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(54) Title: ARRANGEMENT FOR INTRODUCING A LIQUID MEDIUM INTO EXHAUST GASES FROM A COMBUSTION ENGINE

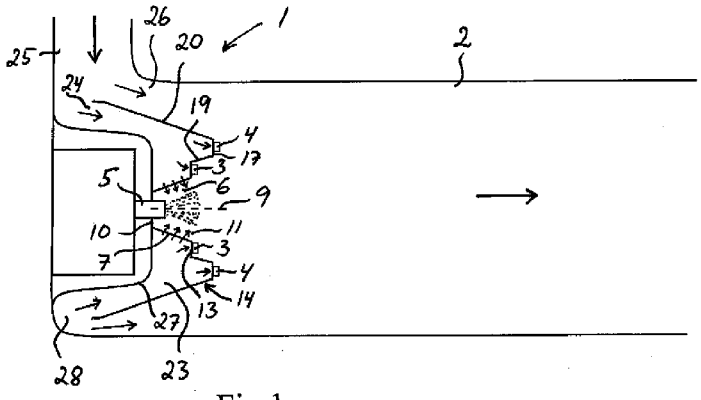


Fig 1

(57) Abstract: Arrangement for introducing a liquid medium into exhaust gases from a combustion engine, comprising - a mixing duct (2), - first flow guide means (3) for creating a first exhaust vortex in the mixing duct such that the exhaust gases in this first exhaust vortex rotate in a first direction of rotation during their movement downstream in the mixing duct, - an injection means (5) for injecting the liquid medium in the form of a finely divided spray into exhaust gases which are led into the liquid medium in an exhaust flow at the centre of the first vortex, and - second flow guide means (4) for creating a second exhaust vortex in the mixing duct concentrically with and externally about the first vortex, such that the exhaust gases in this second vortex rotate in a second direction of rotation, which is opposite to said first direction of rotation, during their movement downstream in the mixing duct.

WO 2012/047159 A1

Arrangement for introducing a liquid medium into exhaust gases from a combustion engine

FIELD OF THE INVENTION, AND PRIOR ART

The present invention relates to an arrangement according to the preamble of claim 1 for introducing a liquid medium, e.g. urea, into exhaust gases from a combustion engine.

To meet prevailing exhaust cleaning requirements, today's motor vehicles are usually provided with a catalyst in the exhaust line to effect catalytic conversion of environmentally hazardous constituents of the exhaust gases to environmentally less hazardous substances. A method which has been employed for achieving effective catalytic conversion is based on injecting a reducing agent into the exhaust gases upstream of the catalyst. A reductive substance which forms part of, or is formed by, the reducing agent is carried by the exhaust gases into the catalyst and is adsorbed on active seats in the catalyst, resulting in accumulation of the reductive substance in the catalyst. The accumulated reductive substance may then react with and thereby convert an exhaust substance to a substance with less environmental impact. Such a reduction catalyst may for example be of SCR (selective catalytic reduction) type. This type of catalyst is hereinafter called SCR catalyst. An SCR catalyst reduces NO_x in the exhaust gases. In the case of an SCR catalyst, a reducing agent in the form of urea solution is usually injected into the exhaust gases upstream of the catalyst. The injection of urea into the exhaust gases results in the formation of ammonia which then serves as the reductive substance which assists the catalytic conversion in the SCR catalyst. The ammonia accumulates in the catalyst by being adsorbed on active seats in the catalyst, and NO_x present in the exhaust gases is converted to nitrogen gas and water when it is brought into contact in the catalyst with accumulated ammonia on the active seats in the catalyst.

When urea is used as reducing agent, it is injected into the exhaust line in the form of a liquid urea solution via an injection means. The injection means comprises a nozzle via which the urea solution is injected under pressure into the injection means in the form of a finely divided spray. In many operating states of a diesel engine the exhaust gases will be at a high enough temperature to be able to vaporise the urea solution so that ammonia is formed. It is difficult, however, to avoid part of the urea solution supplied coming into contact with and becoming attached to the internal wall surface of the exhaust line in an unvaporised state. The exhaust line, which is often in contact with and cooled by surrounding air, will be at a lower temperature than the exhaust gases within the exhaust line. When a combustion engine is run in a uniform way for a period of time, i.e. during steady-state operating conditions, no appreciable variations in the exhaust flow occur and the urea solution injected into the exhaust gases will therefore reach substantially the same region of the exhaust line throughout said period of time. The relatively cool urea solution may cause local lowering of the temperature in that region of the exhaust line, which may lead to the formation in that region of a film of urea solution which is then entrained by the exhaust flow. When this film has moved a certain distance in the exhaust line, the water in the urea solution will boil away under the influence of the hot exhaust gases. Solid urea will remain and be slowly vaporised by the heat in the exhaust line. If the supply of solid urea is greater than the vaporisation, solid urea will accumulate in the exhaust line. If the resulting layer of urea becomes thick enough, the urea and its decomposition products will react with one another to form urea-based primitive polymers known as urea lumps. Such urea lumps may over time block an exhaust line.

It is therefore desirable that the injected urea solution be spread well out in the exhaust gases so that it is prevented from reaching substantially the same region of the exhaust line. A good spread of the urea solution in the exhaust gases also

facilitates its vaporisation. It is also desirable that the injected urea solution be broken up into as small drops as possible, since the vaporisation rate increases with decreasing drop size.

An arrangement according to the preamble of claim 1 is already known from WO 2007/115748 A1. In that known arrangement a first exhaust flow is led into a mixing duct in such a way that the exhaust gases in this first exhaust flow are caused to rotate about the centreline of the mixing duct, resulting in an exhaust vortex in the mixing duct. An injection means is provided to inject a liquid medium into a tubular injection chamber, thereby bringing the injected medium into contact with a second exhaust flow which passes through the injection chamber. The mixture of exhaust gases and injected medium formed within the injection chamber is then led into the mixing duct at the centre of said exhaust vortex in order to achieve good distribution of the liquid medium in the exhaust gases.

OBJECT OF THE INVENTION

The object of the present invention is to propose a further development of an arrangement of the type described above in order to achieve an arrangement with a configuration which in at least some aspects affords an advantage compared therewith.

SUMMARY OF THE INVENTION

According to the present invention, said object is achieved by means of an arrangement which presents the features defined in claim 1.

The arrangement according to the invention comprises:
- a mixing duct intended to have exhaust gases flowing through it,
- first flow guide means for creating a first exhaust vortex in the mixing duct, which first flow guide means are adapted to causing the exhaust gases in this first exhaust vortex to rotate in a first

direction of rotation during their movement downstream in the mixing duct,

- an injection means for injecting the liquid medium in the form of a finely divided spray into exhaust gases which are led into the mixing duct in an exhaust flow at the centre of the first exhaust vortex, and

- second flow guide means for creating a second exhaust vortex in the mixing duct concentrically with and externally about the first exhaust vortex, which second flow guide means are adapted to causing the exhaust gases in this second exhaust vortex to rotate in a second direction of rotation, which is opposite to said first direction of rotation, during their movement downstream in the mixing duct.

The first exhaust vortex helps to centrifuge the liquid medium in radial directions outwards so that it comes into contact with the second exhaust vortex. The fact that the first exhaust vortex and the second exhaust vortex rotate in opposite directions results in very turbulent flow where they come into contact with one another. This turbulent flow helps to spread the liquid medium out in the exhaust gases. The resulting small drops of liquid medium are thus spread well out in the exhaust gases in the mixing duct before they have occasion to reach any wall surface of the duct, thereby eliminating or at least substantially reducing the risk of the previously mentioned lump formation. The turbulent flow also helps to break the drops of liquid medium into smaller drops which are more quickly vaporised.

According to an embodiment of the invention, the injection means is adapted to injecting the liquid medium into an injection chamber situated upstream of the mixing duct, which chamber is intended to have exhaust gases flowing through it and is connected to the mixing duct in such a way that the exhaust gases received in the injection chamber are led into the mixing duct in an exhaust flow at the centre of the first exhaust vortex. In the injection chamber, an initial spreading of the liquid medium

in a first amount of exhaust gases takes place before the liquid medium comes into contact with the vortices in the mixing duct.

According to another embodiment of the invention, the injection chamber is bounded in radial directions by a casing which is provided with throughflow apertures distributed round its circumference to allow exhaust gases to enter the injection chamber via these apertures. The exhaust flow through the casing apertures pushes the medium injected in the injection chamber towards the centre of the chamber so that it is prevented from reaching its wall surfaces.

According to another embodiment of the invention, the arrangement comprises third flow guide means for creating a third exhaust vortex in the mixing duct concentrically with and externally about the second exhaust vortex, which third flow guide means are adapted to causing the exhaust gases in the third exhaust vortex to rotate in said first direction of rotation during their movement downstream in the mixing duct. The fact that the second exhaust vortex and the third exhaust vortex rotate in opposite directions results in very turbulent flow where they come into contact with one another. This turbulent flow contributes to further spread of the liquid medium out in the exhaust gases and further breaking up of the drops.

Other advantageous features of the arrangement according to the invention are indicated by the independent claims and the description set out below.

BRIEF DESCRIPTION OF THE DRAWING

The invention is described below in more detail on the basis of embodiment examples with reference to the attached drawings, in which:

Fig. 1 is a schematic longitudinal section through an arrangement according to a first embodiment of the present invention,

Fig. 2 is a schematic cross-section through the mixing duct of the arrangement according to Fig. 1,

Fig. 3 is a schematic perspective view of parts of the arrangement according to Fig. 1,

Fig. 4 is a schematic longitudinal section through an arrangement according to a second embodiment of the present invention, and

Fig. 5 is a schematic cross-section through the mixing duct of the arrangement according to Fig. 4.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Figs. 1 and 4 illustrate an arrangement 1 according to two different embodiments of the present invention for introducing a liquid medium into exhaust gases from a combustion engine. The arrangement may for example be situated in an exhaust line upstream of an SCR catalyst in order to introduce a liquid reducing agent in the form of urea or ammonia into the exhaust line upstream of the SCR catalyst, or be situated in an exhaust post-treatment device in order to introduce a liquid reducing agent in the form of urea or ammonia upstream of an SCR catalyst which forms part of the exhaust post-treatment device.

The arrangement 1 comprises a mixing duct 2 intended to receive at its upstream end exhaust gases from a combustion engine and to lead them towards an exhaust post-treatment unit, e.g. in the form of an SCR catalyst. The mixing duct 2 is thus intended to have exhaust gases flowing through it.

The arrangement 1 further comprises first flow guide means 3 for creating a first exhaust vortex V1 (see Figs. 2 and 5) in the mixing duct 2, and second flow guide means 4 for creating a second exhaust vortex V2 (see Figs. 2 and 5) in the mixing duct 2 concentrically with and immediately external to the first exhaust vortex. The flow guide means 3 are adapted to causing the exhaust gases in the first exhaust vortex V1 to rotate in a first direction of rotation (indicated by the arrow P1 in Fig. 2) during their movement downstream in the mixing duct, and the second flow guide means 4 are adapted to causing the exhaust gases in the second exhaust vortex V2 to rotate in a second direction of rotation (indicated by the arrow P2 in Fig. 2), which is opposite to said first direction of rotation, during their movement downstream in the mixing duct. The two exhaust vortices thus rotate in mutually opposite directions such that exhaust gases in the first exhaust vortex V1 will collide with exhaust gases in the second exhaust vortex V2, resulting in turbulent flow in the boundary region between the exhaust vortices.

The arrangement 1 further comprises an injection means 5 adapted to injecting the liquid medium under pressure in the form of a finely divided spray into exhaust gases which are led into the mixing duct 2 in an exhaust flow at the centre of the first exhaust vortex V1. The injection means 5 may for example comprise of an injection nozzle.

In the embodiments illustrated in Figs. 1 and 4, the arrangement 1 comprises an injection chamber 6 situated upstream of the mixing duct 2 and intended to have exhaust gases flowing through it. This injection chamber 6 is connected to the mixing duct 2 in such a way that the exhaust gases received in the injection chamber 6 are led into the mixing duct 2 in an exhaust flow at the centre of the first exhaust vortex V1. The injection means 5 is adapted to injecting the liquid medium into the injection chamber 6. The injection chamber 6 is bounded in radial directions by a casing 7 which is provided with throughflow apertures 8 (see Fig. 3) distributed in its circumferential direction

in order to allow exhaust gases to enter the injection chamber 6 via these apertures 8. The apertures 8 are distributed symmetrically about the centreline 9 of the casing. Each aperture 8 may for example take the form of a slit extending in the axial direction of the casing, as illustrated in Fig. 3. The apertures 8 might have also have other alternative shapes. In the embodiments depicted, the casing 7 takes the form of a truncated cone which broadens towards the downstream end of the injection chamber.

In the embodiments illustrated, the injection chamber 6 has a closed rear end 10 and an open forward end 11. The chamber 6 is connected to the mixing duct 2 via its open forward end 11. The aforesaid casing 7 extends between the chamber's rear end 10 and its open forward end 11. The injection means 5 is situated at the centre of the chamber's rear end 10 in order to inject the liquid medium towards the chamber's open forward end 11. In the examples illustrated, the injection means 5 extends into the injection chamber 6 via its rear wall 10.

The flow guide means 3 may for example take the form of a set of first guide flaps situated at spacings from one another in a circle, as illustrated in Fig. 3. In the example illustrated, these guide flaps 3 are situated on a first annular surface 13 of a cowl 14 which is situated externally about the casing 7. The cowl 14 is connected to the forward end of the casing 7. The first annular surface 13 extends round the injection chamber's open forward end 11. The guide flaps 3 are evenly distributed round the centre of the first annular surface and each extend at an angle outwards across their respective throughflow aperture 15 in the first annular surface 13. In the example illustrated, the second guide means 4 takes the form of a set of second guide flaps situated at spacings from one another in a circle. In the example illustrated, these guide flaps 4 are situated on a second annular surface 17 of the cowl 14. The guide flaps 4 are evenly distributed round the centre of the second annular surface and each extend at an angle outwards across their respective

throughflow aperture 18 in the second annular surface 17. In the example illustrated, the first guide flaps 3 are angled anticlockwise, whereas the second guide flaps 4 are angled clockwise. The second annular surface 17 is concentric with the first annular surface 13 and has a larger inside diameter than the outside diameter of the first annular surface 13. A wall 19 in the form of a truncated cone extends between the first annular surface 13 and the second annular surface 17. The cowl 14 further has an outer wall 20 connected at its forward end 21 to the outer edge of the second annular surface 17. This outer wall 20 takes the form of a truncated cone which broadens from the wall's forward end 21 upstream towards its rear end 22.

A gathering chamber 23 is situated between the casing 7 and the cowl 14. This chamber 23 surrounds the casing 7. The gathering chamber 23 has an inlet 24 for receiving exhaust gases from an exhaust line 25 and is connected to the injection chamber 6 via the casing apertures 8 in order to allow exhaust gases to flow into the injection chamber 6 from the gathering chamber 23 via these apertures 8. The gathering chamber 23 is also connected to the mixing duct 2 via the cowl apertures 15, 18 in order to allow exhaust gases to enter the mixing duct 2 from the gathering chamber 23 via these apertures 15, 18, resulting in the aforesaid exhaust vortices V1, V2.

In the embodiments illustrated, a bypass duct 26 is provided upstream of the mixing duct 2 to lead exhaust gases into the mixing duct without passing through the gathering chamber 23. The bypass duct 26 surrounds the gathering chamber 23 and is demarcated from it by the cowl 14. The bypass duct 26 surrounds, and extends along the outside of, the cowl 14.

The gathering chamber's inlet 24 is adapted to diverting part of the exhaust gases passing through the exhaust line 25 in order to allow these diverted exhaust gases to enter the gathering chamber 23, while the bypass line 26 is adapted to leading another portion of the exhaust gases passing through the

exhaust line 25 directly into the mixing duct 2 in order to be mixed there with said diverted exhaust gases. The spray of liquid medium injected into the injection chamber 6 via the injection means 5 comes into contact in the injection chamber 6 with exhaust gases which enter the injection chamber via the casing apertures 8 in a substantially symmetrical flow about this spray. The exhaust gases entering the injection chamber 6 prevent the liquid medium in said spray from coming into contact with the inside of the casing 7 and carry the liquid medium with them into the mixing duct 2, in which the liquid medium comes into contact with the exhaust vortices V1, V2, is broken up and spread out in the exhaust gases and is vaporised by their heat.

In the embodiments illustrated in Figs. 1 and 4, the arrangement 1 comprises a bulging portion 27 which has the casing 7 protruding from its upper side. The gathering chamber 23 is formed between this bulging portion 27, the casing 7 and the cowl 14. The inlet 24 of the gathering chamber is in this case annular and extends round the bulging portion 27. Upstream of the gathering chamber's inlet 24 the exhaust line 25 has an annular space 28 which extends round the bulging portion 27.

In the embodiment illustrated in Figs. 4 and 5, the arrangement 1 comprises also third flow guide means 30 for creating a third exhaust vortex V3 in the mixing duct 2 concentrically with and immediately externally about the second exhaust vortex V2. These third flow guide means 30 are adapted to causing the exhaust gases in this exhaust vortex V3 to rotate in said first direction of rotation during their movement downstream in the mixing duct 2. The second and third exhaust vortices V2, V3 thus rotate in mutually opposite directions such that exhaust gases in the second vortex V2 will collide with exhaust gases in the third vortex V3, resulting in turbulent flow in the boundary region between the vortices. The third flow guide means 30 may for example take the form of guide flaps of the type described above.

Where necessary, the arrangement may comprise further flow guide means for creating any desired number of exhaust vortices in the mixing duct 2 concentrically with and externally about one another, such that alternate vortices are caused to rotate clockwise and the respective intermediate vortices anticlockwise.

The arrangement according to the invention is particularly intended for use in a heavy motor vehicle, e.g. a bus, a tractor vehicle or a truck.

The invention is of course in no way restricted to the embodiments described above, since many possibilities for modifications thereof are likely to be obvious to a specialist in the field without having to deviate from the invention's basic concept such as defined in the attached claims. For example, the flow guide means 3, 4, 30 may be configured differently from what is described above.

CLAIMS

1. An arrangement for introducing a liquid medium, e.g. urea, into exhaust gases from a combustion engine, which arrangement (1) comprises
- a mixing duct (2) intended to have exhaust gases flowing through it,
- first flow guide means (3) for creating a first exhaust vortex (V1) in the mixing duct (2), which first flow guide means (3) are adapted to causing the exhaust gases in this first vortex to rotate in a first direction of rotation during their movement downstream in the mixing duct, and
- an injection means (5) for injecting the liquid medium in the form of a finely divided spray into exhaust gases which are led into the mixing duct (2) in an exhaust flow at the centre of the first vortex (V1),
characterised in that the arrangement (1) comprises second flow guide means (4) for creating a second exhaust vortex (V2) in the mixing duct (2) concentrically with and externally about the first vortex (V1), which second flow guide means (4) are adapted to causing the exhaust gases in this second vortex to rotate in a second direction of rotation, which is opposite to said first direction of rotation, during their movement downstream in the mixing duct.

2. An arrangement according to claim 1, **characterised**
- in that the arrangement (1) comprises an injection chamber (6) situated upstream of the mixing duct (2), intended to have exhaust gases flowing through it and connected to the mixing duct (2) in such a way that the exhaust gases received in the injection chamber (6) are led into the mixing duct (2) in an exhaust flow at the centre of the first vortex (V1), and
- that the injection means (5) is adapted to injecting the liquid medium into the injection chamber (6).

3. An arrangement according to claim 2, **characterised** in that the injection chamber (6) is bounded in radial directions by a

casing (7) which is provided with throughflow apertures (8) which are distributed in its circumferential direction in order to allow exhaust gases to enter the injection chamber (6) via these apertures (8).

4. An arrangement according to claim 3, **characterised** in that the casing apertures (8) are distributed symmetrically about its centreline (9).

5. An arrangement according to claim 3 or 4, **characterised**
- in that the injection chamber (6) has a rear end (10) and an open forward end (11) and is connected to the mixing duct (2) via said open forward end (11), and
- that the injection means (5) is situated at the centre of the injection chamber's rear end (10) and is adapted to injecting the liquid medium towards the chamber's open forward end (11).

6. An arrangement according to any one of claims 1-5, **characterised** in that the first flow guide means (3) take the form of a set of first guide flaps situated at spacing from one another in a circle.

7. An arrangement according to any one of claims 1-6, **characterised** in that the second flow guide means (4) take the form of a set of second guide flaps situated at spacing from one another in a circle.

8. An arrangement according to any one of claims 1-7, **characterised** in that the arrangement (1) comprises third flow guide means (30) for creating a third exhaust vortex (V3) in the mixing duct (2) concentrically with and externally about the second vortex (V2), which third flow guide means (30) are adapted to causing the exhaust gases in the third vortex to rotate in said first direction of rotation during their movement downstream in the mixing duct.

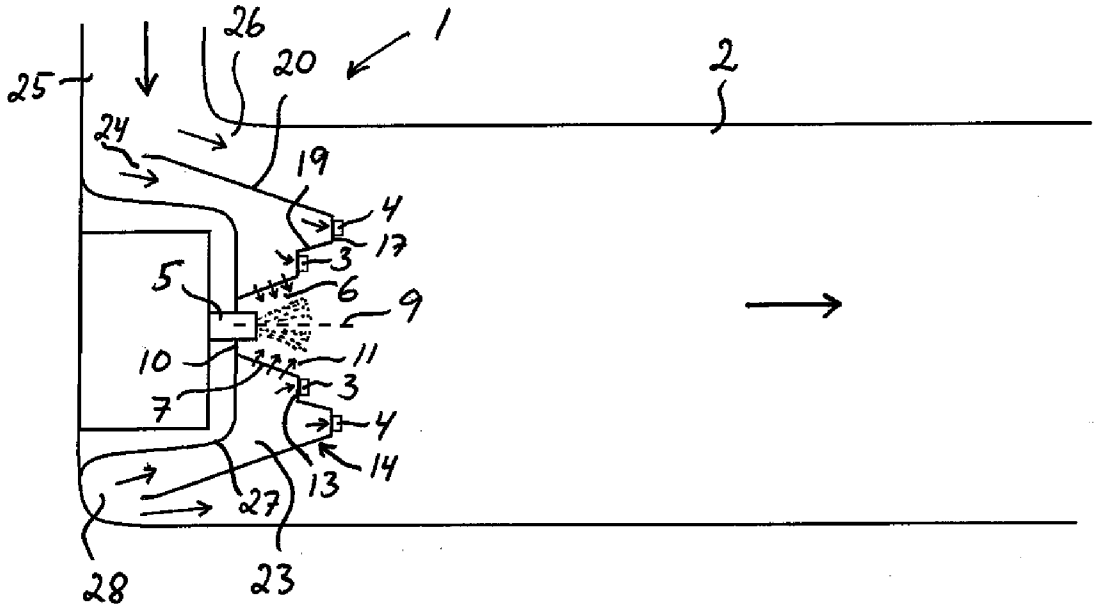


Fig 1

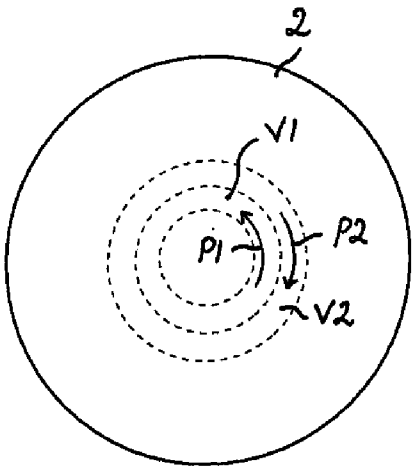


Fig 2

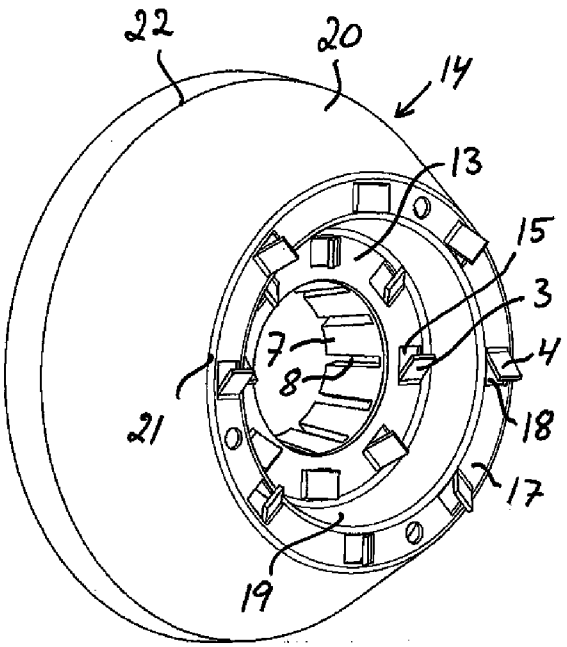


Fig 3

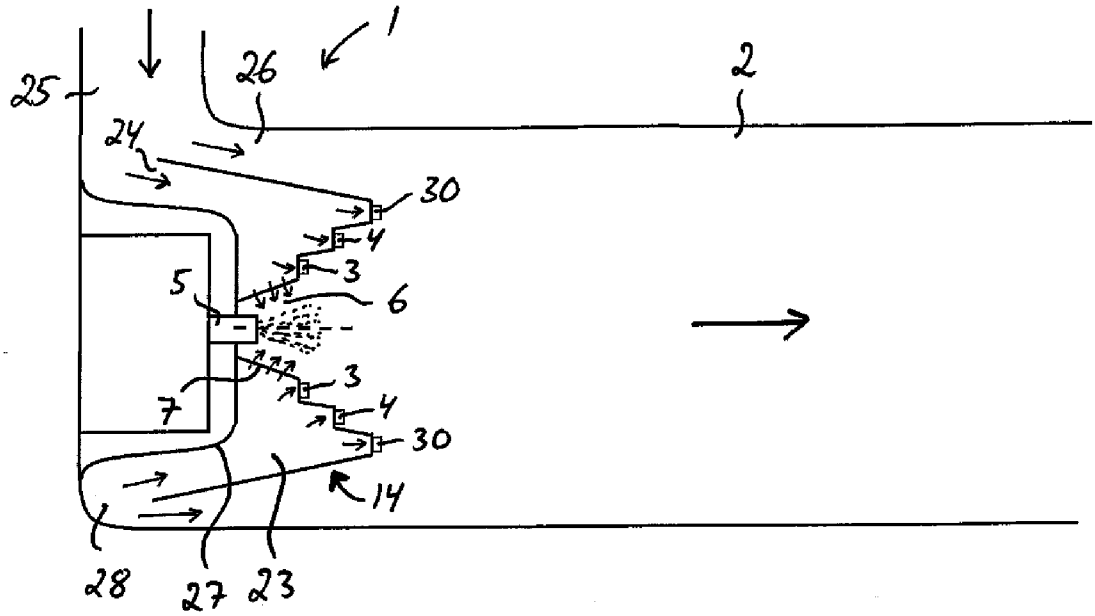


Fig 4

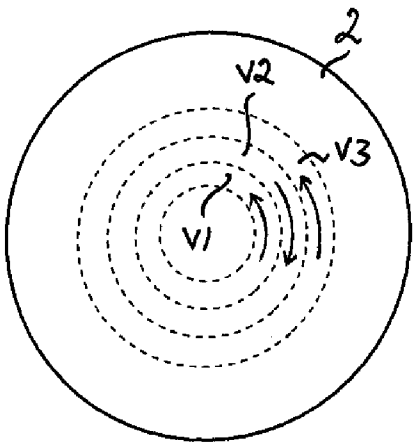


Fig 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/051178

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	--	2-5
X	US 20080250776 A1 (BROWN DAVID B ET AL), 16 October 2008 (2008-10-16); abstract; paragraphs [0004]-[0005], [0016]-[0019]; figures	1, 6-8
A	--	2-5

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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03-01-2012	12-01-2012

Name and mailing address of the ISA/SE	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/051178

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20100005790 A1 (ZHANG XIAOGANG), 14 January 2010 (2010-01-14); abstract; figures 5,8	1-8
A	GB 2381218 A (EMINOX LTD), 30 April 2003 (2003-04-30); page 7, line 10 - line 23; page 9, line 3 - line 19; page 16, line 4 - line 18; page 25, line 12 - line 28; page 26, line 25 - page 27, line 15; page 28, line 25 - page 29, line 11; figures 5,7,10	1-8
A	DE 4203807 A1 (MAN NUTZFAHRZEUGE AG), 12 August 1993 (1993-08-12); page 2, line 42 - line 49; page 3, line 37 - line 41; page 5, line 46 - page 6, line 5; figures 3,6	1-8
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International Patent Classification (IPC)

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Cited literature, if any, will be enclosed in paper form.

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