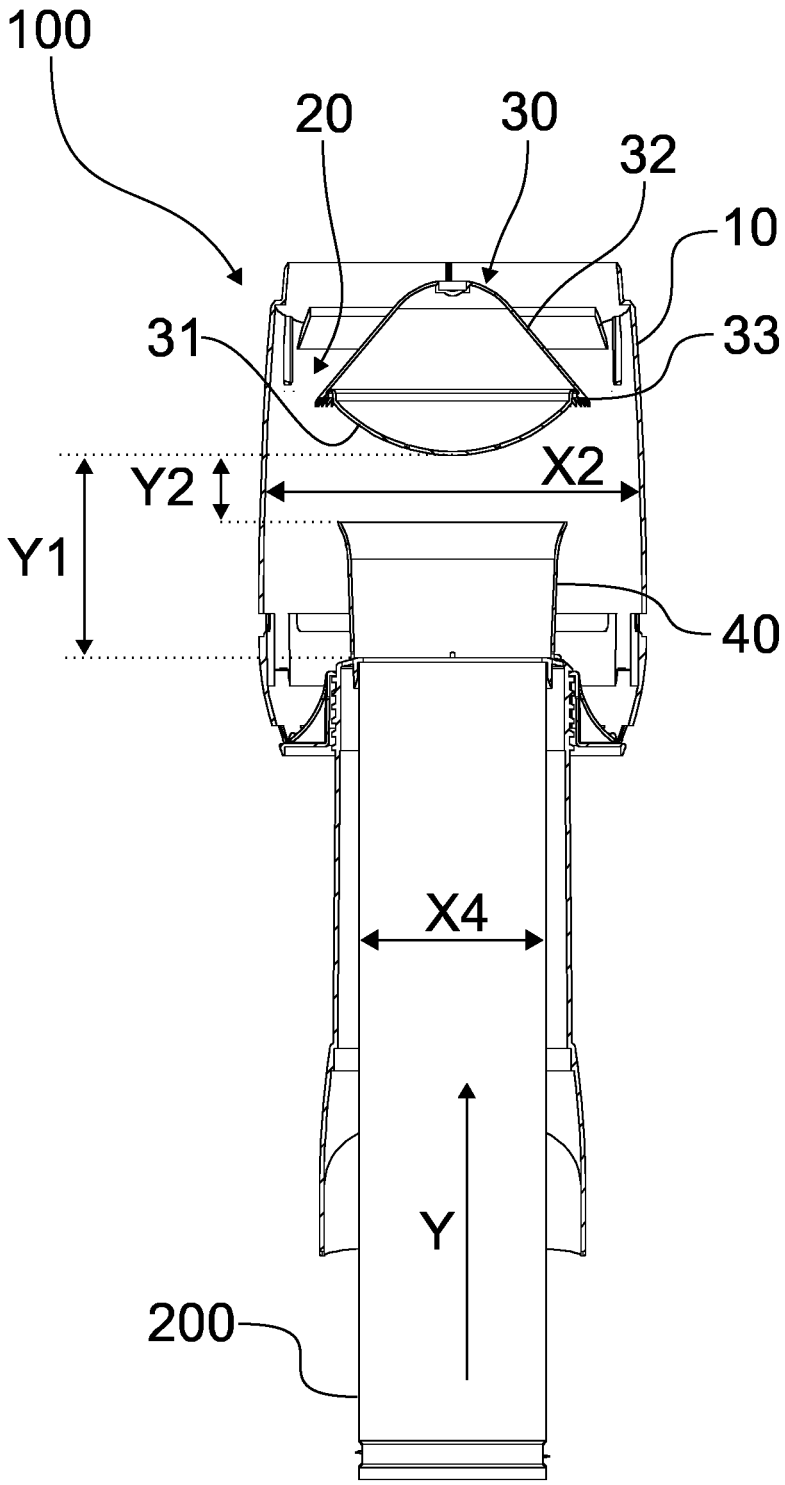

FIG. 1

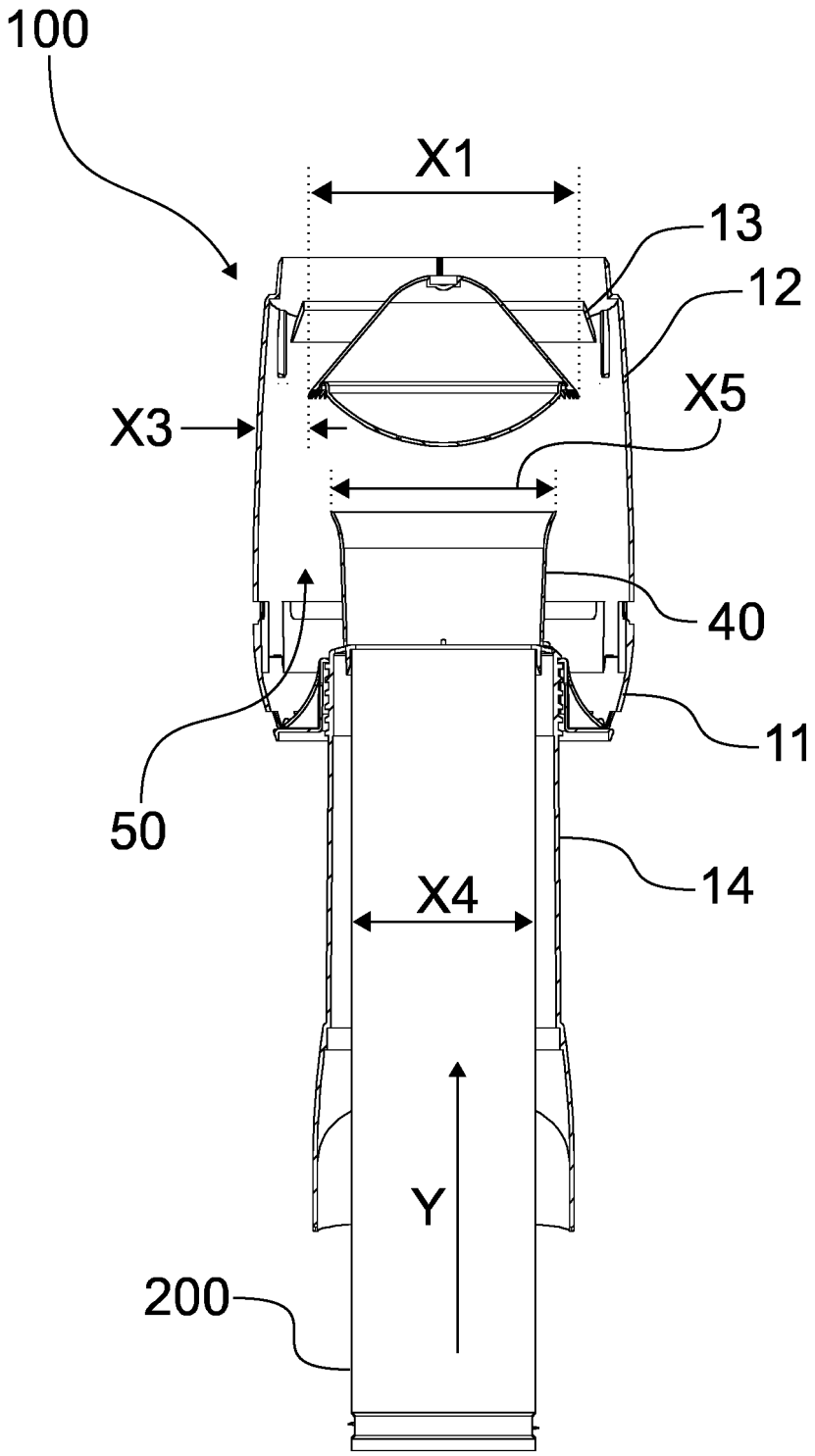

FIG. 2

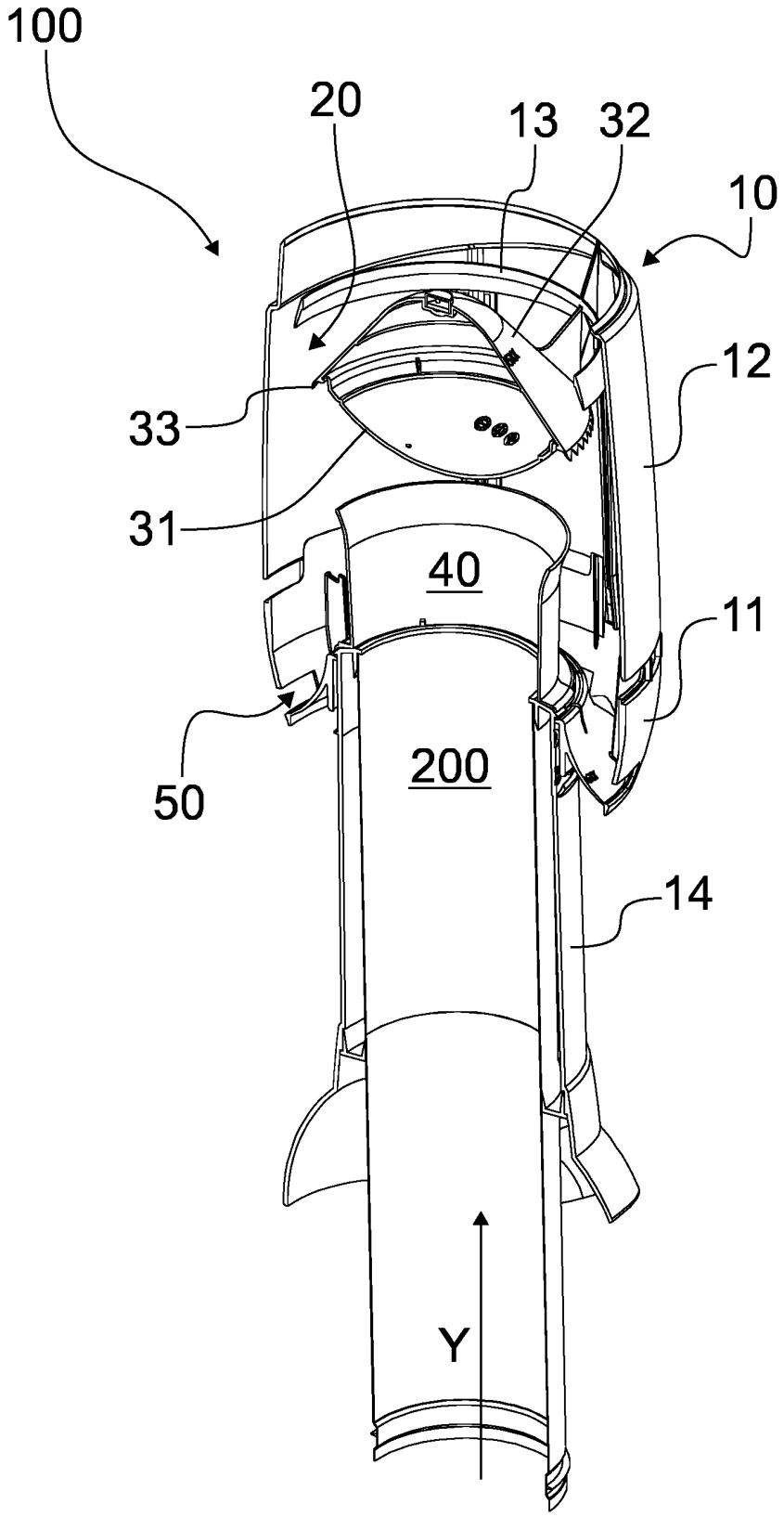

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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