



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.04.2007 Bulletin 2007/14

(51) Int Cl.:
F01N 1/12 (2006.01) F01N 7/08 (2006.01)

(21) Application number: **05394027.6**

(22) Date of filing: **28.09.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

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(54) **Exhaust gas diffuser**

(57) An exhaust gas diffuser (1) is provided comprising an elongate exhaust gas cylinder (3) with a gas inlet (5) and gas outlet (7) and a primary vortex inducer (9) within the exhaust gas cylinder (3) which transforms the laminar flow of the exhaust gas passing through the exhaust cylinder (3) into a turbulent spinning vortex flow. The diffuser (1) further includes means to provide a flow

of ambient temperature atmospheric air from external the exhaust gas cylinder (3) to a position internal the exhaust gas cylinder (3). The flow of ambient temperature atmospheric air mixes with the spinning vortex flow of exhaust gases prior to their release from the gas outlet (7). This serves to cool the exhaust gases significantly and ensures the gases are dispersed in a less concentrated form from the diffuser.

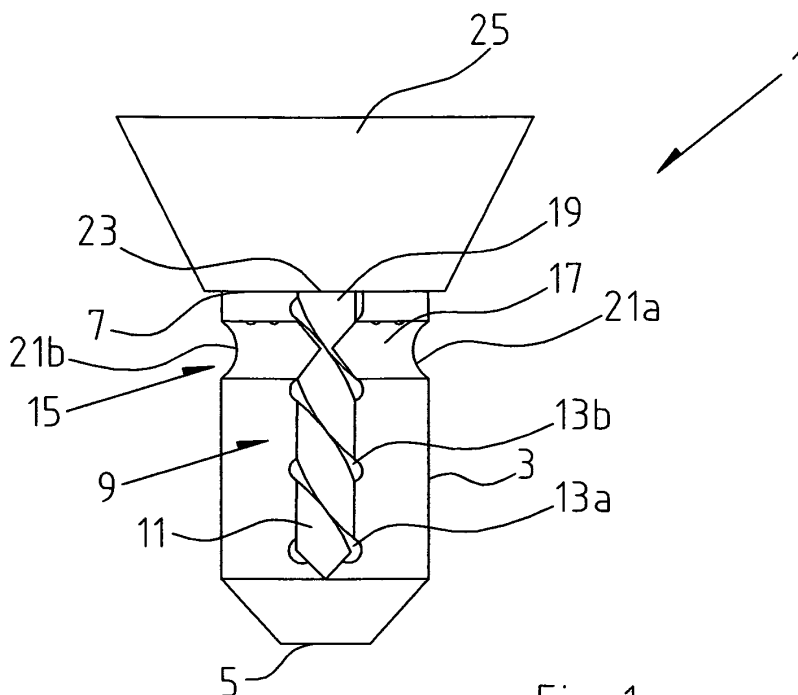


Fig. 1

Description

Introduction

[0001] This invention relates to an exhaust gas diffuser comprising an elongate exhaust gas cylinder having a gas inlet and a gas outlet and in particular to an exhaust gas diffuser for a diesel engine.

[0002] Diesel oil burning boilers and diesel engines have been known for many years and are widely used in central heating systems, uninterrupted power-supplies, vehicle engines and the like. Diesel is seen as a particularly useful fuel due to its low cost and widespread availability. There are however numerous disadvantages associated with diesel oil burning boilers and diesel engines. One of the main problems associated with diesel oil burning boilers and diesel engines in general is that the exhaust gases generated by the boilers and engines have a high concentration of harmful vapours and entrained particles which can have serious health and environmental consequences. The main components of the exhaust gases include carbon monoxide, carbon dioxide, nitrogen oxide, nitrogen dioxide, sulphur dioxide, hydrocarbon compounds and particulates which are visible as black smoke. When in a concentrated form, these components increase the harmful effects of the exhaust gas, as well as causing the exhaust gas to look rather unsightly.

[0003] Another major problem with exhaust gases from diesel oil burning boilers and diesel engines is the temperature of the diesel exhaust gases. In many cases the exhaust gases may have a temperature as high as 500°C when exiting an exhaust chamber or pipe. Therefore, these gases can cause a significant fire hazard threat and great care must be taken to separate any combustible materials from the vicinity of the exhaust of the diesel boiler or engine. Furthermore, such high temperature gases often result in serious burns to unwary individuals coming into contact with the exhaust gases which, in the worst case, can prove fatal. Therefore, the release of the exhaust gases themselves provide a significant health and safety risk.

[0004] It is an object therefore of the present invention to overcome at least some of the difficulties associated with diesel oil burning boilers and diesel engines.

Statements of Invention

[0005] According to the invention there is provided an exhaust gas diffuser comprising an elongate exhaust gas cylinder having an exhaust gas inlet and an exhaust gas outlet, the exhaust gas diffuser further comprising a primary vortex inducer located internal the exhaust gas cylinder for turning a substantially laminar flow of exhaust gases flowing through the exhaust gas cylinder into a turbulent spinning vortex flow of exhaust gases, and an air introducer for introducing air from a position external the exhaust gas cylinder to a position internal the exhaust

gas cylinder downstream of the primary vortex inducer for mixing with the turbulent spinning vortex flow of exhaust gases.

[0006] By having such a device, it is possible to dilute the exhaust gas with air prior to the exhaust gases leaving the exhaust gas diffuser. The exhaust gases will therefore be in a less concentrated form and will be less unsightly than was previously the case. Furthermore, the exhaust gases will also have had an opportunity to cool down due to the introduction of ambient temperature air from outside the exhaust gas diffuser and will therefore not pose such a fire hazard risk as may have previously been the case. By turning the exhaust gases into a turbulent spinning vortex flow of exhaust gases, the air will be able to mix with the gases in a more efficient manner and furthermore, the turbulent spinning vortex flow of exhaust gases will create a vacuum at its center thereby causing air to be drawn in to the centre of the turbulent spinning vortex flow of exhaust gases without the need to positively pump air into the exhaust gas diffuser for mixing with the exhaust gases. This is also therefore particularly cost effective.

[0007] In one embodiment of the invention there is provided an exhaust gas diffuser in which the air introducer further comprises an elongate pipe having an air inlet and an air outlet and a throughbore therebetween, the air inlet being in communication with the exterior of the exhaust gas cylinder and the air outlet being in communication with the interior of the exhaust gas cylinder. This is a particularly simple way of delivering the air to the interior of the exhaust gas diffuser that will be able to mix effectively with the exhaust gases.

[0008] In another embodiment of the invention there is provided an exhaust gas diffuser in which the elongate pipe comprises a cross member mounted transversely across the exhaust gas cylinder, at least one end of which being in communication with the exterior of the exhaust gas cylinder thereby forming the air inlet, the cross member having an air vent formed intermediate its ends facing away from the exhaust gas inlet of the exhaust gas cylinder thereby forming the air outlet. This is seen as a useful construction of exhaust gas diffuser and the cross member will serve to add rigidity to the structure thereby making the exhaust gas diffuser more durable.

[0009] In a further embodiment of the invention there is provided an exhaust gas diffuser in which both ends of the cross member are in communication with the exterior of the exhaust gas cylinder thereby forming a pair of air inlets. This is seen as a particularly useful configuration of exhaust gas diffuser and a large amount of air will be drawn into the exhaust gas diffuser for mixing with the turbulent spinning vortex flow of exhaust gases which will allow for the exhaust gases to be diluted to a greater extent.

[0010] In one embodiment of the invention there is provided an exhaust gas diffuser in which there are provided a pair of deflector plates mounted internal the cross member adjacent the air vent for turning a flow of air entering

the cross member through the air inlets into a secondary turbulent spinning vortex flow of air as it exits the cross member through the air outlet. This is seen as particularly advantageous as the air coming into the exhaust gas diffuser for mixing with the turbulent spinning vortex flow of exhaust gases will itself become a turbulent spinning vortex flow which will assist in the mixing of the air and the exhaust gases and ensure that the maximum amount of cooling and dilution may be achieved.

[0011] In another embodiment of the invention there is provided an exhaust gas diffuser in which there is provided an elongate guide pipe mounted on the cross member and substantially orthogonal thereto, one end of the elongate guide pipe surrounding the air vent and the other end of the elongate guide pipe facing away from the exhaust gas inlet and thereby forming the air outlet. By having the guide pipe, the spinning vortex of air is allowed to properly form and establish itself before it is allowed to mix with the turbulent spinning vortex flow of exhaust gases. This ensures that the air and the exhaust gases will mix to the optimum amount possible.

[0012] In a further embodiment of the invention there is provided an exhaust gas diffuser in which the air outlet is located adjacent one end of the elongate pipe and the elongate pipe is cranked intermediate its ends so that the air outlet faces away from the exhaust gas inlet of the exhaust gas cylinder. This is seen as a simple construction of exhaust gas diffuser that will allow a flow of air to be mixed with the turbulent spinning vortex flow of exhaust gases.

[0013] In one embodiment of the invention there is provided an exhaust gas diffuser in which the air outlet is located substantially along the longitudinal axis of the exhaust gas cylinder in a position for communication with the interior of a turbulent spinning vortex flow of exhaust gases. By positioning the air outlet so that the air communicates with the interior of the turbulent spinning vortex flow of exhaust gases, the air will be able to mix very thoroughly and quickly with the exhaust gases and furthermore, by placing the air outlet in this position, the turbulent spinning vortex flow of exhaust gases will itself cause a vacuum at its centre thereby causing the air to be drawn through the air inlet from the exterior of the exhaust gas cylinder into the centre of the turbulent spinning vortex flow of exhaust gases. This means that air will not have to be pumped into the exhaust gas cylinder by other means which reduces the operating costs of the exhaust gas diffuser.

[0014] In another embodiment of the invention there is provided an exhaust gas diffuser in which there are provided a plurality of air venting apertures formed along the length of the pipe, each of the air venting apertures being of a diameter less than the diameter of the air vent and each of the air venting apertures facing away from the exhaust gas inlet of the exhaust gas cylinder. By having these additional air venting apertures, it will be possible to create Karman street vortices internal the exhaust gas diffuser which will also cause mixing of air with the

exhaust gases thereby further diluting and cooling the exhaust gases.

[0015] In a further embodiment of the invention there is provided an exhaust gas diffuser in which the air introducer further comprises a plurality of apertures circumferentially spaced around the exhaust gas cylinder in a position downstream of the primary vortex inducer. By having air apertures circumferentially spaced around the exhaust gas cylinder, the turbulent spinning vortex flow of exhaust gases will also cause air to be drawn inwards through the apertures and this air will mix with the turbulent spinning vortex flow of exhaust gases, thereby cooling and diluting the exhaust gases.

[0016] In one embodiment of the invention there is provided an exhaust gas diffuser in which the exhaust gas cylinder further comprises an integral exhaust gas diffuser bowl substantially frusto-conical in shape, the exhaust gas diffuser bowl tapering outwardly towards the exhaust gas outlet. This is seen as a useful shape of exhaust gas diffuser as the turbulent spinning vortex flow of exhaust gases will be allowed to expand outwardly as it develops thereby allowing the gases to dilute somewhat as they are being introduced to the air for mixing with the air.

[0017] In another embodiment of the invention there is provided an exhaust gas diffuser in which there are provided a plurality of apertures circumferentially spaced around the narrowest portion of the exhaust gas diffuser bowl. By having the apertures spaced around adjacent the narrowest portion of the exhaust gas diffuser bowl, air will be drawn into the exhaust gas diffuser bowl as the turbulent spinning vortex flow of exhaust gases expands out into the larger part of the bowl. This will cause to further cool the exhaust gases down.

[0018] In a further embodiment of the invention there is provided an exhaust gas diffuser in which the circumference of the narrowest portion of the exhaust gas diffuser bowl is greater than the circumference of the exhaust gas cylinder and there is provided an annular ring mounted intermediate the exhaust gas diffuser bowl and the exhaust gas cylinder connecting the exhaust gas diffuser bowl to the exhaust gas cylinder, the annular ring having a plurality of apertures circumferentially spaced around its surface. This is seen as a particularly useful construction to have as not only will the apertures allow air to be drawn into the diffuser bowl for mixing with the exhaust gases but the apertures will also allow for drainage of any rain water that may fall into the diffuser bowl should the exhaust gas diffuser be mounted on an upright exhaust pipe.

[0019] In one embodiment of the invention there is provided an exhaust gas diffuser in which there is further provided a rain protector shield mounted internal the diffuser bowl. By having a rain protector shield, it will be possible to prevent rain from traveling down the exhaust gas diffuser into the exhaust pipe of an engine. This will help to protect the engine particularly when the engine is not running as rain water can cause serious damage to the engine if it is allowed to enter the engine through

the exhaust pipe.

[0020] In another embodiment of the invention there is provided an exhaust gas diffuser in which the rain protector shield is substantially frusto-conical in shape and tapers outwardly towards the exhaust gas outlet of the exhaust gas cylinder, the circumference of the widest portion of the rain protection shield being greater than the circumference of the exhaust gas cylinder. This is seen as a useful construction of rain shield that will act to move rain water away from the exhaust pipe to be safely drained away.

[0021] In a further embodiment of the invention there is provided an exhaust gas diffuser in which the primary vortex inducer further comprises an elongate vortex cylinder mounted internal the exhaust gas cylinder substantially in line with a laminar flow of exhaust gases passing through the exhaust gas cylinder, the elongate vortex cylinder having at least one helical strake mounted on the outer surface thereof. This is seen as a particularly efficient construction of primary vortex inducer that is both robust and relatively simple and cost efficient to manufacture. The primary vortex inducer will be easily positioned within the exhaust gas diffuser and will be very efficient at producing a turbulent spinning vortex flow of exhaust gases.

[0022] In one embodiment of the invention there is provided an exhaust gas diffuser in which the elongate vortex cylinder has a pair of helical strakes mounted on the outer surface thereof. By having a pair of helical strakes it will be possible to create two turbulent spinning vortex flow of exhaust gases which will allow for more effective mixing of the exhaust gases with the air that is introduced into the exhaust gas diffuser.

[0023] In another embodiment of the invention there is provided an exhaust gas diffuser in which the end of the vortex cylinder facing the flow of exhaust gases is tapered into a conical portion, the apex of which facing the flow of exhaust gases. By tapering the vortex cylinder end in this fashion, the exhaust gases will more easily be trained over the helical strakes for turning into turbulent spinning vortex flows of exhaust gases.

[0024] In a further embodiment of the invention there is provided an exhaust gas diffuser in which the primary vortex inducer further comprises a vortex cone, mounted internal and substantially in line with a flow of exhaust gases passing through the exhaust gas cylinder. This is seen as a useful alternative device for creating a turbulent spinning vortex flow of exhaust gases that is also simple and cost effective to construct.

[0025] In one embodiment of the invention there is provided an exhaust gas diffuser in which the primary vortex inducer further comprises a half ball, mounted internal and substantially in line with a flow of exhaust gases passing through the exhaust gas cylinder. This is also seen as a useful alternative device for creating a turbulent spinning vortex flow of exhaust gases that is also simple and cost effective to construct.

[0026] In another embodiment of the invention there

is provided an exhaust gas cylinder in which the primary vortex inducer is mounted centrally and substantially co-axially with the exhaust gas cylinder. This will ensure that the turbulent spinning vortex flow of exhaust gases will be formed evenly throughout the exhaust gas cylinder and will expand evenly on all sides of the primary vortex inducer without significant amounts of gases rebounding off the side walls of the exhaust gas cylinder and disrupting the turbulent spinning vortex flow of exhaust gases.

[0027] In a further embodiment of the invention there is provided an exhaust gas cylinder in which the primary vortex inducer is mounted centrally and substantially co-axially with the exhaust gas cylinder on the elongate pipe. This is seen as particularly useful and it is envisaged that the pipe and the primary vortex inducer may indeed be constructed as a single unit that will ease manufacturing of the device.

[0028] In a still further embodiment of the invention, the exhaust gas diffuser is adopted for connection onto an exhaust pipe of an engine, the exhaust gas cylinder having a greater internal diameter than the exhaust pipe.

[0029] Ideally, the exhaust gas diffuser is formed integrally with an exhaust pipe of an engine, the exhaust gas cylinder having a greater internal diameter than the exhaust pipe.

Detailed Description of the Invention

[0030] The invention will now be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Fig. 1 is a front elevation part cross sectional view of an exhaust gas diffuser in accordance with the invention;

Fig. 2 is a plan view of the exhaust gas diffuser of Fig. 1;

Fig. 3 is a front elevation part cross sectional view similar to Fig. 1 rotated through 90°;

Fig. 4 is a plan view of the exhaust gas diffuser as in Fig. 3;

Fig. 5 is a further elevation of portion of the diffuser;

Fig. 6 is an elevation similar to Fig. 5 shifted through 90°;

Fig. 7 is a cross sectional view of the arrangement of Fig. 5 taken along the lines A - A;

Fig. 8 is a view similar to that shown in Fig. 7 showing part of the operation of the diffuser;

Fig. 9 is a view similar to Fig. 5 illustrating part of the operation of the diffuser;

Fig. 10 illustrates a turbulent spinning vortex flow of exhaust gases created by a primary vortex inducer of the diffuser;

Fig. 11 illustrates an inner turbulent spinning vortex flow of ambient temperature air created by a secondary vortex inducer of the diffuser;

Fig. 12 illustrates an outer turbulent spinning vortex flow of ambient temperature air created by a tertiary vortex inducer of the diffuser;

Fig. 13 is a perspective part cross sectional view illustrating an exhaust gas diffuser in operation;

Fig. 14 illustrates a Karman vortex street formed in the diffuser;

Fig. 15 is a front elevation cross sectional view of an alternative embodiment of exhaust gas diffuser according to the invention; and

Fig. 16 is a plan view of the exhaust gas diffuser shown in Fig. 15.

[0031] Referring to the drawings and initially to Figs. 1 to 4 thereof, there is shown an exhaust gas diffuser, indicated generally by the reference numeral 1, comprising an elongate exhaust gas cylinder 3 having an exhaust gas inlet 5 and an exhaust gas outlet 7. A primary vortex inducer (PVI) 9 comprising an elongate vortex cylinder 11 is positioned internal the exhaust gas cylinder and is substantially coaxial with the exhaust gas cylinder and substantially in line with a flow of exhaust gases (not shown) passing through the exhaust gas cylinder 3. The PVI further comprises a pair of helical strakes 13(a), 13(b) formed along the length of the vortex cylinder 11.

[0032] There is further provided an air introducer 15 for introducing air from a position external the exhaust gas cylinder to a position internal the exhaust gas cylinder downstream of the PVI having an air inlet and an air outlet. The air introducer 15 comprises a pipe having a substantially inverted T-shape comprising a cross member 17 mounted transversely across the exhaust gas cylinder 3 and an elongate guide pipe 19 connected to the cross member intermediate its ends. Each of the ends 21(a), 21(b) of the cross member 17 are in communication with the ambient air external the exhaust gas cylinder thereby forming air inlets and there is provided an air vent 22 formed intermediate the cross members ends 21a, 21 b and facing away from the exhaust gas inlet 5 of the exhaust gas cylinder. One end of the guide pipe 19 surrounds the air vent 22 formed in the cross member 17 intermediate its ends, and the other end 23 of the guide pipe 19, which forms the air outlet, is positioned facing

away from the exhaust gas inlet in a location for communication with the interior of a primary spinning vortex of exhaust gases (not shown) formed in the exhaust gas cylinder. A diffuser bowl 25 is connected to the gas outlet 7, the diffuser bowl 25 being frusto-conical in shape, tapering outwardly from the gas outlet 7. The air introducer comprising a pipe, one end of which being in communication with the air external the exhaust gas cylinder and the other end of which being in communication with the interior of the exhaust gas cylinder, is also referred to throughout this specification as a secondary vortex inducer (SVI) and these terms may be used interchangeably throughout the specification.

[0033] Referring specifically to Figs. 2 and 4 of the drawings, there is illustrated an air introducer formed by a plurality of apertures 27 spaced circumferentially about the end of the diffuser bowl 25 connected to the gas outlet 7. The air introducer formed by a plurality of air apertures 27 is also referred to throughout this specification as a tertiary vortex inducer (TVI) and these terms may be used interchangeably throughout the specification. A plurality of air venting apertures 29 are formed in the cross member 17 of the SVI 15 facing the gas outlet 7. Each of the air venting apertures 29 is of a diameter less than the diameter of the air vent 22.

[0034] Referring to Figs. 5 and 6 of the drawings, there is shown a combined PVI 9 and SVI 15 for use with the present invention. The PVI 9 and SVI 15 are formed as one unit which may be subsequently attached to the exhaust gas cylinder by welding or any other suitable method. The plurality of air venting apertures 29 are punched in the side of the cross member 17 of the SVI, facing the gas outlet (not shown). The cross member is substantially cylindrical in shape and the air venting apertures 29 of the cross member 17 are asymmetrical to promote rotational flow in the ambient temperature air drawn into the SVI 15. Referring to Figs. 7 and 8, a pair of arcuate deflector plates 31(a), 31(b) is provided mounted internal the cross member 17 adjacent to air vent 22.

[0035] In use, as air is drawn into the cross member 17 of the air introducer through its ends 21(a) and 21(b), it travels along the cross member 17 and is directed against arcuate deflector plates 31(b) and 31(a) respectively. Essentially, there are two opposed but offset streams of air. The arcuate deflector plates impart a spinning motion on the air flow passing through the air introducer, thereby forming a secondary turbulent spinning vortex flow of air. The spinning flow of air travels upwards out of the cross member through the air vent 22 into the guide pipe 19 and from there is delivered to a position internal a turbulent spinning vortex flow of exhaust gases.

[0036] Referring to Fig. 9, there is shown a combined PVI and SVI illustrating the formation of a turbulent spinning vortex flow of exhaust gases. The exhaust gases passing over the PVI are separated into two separate gas flows, 33(a) and 33(b), by the helical strakes 13(a) and 13(b). These flows of exhaust gases then follow the helical strakes up along the vortex cylinder 11 along its

length until the attachment is broken once the gas flows 33(a) and 33(b) encounter the cross member 17 of the SVI. This results in a turbulent spinning vortex flow of exhaust gases being created.

[0037] Referring to Fig. 10, there is shown a diagrammatic representation of the turbulent spinning vortex flow of exhaust gases created by the PVI. Exhaust gases 35 enter the exhaust gas diffuser 1 through inlet 5 and pass over the vortex cylinder 11 of the PVI 9. The exhaust gases follow the helical strakes (not shown) as described previously on the PVI 9 which impart a spinning turbulent flow to the exhaust gases 35. The exhaust gases separate into two separate streams of exhaust gases but for reasons of clarity, only one stream of the exhaust gases is shown. The gases accelerate as they are guided by the strakes (not shown) on the vortex cylinder 11 of the PVI 9 so that a turbulent spinning vortex flow is created. This spinning vortex expands outwardly once the gas 35 separates from the end of the vortex cylinder into the diffuser bowl 25 before exiting the diffuser bowl into the atmosphere. By having the spinning vortex flow the exhaust gases are retained in the exhaust gas diffuser for some time before exiting the diffuser bowl 25.

[0038] Referring to Fig. 11, there is shown a diagrammatic representation of the creation of a secondary turbulent spinning vortex of ambient air created by the SVI 15. The primary turbulent spinning vortex flow of exhaust gases (not shown) described previously will have a vacuum created in its centre. This vacuum causes an intake of air 36 through ends 21(a) and 21(b) of the SVI 15. The air 36 entering the SVI 15 is given a spinning vortex motion, as described previously, by the deflector plates (not shown) located internal the cross member of the SVI 15 before the spinning vortex of air 37 is drawn upwards through the guide pipe 19 of the SVI 15 into the vacuum at the centre of the primary spinning turbulent vortex flow of exhaust gases (not shown). In this way, a spinning vortex of air 37 is formed inside the spinning vortex of exhaust gases (not shown).

[0039] Referring to Fig. 12, there is shown a diagrammatic representation of the formation of a spinning vortex flow of ambient air external the spinning vortex of exhaust gases (not shown), namely, a tertiary vortex. An air stream 38 is drawn in through apertures 27, which for reasons of clarity only one of which is shown, located in the portion of the diffuser bowl 25 adjacent the outlet 7 of the exhaust gas cylinder 3. This air stream 38 is drawn into the diffuser bowl by the motion of the spinning turbulent vortex flow of exhaust gases (not shown) inside the diffuser bowl 25. The spinning turbulent vortex flow of exhaust gases (not shown) imparts a spinning motion on the air drawn in through the apertures 27, thereby creating a tertiary turbulent spinning vortex air flow, indicated by the reference numeral 39. This tertiary vortex of air will be formed outside the primary vortex of exhaust gases.

[0040] Referring to Fig. 13, there is shown a diagrammatic representation of the exhaust gas diffuser in oper-

ation. This shows the three vortices combined together. The exhaust gas diffuser 1 is connected to an exhaust pipe 41 of a diesel engine (not shown). The exhaust gases emitted by the engine pass over the primary vortex inducer (not shown). This creates a turbulent spinning vortex flow of exhaust gas 43. The turbulent spinning vortex flow of exhaust gases 43 will in turn create a vacuum at its centre. This vacuum will cause an air stream 36 of ambient temperature air to be drawn in through the inlets 21(a) and 21(b) into the secondary vortex inducer. The air stream 36 passes over the arcuate deflector plates (not shown) which impart a spinning motion on the air stream 36 which is drawn upwards through the SVI 15 into the vacuum of the centre of the spinning vortex of exhaust gases. A spinning vortex of air 45 internal the spinning vortex of exhaust gases 43 is thereby created. Finally, air streams 38 of ambient temperature air are drawn in through the apertures 27 in the diffuser bowl 25 by the spinning vortex of exhaust gas 43. The air streams 36 drawn into the diffuser bowl 25 are caused to rotate due to the motion of the spinning vortex of exhaust gas 43. This in turn creates an outer spinning vortex of air 47. The spinning vortex of exhaust gas 43 is therefore sandwiched between the inner spinning vortex of air 45 and the outer spinning vortex of air 47. The spinning vortex of exhaust gas is cooled and diluted between the two adjacent spinning vortices of ambient temperature air, before exiting the diffuser bowl 25.

[0041] In addition to the exhaust gas being cooled between the two spinning vortices of air, ambient temperature air is introduced into the vortex flow of exhaust gas through the air venting apertures 29 formed in the cross member 17 of the SVI.

Fig. 14 shows a side view of an exhaust gas flow 51 as it encounters the cross member of the SVI. The exhaust gases part into two streams of gases 52a, 52b before joining up again on the leeward side of the cross member. As the turbulent spinning vortex flow passes over the cylindrical cross member 17 of the secondary vortex inducer, a partial vacuum is formed on the leeward side of the cylinder as the two gas streams will not recombine instantaneously as they reach the far side of the cross member. This partial vacuum causes air to be drawn into the SVI through the inlets 21 (a) and 21(b) and passed through the air venting apertures 29 into the vacuum on the leeward side of the cross member. A Karman vortex street comprising a regular pattern of stable staggered vortices is formed as the gases pass over the cross member 17 and the ambient air passing through the air venting apertures 29 is mixed with the exhaust Karman vortex street gas flow on the leeward side of the cross member 17. This mixing of exhaust gases with ambient air causes further cooling and dilution of the exhaust gases.

[0042] Referring now to Figs. 15 and 16, there is shown an alternative construction of exhaust gas diffuser 1 according to the present invention, where like parts have been given the same reference numerals as before. The exhaust gas diffuser 1 further comprises a rain guard

protector 54. The rain guard protector 54 is substantially frusto-conical in shape, the narrow end of which is connected to the air outlet 23 of the guide member 19. The rain guard protector tapers outwardly towards the exhaust gas outlet of the diffuser bowl 25. The widest portion of the rain guard protector 54 is wider than the exhaust gas outlet 7 of the exhaust gas cylinder. In use, the exhaust gas diffuser with rain guard protector may be mounted on a vertical exhaust pipe (not shown). Rain falling on the exhaust gas diffuser will either fall on the interior of the rain guard protector 54 or will fall on the interior walls of the diffuser bowl 25. Rain falling on the interior of the rain guard protector 54 will flow downwardly through the air outlet 23 of the secondary vortex inducer, through the guide pipe 19 and then out through the cross member 17 until it exits through the air inlets 21 (a) and 21(b). Rain falling on the interior of the diffuser bowl 25 will travel down along the sides of the diffuser bowl and will be drained out of the diffuser bowl through apertures 27 (not shown). In this way, rain will not be able to travel into the exhaust pipe of the engine when the engine is not operational. All the rain will be drained safely away from the exhaust of the engine.

[0043] It is envisaged that other suitable types of primary vortex inducers may be used, such as a vortex cone, half ball, or other known devices that will cause a vortex to form in the exhaust gases. It is important that a turbulent spinning vortex flow of exhaust gases is created which may in turn be mixed with a spinning vortex flow of ambient air.

[0044] In addition to the above, it is envisaged that various different shapes of secondary vortex inducers could be provided other than the invented T-shaped construction described above. For example, it is envisaged that a simple elongate guide pipe having an air inlet in communication with the air external the exhaust gas cylinder and an air outlet in communication with the interior of the exhaust gas cylinder could be provided. What is important is that the secondary vortex inducer allows for a path of air to be introduced from the exterior of the exhaust gas cylinder to the interior so that a stream of air is delivered to the interior of a turbulent spinning vortex flow of exhaust gases. In the embodiment shown the cross member 17 extends across the entire interior of the exhaust gas cylinder but the secondary vortex inducer need only extend from the side wall of the exhaust gas cylinder to a position internal the exhaust gas cylinder, preferably substantially in line with the longitudinal access of the exhaust gas cylinder. Indeed, the elongate pipe could be cranked intermediate its ends into a right angle or other such angle so that the air outlet faces away from the exhaust gas inlet of the exhaust gas cylinder.

[0045] It is further envisaged that the internal spinning vortex of air or the external spinning vortex of air could be provided alone with the exhaust gas and both need not necessarily be supplied. Similarly the air venting apertures 29 providing the ports for introducing air into the Karman vortex street may also be provided either alone

or in conjunction with the inner or outer spinning vortices of ambient air. Furthermore, the apertures 27 could be supplied on the side of the gas cylinder 3, instead of the gas diffuser bowl 25. What is important is that the air is introduced in such a way so that the spinning vortex flow of exhaust gases will impart a spinning vortex flow on the air entering through the apertures 27.

[0046] Finally, although this invention has been described in relation to a diesel oil burning boiler and diesel engines it is envisaged that the same principles could be applied to other exhaust gases such as those coming from petrol engines and the like. What is important is that the hot gases may be cooled significantly by the device described, as well as being dispersed into a less concentrated form by the device.

[0047] In the specification the terms "comprise, comprises, comprised and comprising" or any variation thereof and the terms "include, includes, included and including" or any variation thereof are considered to be totally interchangeable and they should all be afforded the widest possible interpretation and vice versa.

[0048] The invention is not limited to the embodiment hereinbefore described, but may be varied in both construction and detail.

Claims

1. An exhaust gas diffuser (1) comprising an elongate exhaust gas cylinder (3) having an exhaust gas inlet (5) and an exhaust gas outlet (7), the exhaust gas diffuser further comprising a primary vortex inducer (9) located internal the exhaust gas cylinder for turning a substantially laminar flow of exhaust gases flowing through the exhaust gas cylinder (3) into a turbulent spinning vortex flow of exhaust gases, and an air introducer (15) for introducing air from a position external the exhaust gas cylinder (3) to a position internal the exhaust gas cylinder (3) downstream of the primary vortex inducer (9) for mixing with the turbulent spinning vortex flow of exhaust gases.
2. An exhaust gas diffuser (1) as claimed in claim 1 in which the air introducer (15) further comprises an elongate pipe having an air inlet (21a, 21b) and an air outlet (23) and a throughbore therebetween, the air inlet (21 a, 21 b) being in communication with the exterior of the exhaust gas cylinder (3) and the air outlet (23) being in communication with the interior of the exhaust gas cylinder (3).
3. An exhaust gas diffuser (1) as claimed in claim 2 in which the elongate pipe (15) comprises a cross member (17) mounted transversely across the exhaust gas cylinder (3), at least one end (21a, 21b) of which being in communication with the exterior of the exhaust gas cylinder (3) thereby forming the air inlet, the cross member (17) having an air vent (22)

formed intermediate its ends (21 a, 21 b) facing away from the exhaust gas inlet (5) of the exhaust gas cylinder (3) thereby forming the air outlet (23).

4. An exhaust gas diffuser (1) as claimed in claim 3 in which both ends (21 a, 21 b) of the cross member (17) are in communication with the exterior of the exhaust gas cylinder (3) thereby forming a pair of air inlets.
5. An exhaust gas diffuser (1) as claimed in claim 4 in which there are provided a pair of deflector plates (31a, 31b) mounted internal the cross member (17) adjacent the air vent (22) for turning a flow of air entering the cross member (17) through the air inlets (21a, 21b) into a secondary turbulent spinning vortex flow of air as it exits the cross member (17) through the air vent (22).
6. An exhaust gas diffuser (1) as claimed in any of claims 3 to 5 in which there is provided an elongate guide pipe (19) mounted on the cross member (17) and substantially orthogonal thereto, one end of the elongate guide pipe (19) surrounding the air vent (22) and the other end of the elongate guide pipe facing away from the exhaust gas inlet (5) and thereby forming the air outlet.
7. An exhaust gas diffuser (1) as claimed in claim 2 in which the air outlet is located adjacent one end of the elongate pipe and the elongate pipe is cranked intermediate its ends so that the air outlet faces away from the exhaust gas inlet (5) of the exhaust gas cylinder (3).
8. An exhaust gas diffuser (1) as claimed in any of claims 2 to 7 in which the air outlet is located substantially along the longitudinal axis of the exhaust gas cylinder (3) in a position for communication with the interior of a turbulent spinning vortex flow of exhaust gases.
9. An exhaust gas diffuser (1) as claimed in any of claims 2 to 8 in which there are provided a plurality of air venting apertures (29) formed along the length of the pipe, each of the air venting apertures (29) being of a diameter less than the diameter of the air vent (22) and each of the air venting apertures (29) facing away from the exhaust gas inlet (5) of the exhaust gas cylinder (3).
10. An exhaust gas diffuser (1) as claimed in any preceding claim in which the air introducer (15) further comprises a plurality of apertures (27) circumferentially spaced around the exhaust gas cylinder (3) in a position downstream of the primary vortex inducer.
11. An exhaust gas diffuser (1) as claimed in any pre-

ceding claim in which the exhaust gas cylinder (3) further comprises an integral exhaust gas diffuser bowl (25) substantially frusto-conical in shape, the exhaust gas diffuser bowl (25) tapering outwardly towards the exhaust gas outlet.

12. An exhaust gas diffuser (1) as claimed in claim 11 in which there are provided a plurality of apertures (27) circumferentially spaced around the narrowest portion of the exhaust gas diffuser bowl (25).
13. An exhaust gas diffuser (1) as claimed in claim 11 in which the circumference of the narrowest portion of the exhaust gas diffuser bowl (25) is greater than the circumference of the exhaust gas cylinder (3) and there is provided an annular ring mounted intermediate the exhaust gas diffuser bowl (25) and the exhaust gas cylinder (3) connecting the exhaust gas diffuser bowl (25) to the exhaust gas cylinder, the annular ring having a plurality of apertures (27) circumferentially spaced around its surface.
14. An exhaust gas diffuser (1) as claimed in any of claims 11 to 13 in which there is further provided a rain protector shield (54) mounted internal the diffuser bowl (25).
15. An exhaust gas diffuser (1) as claimed in claim 14 in which the rain protector shield (54) is substantially frusto-conical in shape and tapers outwardly towards the exhaust gas outlet (7) of the exhaust gas cylinder (3), the circumference of the widest portion of the rain protector shield (54) being greater than the circumference of the exhaust gas cylinder (3).
16. An exhaust gas diffuser (1) as claimed in any preceding claim in which the primary vortex inducer (9) further comprises an elongate vortex cylinder (11) mounted internal the exhaust gas cylinder (3) substantially in line with a laminar flow of exhaust gases passing through the exhaust gas cylinder, the elongate vortex cylinder (11) having at least one helical strake (13a, 13b) mounted on the outer surface thereof.
17. An exhaust gas diffuser (1) as claimed in claim 16 in which the elongate vortex cylinder (11) has a pair of helical strakes (13a, 13b) mounted on the outer surface thereof.
18. An exhaust gas diffuser (1) as claimed in claim 16 or 17 in which the end of the vortex cylinder (11) facing the flow of exhaust gases is tapered into a conical portion, the apex of which facing the flow of exhaust gases.
19. An exhaust gas diffuser (1) as claimed in any of claims 1 to 15 in which the primary vortex inducer

(9) further comprises a vortex cone, mounted internal and substantially in line with a flow of exhaust gases passing through the exhaust gas cylinder (3).

- 20.** An exhaust gas diffuser (1) as claimed in any of claims 1 to 15 in which the primary vortex inducer (9) further comprises a half ball, mounted internal and substantially in line with a flow of exhaust gases passing through the exhaust gas cylinder (3). 5
- 21.** An exhaust gas diffuser (1) as claimed in any preceding claim in which the primary vortex inducer (9) is mounted centrally and substantially co-axially with the exhaust gas cylinder (3). 10
- 22.** An exhaust gas diffuser (1) as claimed in any of claims 2 to 9 in which the primary vortex inducer (9) is mounted centrally and substantially co-axially with the exhaust gas cylinder (3) on the elongate pipe. 15
- 23.** An exhaust gas pipe having an exhaust gas diffuser (1) as claimed in any preceding claim connected thereto. 20

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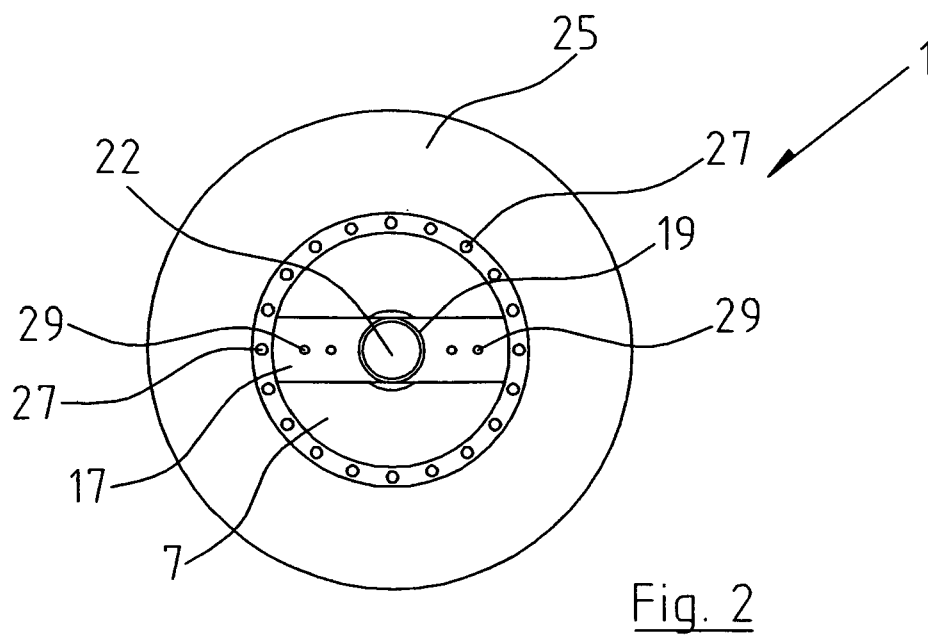
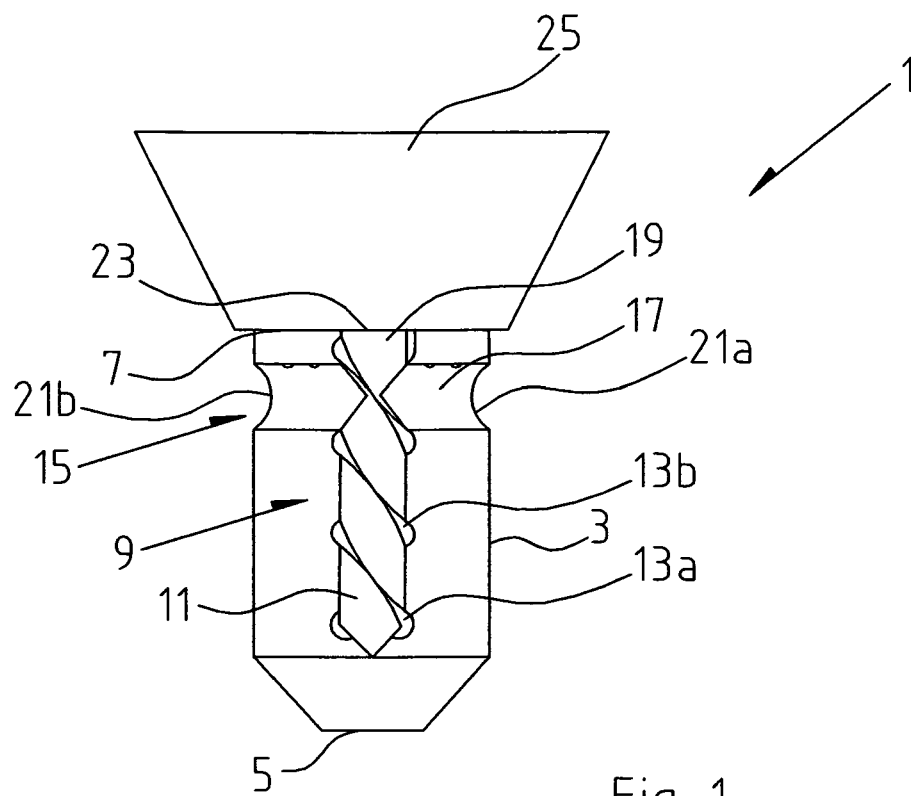
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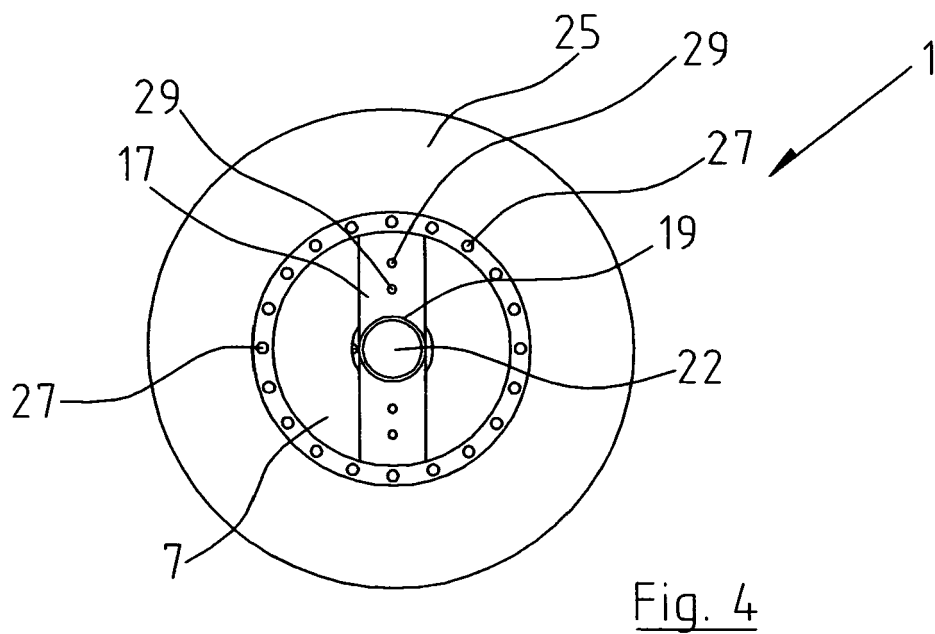
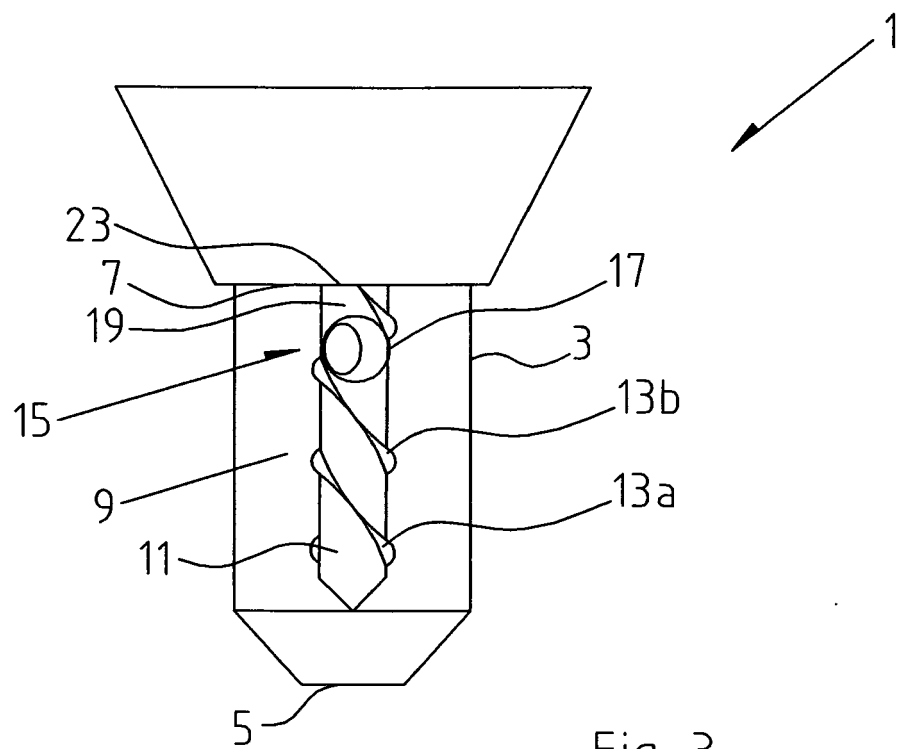
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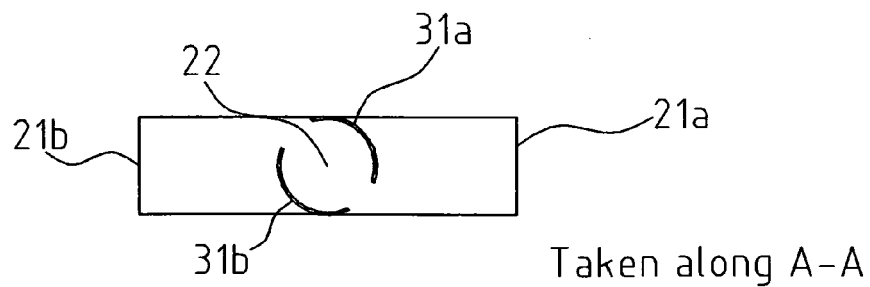


Fig. 7

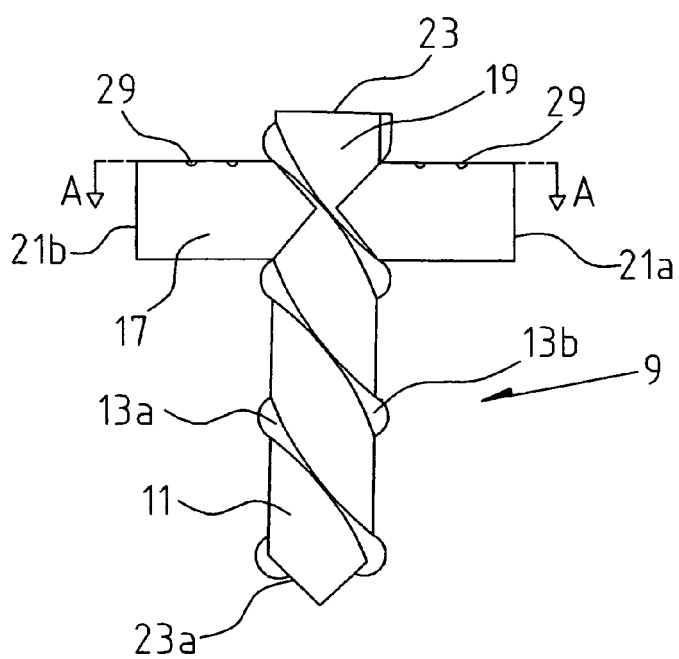


Fig. 5

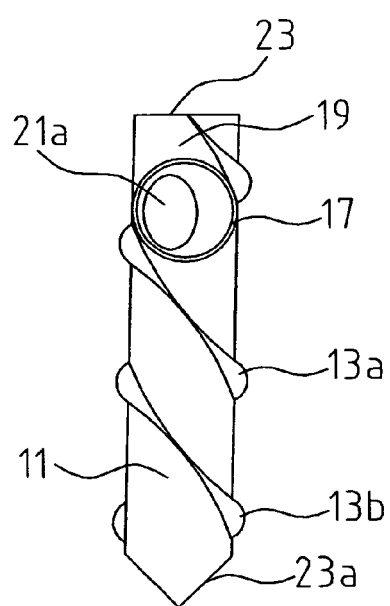


Fig. 6

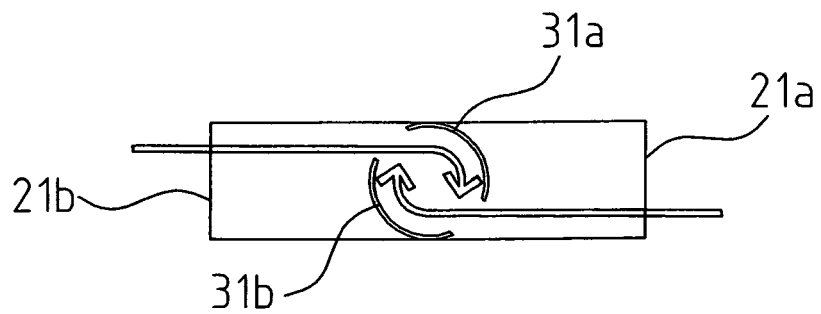


Fig. 8

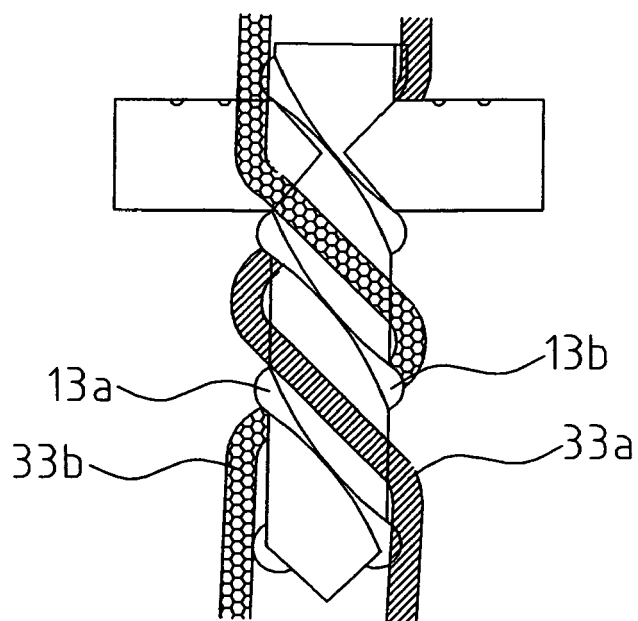


Fig. 9

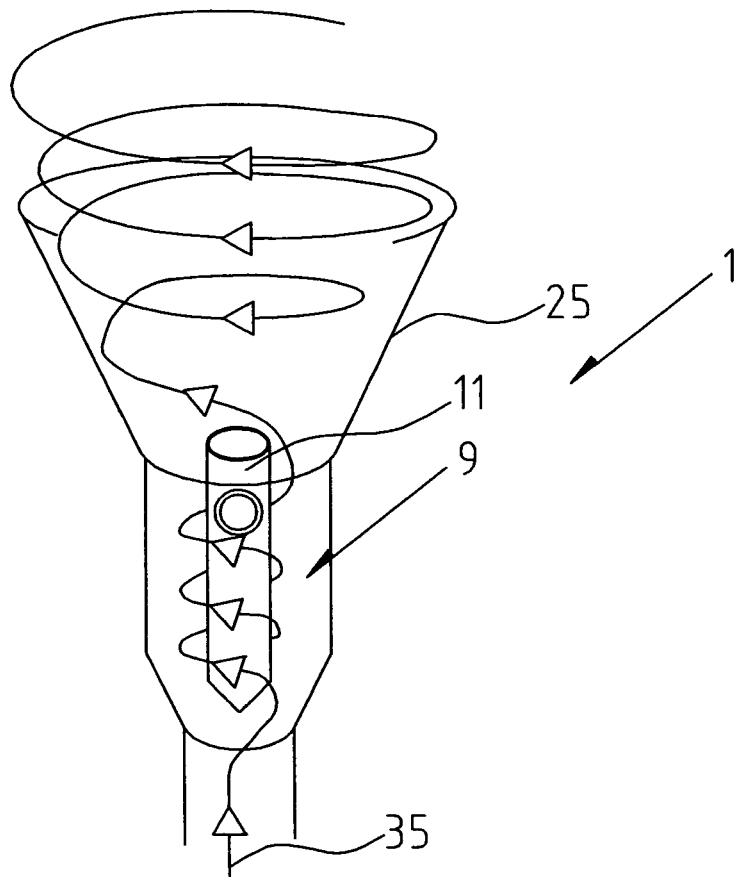


Fig. 10

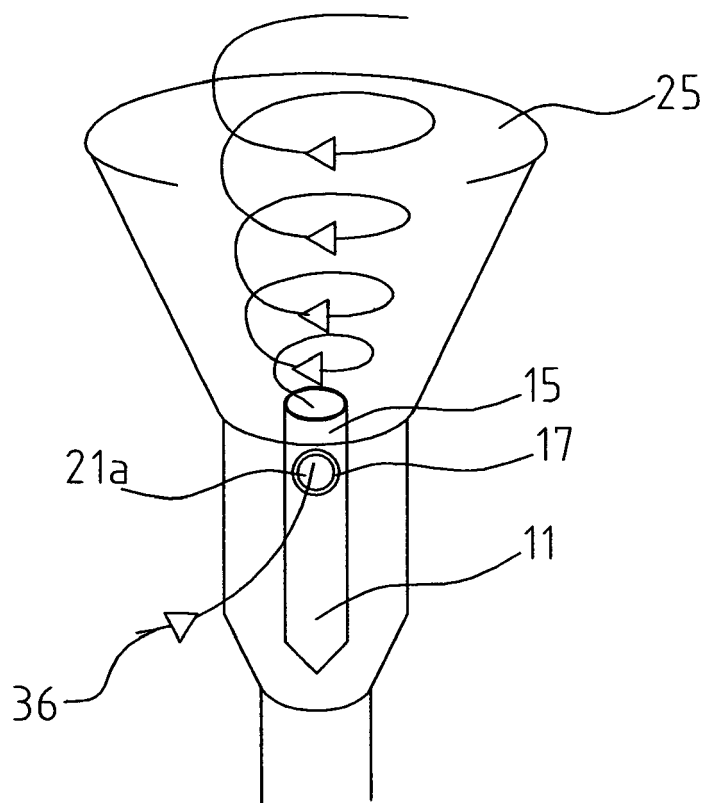


Fig. 11

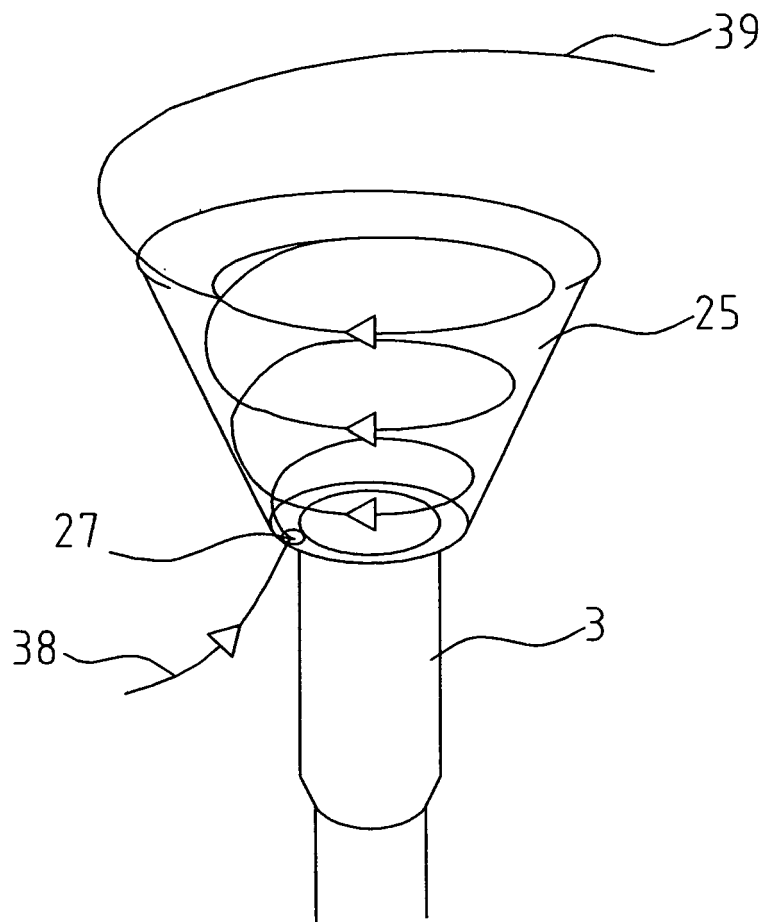


Fig. 12

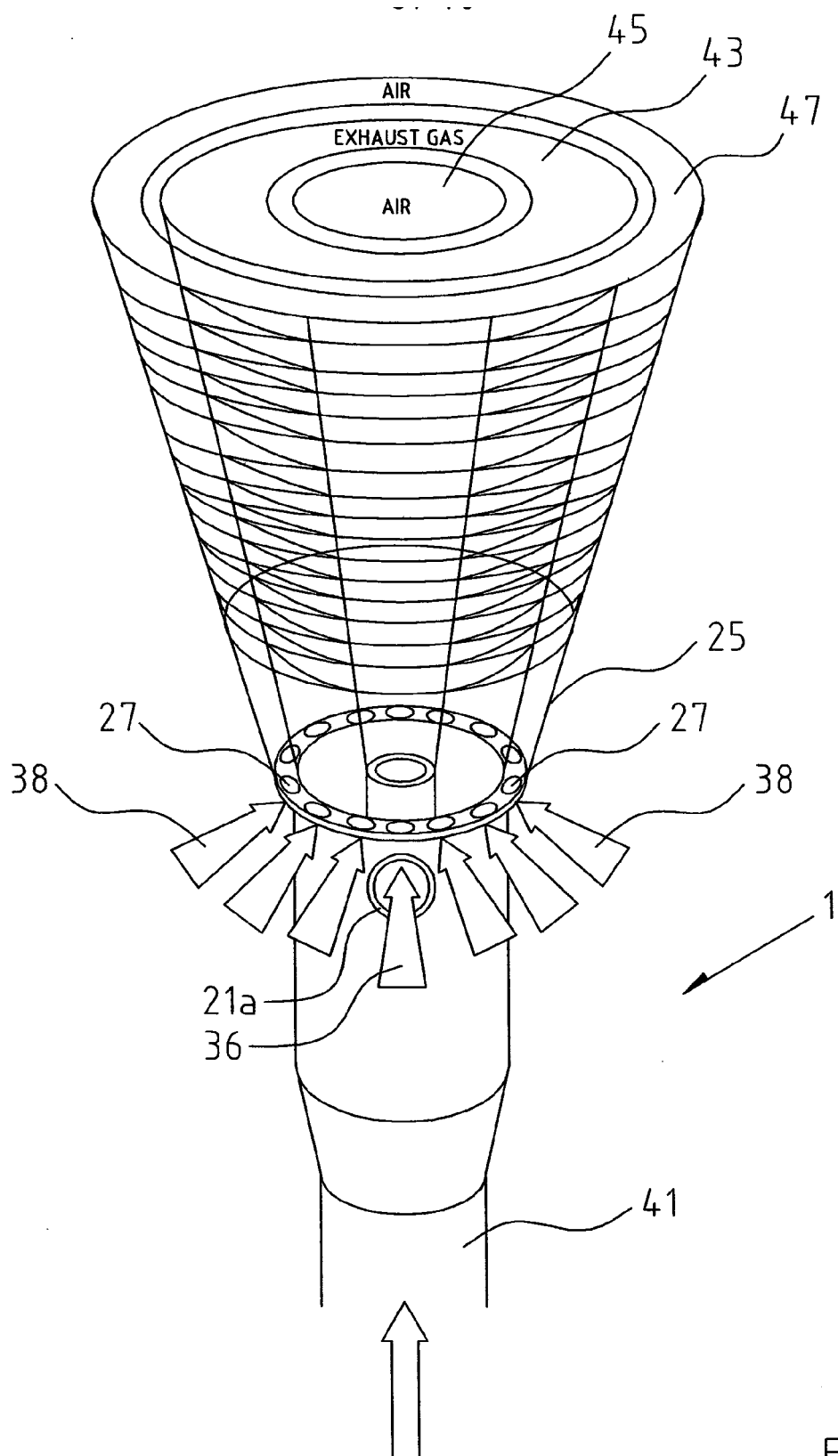


Fig. 13

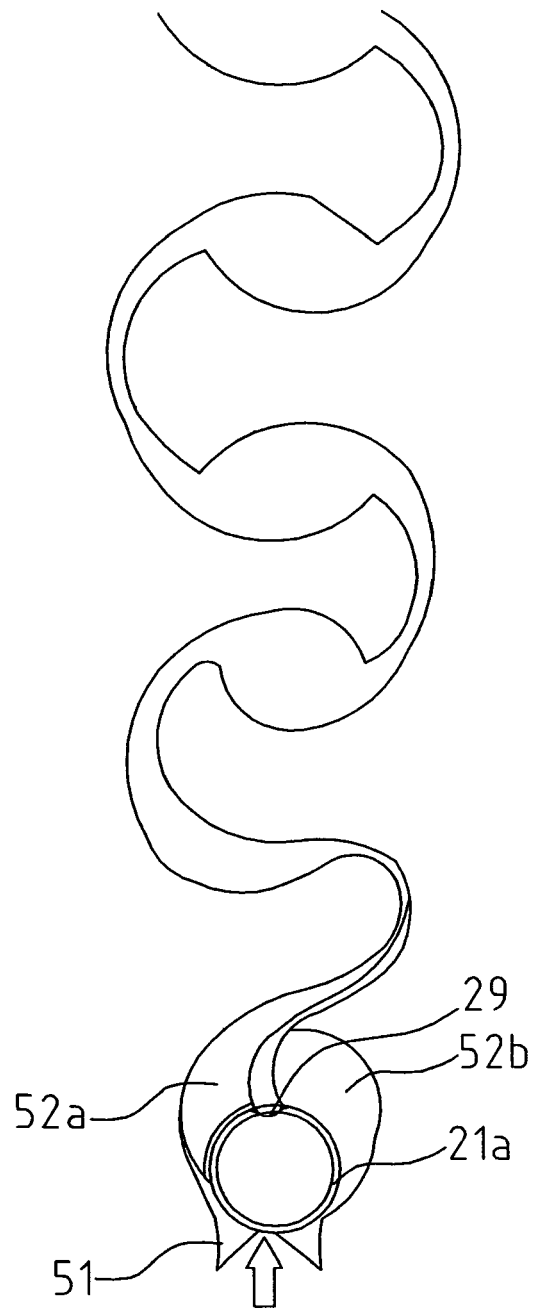
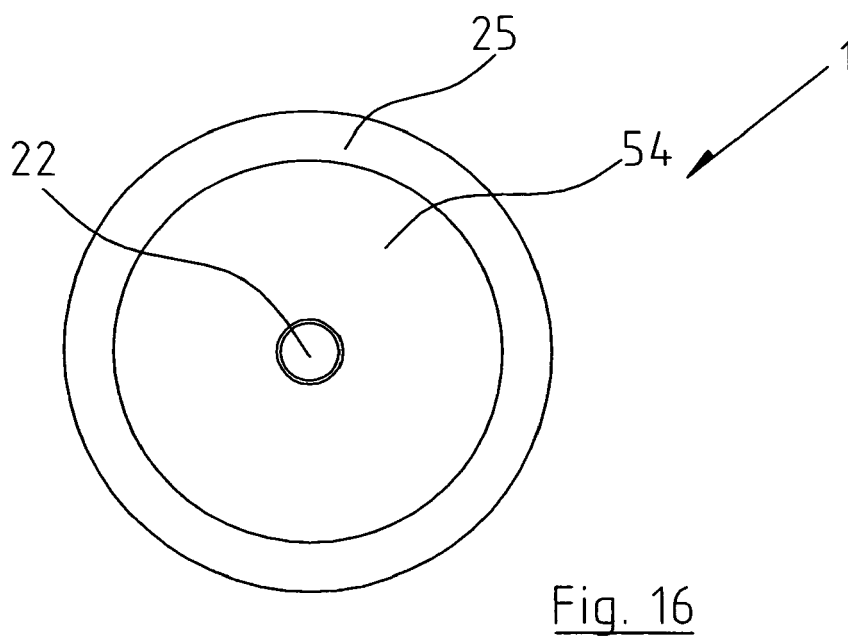
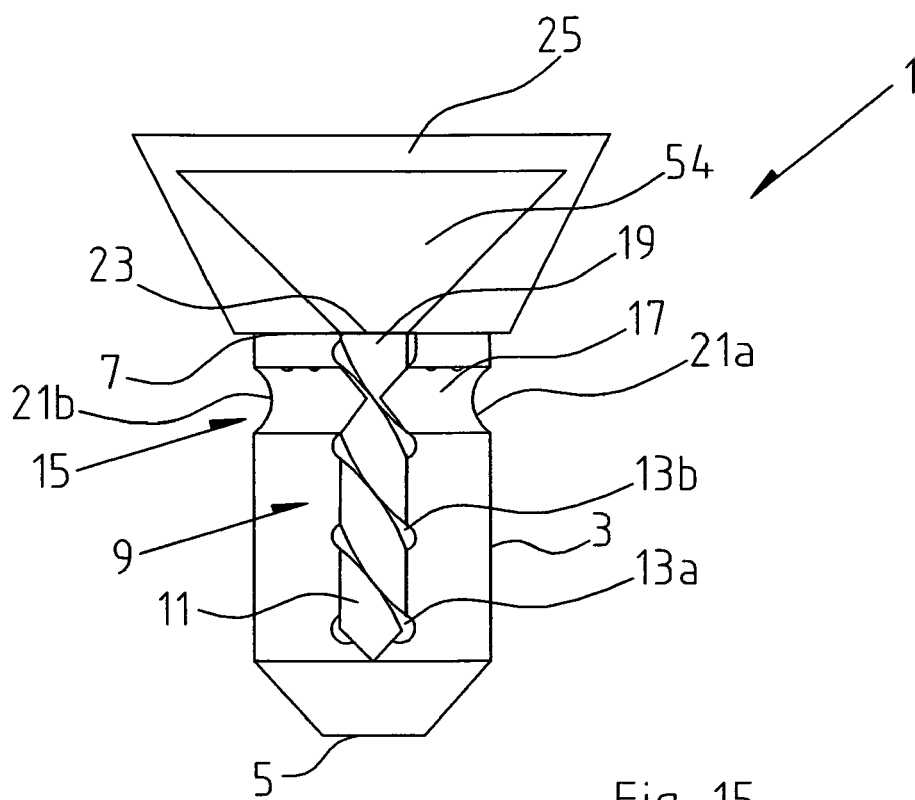


Fig. 14





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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 526 673 A (YU, CHUEN-YUAN) 10 February 1993 (1993-02-10) * column 3, line 50 - column 4, line 9 * * figures 1-8 * -----	1,2,7,8, 10,11, 16,17, 21-23	F01N1/12 F01N7/08
X	US 5 971 097 A (ETHEVE ET AL) 26 October 1999 (1999-10-26) * abstract * * figure 2 * -----	1,16,17, 21,23	
X	US 2 913 871 A (BRADSHAW NORMAN HAROLD) 24 November 1959 (1959-11-24) * column 2, line 33 - column 3, line 30 * * figures 1,2 * -----	1,21,23	
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A	DE 199 29 244 A1 (VOLKSWAGEN AG) 28 December 2000 (2000-12-28) * the whole document * -----	1,11,13, 23	TECHNICAL FIELDS SEARCHED (IPC) F01N
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 January 2006	Examiner Ikas, G
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20-01-2006

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