(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 890 876 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
23.11.2016 Bulletin 2016/47

(21) Application number: **12756367.4**

(22) Date of filing: **31.08.2012**

(51) Int Cl.:
F01N 3/24 *(2006.01)* ***F01N 3/28*** *(2006.01)*

(86) International application number:
PCT/EP2012/003657

(87) International publication number:
WO 2014/032685 (06.03.2014 Gazette 2014/10)

(54) A GAS FLOW UNIT, A GAS TREATMENT DEVICE AND A COMBUSTION ENGINE PROVIDED THEREWITH

EIN GASLEITENDES BAUTEIL, EINE GASBEHANDLUNGSVORRICHTUNG UND EINE DAMIT AUSGESTATTETE BRENNKRAFTMASCHINE

UNE UNITÉ DE CONDUIT DE GAZ, UN DISPOSITIF DE TRAITEMENT DE GAZ ET UN MOTEUR À COMBUSTION INTERNE ÉQUIPPÉ AVEC CECI

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
08.07.2015 Bulletin 2015/28

(73) Proprietor: **Volvo Truck Corporation**
405 08 Göteborg (SE)

(72) Inventors:
- **ISING, Magnus**
  S-222 25 Lund (SE)
- **NAJJAR, Nader**
  S-212 24 Lund (SE)

(74) Representative: **Volvo Technology Corporation**
Volvo Corporate Intellectual Property
BF14100, M1.7
405 08 Göteborg (SE)

(56) References cited:
EP-A1- 2 343 440
DE-A1- 2 358 732
DE-A1- 10 250 366
JP-A- 2007 211 663

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 890 876 B1

Description

TECHNICAL FIELD

[0001] The present invention relates to gas flow unit comprising a gas flow inlet, a gas flow outlet and a gas flow chamber configured to convey a gas flow from the inlet to the outlet, wherein the gas flow inlet is configured to convey the gas flow in a first direction into the gas flow chamber and wherein the gas flow outlet is configured to convey the gas flow in a second direction from the gas flow chamber, wherein the second direction is angular in relation to the first direction, and wherein the gas flow inlet is an inlet into the gas flow chamber and the gas flow outlet is an outlet from the gas flow chamber.

[0002] The present invention also relates to a gas treatment device comprising such a gas flow unit together with a gas treatment element provided downstream said gas flow unit.

[0003] Furthermore the invention relates to an internal combustion engine comprising a combustion chamber, from which exhaust gas is emitted, wherein said engine comprises a gas treatment device according to the invention for the treatment of either exhaust gas emitted from the combustion chamber or inlet air to said combustion chamber.

BACKGROUND OF THE INVENTION

[0004] The background of the invention is related to design considerations with regard to exhaust gas recirculation coolers in internal combustion engines. However, it should be understood that the defined problem may be found also in other gas conducting systems and the solution thereto may thus also be applied in such systems.

[0005] Most gas/liquid coolers used in internal combustion engines need a significant distance upstream their inlet on the gas side to distribute the gas flow uniformly over the cooler area. This is necessary to achieve high cooler effectiveness and ensure metal temperature below critical limits. One example of a cooler is the one used in the exhaust gas recirculation (EGR) circuit to increase the amount of EGR in modern diesel engines. EGR is used to reduce the combustion temperature in the cylinders and thereby reduce the NOx formation, which progresses faster at high temperatures.

[0006] In modern vehicles the available space in the engine compartment is limited due to more and more components used to fulfil stringent emission regulations, such as variable geometry turbo, crank case ventilation etc. This sometimes makes it very difficult to permit enough distance upstream the inlet of the cooler.

[0007] In a typical case, the exhaust gas flowing in a gas channel from the combustion chamber to a gas cooler in the EGR circuit has to undergo a substantial change of direction, in the range of 90°, shortly before entering the cooler. In order to achieve an optimum cooler efficiency it is important that the gas flow is uniformly distributed over the cross sectional area of the channel from which it is introduced into the cooler. If the distance between the region in which the direction of the gas is changed and the entrance to the cooler is very short, there will be difficulties in obtaining such uniform distribution of the gas flow as mentioned above for the gas that enters the cooler if not specific design measures are taken in order to promote such uniform distribution.

PRIOR ART

[0008] A certain type of pipe bend sometimes referred to as a NACA (National Advisory Council for Aeronautics) design is sometimes used to improve the flow distribution when available space is limited and hence the radius of curvature becomes very small compared to the size of the pipe itself. However, as the space available in modern internal combustion engines is becoming more restricted than ever, also this design has been found to be somewhat too space-requiring. Accordingly, an even more slim design of a pipe bend that promotes uniform flow of gas shortly downstream a substantial change of direction of the gas flow direction in any kind of gas-conduction system, and in particular an exhaust gas system of an internal combustion engine, is sought for.

[0009] According to its abstract, DE 23 58 732 A discloses a device for deflecting and reducing the speed of a flowing medium prior to entry into catalyzer, heat exchanger, etc., which is particularly for effectively purifying exhaust gases, and comprises a chamber with approx. round cross-section. The medium flows into the centre of the chamber approx. parallel to a screen forming one wall of the chamber arranged at a distance from the catalyzer etc. located behind. The cross-section area of the flow chamber is approximately the same as that of the catalyzer.

[0010] According to its abstract, EP 2 343 440 A discloses an exhaust purification system provided with an exhaust manifold, a catalytic converter which is arranged at a downstream side of the exhaust manifold at an angle with respect to the exhaust manifold and which houses an NO_x storage and reduction catalyst, and a reducing agent feed system which feeds reducing agent into exhaust gas which passes through the inside of the exhaust manifold.

[0011] According to its abstract, JP 2007 211663 A discloses an introduction passage for guiding exhaust gas from an outlet of the collective exhaust port of a cylinder head into the inlet end area of a catalyst converter is provided in an exhaust catalyst device of a multi-cylinder internal combustion engin. The introduction passage comprises: an area upstream the point of exhaust gas flowing into the passage; a curved part where exhaust gas becomes curved streams; and an area downstream the point of discharging the curved exhaust gas streams into an inlet end area. A swelling part is provided in the curved part.

THE OBJECT OF THE INVENTION

[0012] The object of the invention is to present a gas flow unit design that enables a substantial change of direction of a gas flow and a uniform flow distribution of the gas across a cross section of an outlet through which the gas is emitted from said gas flow unit within a distance as short as possible downstream the point of change of flow direction. The design shall be such that it is not space-requiring, and thereby suitable for use as a component in the design of an internal combustion engine for the vehicle industry, where the demands regarding space-saving are high.

[0013] In particular, the gas flow unit shall be of such design that it is suitable for use in connection to a gas treatment element such as a cooler or silencer device arranged at a very short distance downstream the gas flow unit and requiring a uniform flow of gas over its cross section in order to enable an optimum performance thereof.

SUMMARY OF THE INVENTION

[0014] The object of the invention is achieved by means of the gas flow unit according to the preamble of claim 1, characterised in that, in the first gas flow direction, the gas flow chamber extends beyond a projection of an outer periphery of the gas flow outlet and defines a prolongation configured for conveying a first part of the gas flow such that it enters the gas flow outlet from a different direction than a second part of the gas flow entering the gas flow outlet without passing through said prolongation. Preferably, the distance that the prolongation extends beyond a centre line of the outlet corresponds to 0,7-2,0 times the diameter of the outlet (which preferably has a circular cross section), even more preferably 1,0-1,3 times the diameter of the outlet.

[0015] Preferably said prolongation forms a rounded end portion of the gas flow chamber. The rounded shape promotes a smooth redirection of the gas flow direction in said prolongation. Preferably there is provided a means for preventing the upcoming of swirl in the outlet. Swirl is a phenomenon that can be caused by an uneven flow of gas from the gas flow inlet into the chamber and that is detrimental to a uniform flow distribution in the gas flow outlet. Said means may be a dividing wall extending up from the bottom of the prolongation. Preferably said wall extends in a plane which coincides with a centre plane of the outlet. Preferably, said dividing wall divides said first part of the gas flow into two sub-parts on either side of the wall, which meet each other when they leave the wall and enter the gas flow outlet.

[0016] According to a preferred embodiment, said prolongation has a volume and geometry such that the amount of said first part of the gas flow is in the range of 10-50%, preferably 30-50% of the amount of said second part of the gas flow. Such an amount of the first part of the gas flow provides for a more uniform flow distribution over the cross section of the outlet.

[0017] According to one embodiment, said prolongation has the shape of a part of a sphere, and preferably the shape of a semi-sphere. In such an embodiment, it is preferred that there is provided a dividing wall in the bottom of the prolongation for the purpose of preventing swirl in the gas flow. Preferably, said dividing wall is positioned such that it extends in a plane parallel to the first gas flow direction and is positioned in the middle of the semi-sphere such that it divides the latter in two halves. Preferably the extension plane of the dividing wall is the same as a plane that divides the gas flow outlet in two equal halves.

[0018] According to another embodiment, said prolongation has the shape of two part spheres and there is provided a dividing wall between said part spheres. Also here, the dividing wall preferably extends in a plane parallel to the first gas flow direction, wherein said plane preferably coincides with a plane that divides the outlet in two equal halves. However, here, the dividing wall need not be a separate wall arranged at the bottom of the prolongation, but may be a wall that results from the geometry of the two adjacent part spheres, preferably semi-spheres, and the material that separates the latter from each other.

[0019] According to one embodiment, said gas flow chamber is delimited by parallel opposite lateral walls and a curved bottom wall, such that the prolongation has the shape of a part of a cylinder. In other words, the prolongation will have a nearly U-shaped cross section, as seen in the direction of the gas flow outlet. Also in this case it is preferred to arrange a dividing wall at the bottom of the prolongation, in order to prevent swirl, and preferably in accordance with the principles described above for the single half-sphere design.

[0020] According to yet another embodiment, the gas flow chamber is delimited by parallel opposite lateral walls, a curved bottom wall and an intermediate wall which is parallel with said lateral walls, such that the prolongation has the shape of two parallel parts of a cylinder, preferably two parallel half-cylinders. In other words, the prolongation will, according to this embodiment, have a nearly UU-shaped cross section as seen in the direction of the gas flow outlet. The intermediate wall, formed by adjacent walls that delimit the respective part of cylinder, thus forms a dividing wall, preferably in accordance with the principles already mentioned for the double-half-sphere embodiment.

[0021] Preferably, the gas flow inlet and the gas flow outlet are configured such that the second gas flow direction is angular within the range of 45°-135° in relation to the first gas flow direction, preferably in the range of 60°-120°, and more preferably in the range of 85°-95°. The smaller the angle, the less redirecting of the gas flow and hence the less problem with non-uniform flow in the gas flow outlet. Larger angles than the upper limit mentioned here will not be of interest from an overall design point of view and will also further complicate the flow

conditions, and are therefore not taken into further consideration here.

[0022] Preferably, the gas flow inlet comprises at least one inlet channel which extends in said first gas flow direction in a region in which it enters the gas flow chamber, and the gas flow outlet comprises an outlet channel that extends in said second gas flow direction in a region in which it exits from the gas flow chamber. Accordingly, the at least one inlet channel has a centre line which is angular within the range of 45°-135° in relation to a centre line of the outlet channel, preferably in the range of 60°-120°, and more preferably in the range of 85°-95°. The prolongation of the chamber is in the direction of an extension of the centreline of the at least one inlet channel beyond the outlet (i.e. the outlet opening in the wall that defines said chamber). The inlet channel is to a high degree responsible for the characteristics of the gas flow into the chamber. According to one embodiment of the invention the ratio between the total inlet channel cross section area and the outlet channel cross sectional area is in the range of 0,3-3, resulting in either a somewhat diffusing flow in the outlet channel (low ratio value) or to an accelerating flow (high ratio). In typical applications for which the present design is suitable, the gas pressure and the cross sectional areas of the channels involved are such that the flow is generally incompressible, i.e. flow Mach value is below 0,30. Preferably, the flow rate in the inlet channel is in the range of 30-120 m/s.

[0023] Preferably, and as a consequence of the design heretofore described, the gas flow chamber is configured such that the second part of the gas flow enters the gas flow outlet in a portion of the gas flow outlet closer to the gas flow inlet than a portion of the gas flow outlet receiving the first part of the gas flow.

[0024] According to a preferred embodiment the gas flow chamber is substantially wider than a projection of an outer periphery of the gas flow outlet in a direction perpendicular to the first gas flow direction and according to one embodiment about two times wider. In other words, the gas flow chamber is substantially wider than a projection of an outer periphery of the gas flow outlet perpendicular to a direction of a centre line of the outlet (or more precisely the outlet channel). On the other hand, the depth of the chamber perpendicular to said width, as seen in direction of a centre line of the outlet (or more precisely the outlet channel), is substantially smaller than the width of the gas flow chamber, and according to one embodiment about half of said width. Preferably, the depth of the chamber as seen in direction of a centre line of the outlet (or more precisely the outlet channel) substantially corresponds to the width of the inlet (or more precisely the inlet channel thereof). Thereby, the chamber does not require much space in the direction of the outlet, which is important in cases where there is not much room for the gas flow unit in that direction. The width of the chamber is larger than the depth thereof, and the increased width contributes to reduce pressure drop in the chamber and to prevent swirl in the outlet. Preferably, the ratio between the width of the chamber and the diameter of the outlet (chamber width/outlet diameter) is in the range of 1,3-2,1. Preferably, the ratio between the length of the chamber, i.e. the length from the inlet to the bottom end of the prolongation, and the diameter of the outlet (chamber length/outlet diameter) is in the range of 1,7-3,5.

[0025] Preferably, the gas flow chamber comprises a substantially flat wall positioned opposite the gas flow outlet. Thereby, space is saved in the longitudinal direction of the gas flow outlet.

[0026] Preferably, the gas flow chamber has a continuously increasing width in a direction from the inlet to an intermediate portion of the gas flow chamber, wherein the outlet at least partly extends from the intermediate portion. The prolongation is positioned opposite the inlet with regard to the intermediate portion. Preferably, the lateral walls of the gas flow chamber have a curvature matching the curvature of the outlet boundaries in the region with increasing width. Said intermediate portion of the gas flow chamber has an elongated cross sectional shape with a longer extension in a direction of the width and a shorter extension in a direction of the depth. Said intermediate portion of the gas flow chamber has a substantially constant cross section. Further, said intermediate portion of the gas flow chamber comprises said flat wall positioned opposite the gas flow outlet. The gas flow unit is preferably symmetrical with regard to a common centre plane of the inlet and the outlet.

[0027] According to the invention, the gas flow chamber is configured for conveying said first part of the gas flow and said second part of the gas flow such that they meet in the gas flow outlet and achieve a substantially uniform flow distribution in said second gas flow direction.

[0028] The invention also refers to a gas treatment device comprising a gas flow unit according to the invention and a gas treatment element positioned downstream of the gas flow outlet.

[0029] According to one embodiment, the gas treatment element is a gas cooler element. The cooler element typically comprises a circuit of cooling liquid and heat changer surfaces which are to be hit by the incoming gas received from the gas flow unit and to which heat from the gas is transferred to the cooling liquid, which is provided on opposite sides of such surfaces, all in accordance with established cooler technology. As seen in the direction of a centre line of the outlet of the gas flow unit, i.e. in the main flow direction of the gas exiting from the chamber through the outlet, the cooler element has a larger cross section than the outlet. Typically, the cooler comprises a plurality of openings across the cross section thereof through which the gas is to flow. In order to make the cooler element operate efficient, the gas flow entering the cooler element through the outlet of the flow unit shall be as uniform as possible over the cross section thereof.

[0030] According to an alternative embodiment, the gas treatment element is a silencer device. According to

yet another alternative, the gas treatment element is a compressor of a turbo device.

[0031] The invention also relates to an internal combustion engine comprising a combustion chamber from which exhaust gas is emitted, characterised in that it comprises a gas treatment device according to the invention for the treatment of exhaust gas emitted from the combustion chamber or inlet air to said combustion chamber.

[0032] Preferably, said combustion engine comprises an exhaust gas recycling circuit in which said gas treatment device is arranged, and the gas treatment element forms a cooler for recycled exhaust gas in said exhaust gas recycling circuit.

[0033] According to another embodiment, said combustion engine comprises a silencer device through which said exhaust gas is conducted, wherein said gas treatment device forms a part of said silencer device.

[0034] Further features and advantages of the present invention will be presented in the following detailed description of embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] Hereinafter, by way of example, the invention will be described more in detail with reference to the annexed drawing, on which:

Fig. 1A is a perspective view of a gas flow unit according to the invention connected to a gas treatment element,

Fig. 1B is a perspective view from another direction of the gas flow unit shown in fig. 1A,

Fig. 1C is a view from above of the gas flow unit shown in fig. 1B,

Fig. 1D is a front view of the gas flow unit shown in figs. 1A-1C,

Fig. 1E is a cross section according to E-E in fig. 1D,

Fig. 1F is a side view of the gas flow unit shown in figs. 1A-1E,

Fig. 1G is a cross section according to G-G in fig. 1D,

Fig. 1H is a cross section according to H-H in fig. 1F,

Fig. 2A-2F are cross sections of alternative embodiments of the gas flow unit according to the invention, and

Fig. 3 is a schematic representation of an internal combustion engine, in which there is indicated positions in which a gas flow unit according to the invention may be positioned.

DETAILED DESCRIPTION OF THE INVENTION

[0036] Fig. 1A-1H shows a gas flow unit 1 comprising a gas flow inlet 2, a gas flow outlet 3 and a gas flow chamber 4 configured to convey a gas flow from the inlet 2 to the outlet 3. Downstream the outlet 3, a seen in an assumed flow direction, and connected thereto, there is provided a treatment device 5 for the treatment of a gas flowing through the gas flow unit 1 in a direction from said inlet 2 to said outlet 3. In fig. 1A, the gas treatment element 5 is a cooler element. However, as will be seen later, other types of gas treatment elements are also conceivable.

[0037] The inlet 2 comprises at least one inlet channel 6 delimited by the inner periphery of a tubular inlet wall 7. In a corresponding way, the outlet 3 comprises an outlet channel 8 delimited by the inner periphery of a tubular outlet wall 9. The chamber 4 is delimited by an inner periphery of a chamber wall 10. The inlet 2 and the outlet 3 form openings in the chamber wall 10. The outlet 3 has a substantially circular cross sectional shape (compared to, for example, annular cross sections)

[0038] The unit formed by the inlet wall 7, the outlet wall 9 and the chamber wall 10 may, according to one embodiment, be a solitary element (a one-piece unit) formed by means of moulding. Typically, it is made of a metal alloy as its main constituent, but it may also, as an alternative be made of a polymer, or any other suitable material depending on the application.

[0039] With reference to fig. 1G, in which approximate gas flow directions are indicated with arrows, it can be seen that the gas flow inlet 2 is configured to convey the gas flow in a first direction 11 into the gas flow chamber 4, and the gas flow outlet 3 is configured to convey the gas flow in a second direction 12 from the gas flow chamber, wherein the second direction is almost perpendicular in relation to the first direction. The first direction generally corresponds to the direction of a centre line of the inlet channel 6, and the second direction generally corresponds to the direction of a centre line in the outlet channel 8. Accordingly, the centre lines of the inlet channel 6 and the outlet channel 8 are angular to each other, preferably approximately perpendicular to each other. Preferably, as in this embodiment, the inlet channel 6 is, at least in a region close to the chamber, generally straight, i.e. it does not follow a substantially bent or curved line, and the gas flow through it is assumed to have a generally uniform flow direction in the direction of the centre line (i.e. the longitudinal axis) of the inlet channel 6. Likewise the outlet channel 8 is a straight channel, though preferably a very short channel, and when the gas flows through said outlet 3 it has a generally uniform flow direction in the direction of the centre line of said outlet channel 8. It is inside the chamber 4 that the flow direction of the gas is changed.

[0040] As can be seen, the inlet 2 according to this embodiment comprises one single inlet channel 6. However, there may be embodiments in which at least two

inlet channels are comprised in the inlet. Such embodiments will be described later.

[0041] In the first gas flow direction 11 (see figs. 1G and 1H), the gas flow chamber 4 extends beyond a projection of an outer periphery of the gas flow outlet 3 and defines a prolongation 13 configured for conveying a first part 14 of the gas flow such that it enters the gas flow outlet 3 from a different direction than a second part 15 of the gas flow entering the gas flow outlet 3 without passing through said prolongation 13.

[0042] The chamber 4 has a length in the first flow direction 11 (i.e. generally the direction of the centre line of the inlet channel 6) that is larger than the cross section of the outlet 3. It is delimited by front portion of the chamber wall 10, in which the outlet 3 is provided, and an opposite rear portion of the chamber wall 10. The inner surface of said rear portion is generally flat. In other words, the flow chamber 4 comprises a substantially flat wall positioned opposite the gas flow outlet 3.

[0043] The depth of the chamber 4, i.e. its extension in a direction from the outlet 3 to the opposite inner surface of the rear portion of the chamber wall 10, substantially corresponds to the width of the inlet 2, or more precisely the width of the inlet channel 6 thereof. The depth of the chamber 4 is predominantly delimited with regard to the general wish to minimize the extension of the gas flow unit in that direction.

[0044] The width of the chamber 4 is considerably larger than the depth thereof, and is thus considerably larger than the corresponding width of the inlet 2. The width of the chamber 4 is also considerably larger than the width of the outlet 3 (and the width of the outlet channel 8). The enlarged width of the chamber 4 contributes to reduce the pressure drop of the chamber 4 and to prevent swirl in the outlet 3. In fig. 1E there is indicated with arrows how the gas is assumed to flow due to the design with regard to the width of the chamber 4.

[0045] The above-mentioned prolongation 13 of the chamber may have different designs, one of which is shown in fig. 1. In the embodiment of fig. 1 the prolongation 13 forms a rounded end portion of the chamber 4. It has a volume and geometry such that the amount of said first part 14 of the gas flow is in the range of 10-50% of the amount of said second part 15 of the gas flow. More precisely, the prolongation 13 has the shape of two parallel half spheres, a shape that has proven to be advantageous for the purpose of the invention. To a certain extent the two half-spheres are divided from each other at the bottom thereof by a part 16 of the inner periphery of chamber wall 10 that projects up between the half-spheres and defines the shape of the respective half-sphere, thereby forming a dividing wall between the two half-spheres of the prolongation 13. However, there is also provided an intermediate wall 17 in the chamber 4, which wall 17 is connected to the bottom of the prolongation, here defined by the dividing wall 16, and extends into the rest of the chamber 4 all the way to the region of the inlet 2. This intermediate wall 17 is arranged for the purpose of avoiding swirl in the outlet 3. The inlet 2 and the outlet 3 have a common centre plane. The intermediate wall 17 extends in the common centre plane of the inlet 2 and the outlet 3. Thereby, it divides the gas flow from the inlet 2 in two laterally parallel flows, as can bee seen in fig. 1H. In an upper part of the chamber 4, as well as in the prolongation 13, the intermediate wall 17 extends through the full depth of the chamber 4, i.e. from the front wall to the flat rear wall of the chamber wall 10. In a region in front of the outlet 3, the intermediate wall 17 is retracted such that there is an open space in the chamber which is not divided by said intermediate wall 17 where gas flowing from the different sides of the wall towards the outlet 3 can meet and mix before exiting through the outlet 3. The intermediate wall 17 is in contact with the rear portion of the chamber wall 10 all the way from the region of the inlet 2 to the region of the prolongation 13.

Figs. 2A-2F show different embodiments that may be used and have been considered in accordance with the teaching of the present invention. Fig. 2A corresponds to the already disclosed embodiment in which the inlet 2 comprises one inlet channel and the prolongation 13 comprises two parallel half-spheres, and in which the prolongation 13 as well as the chamber 4 is divided by an intermediate wall 17.

[0046] In fig. 2B there is still one inlet channel 6, but the prolongation, here indicated with 20, is formed by one single half-sphere, and the intermediate wall 21 extends to the bottom thereof. Apart from the different shape of the prolongation 20, the embodiment of fig. 2B preferably presents the features disclosed above for the embodiment according to fig. 1A-1H.

[0047] In Fig. 2C the inlet 2 comprises two inlet channels 6', 6", which, preferably, are symmetrically provided on either side of a common centre plane of the inlet 2 and the outlet 3. From the region of a dividing wall 22 between the inlet channels 6', 6" an intermediate wall 23, corresponding to the intermediate wall 17 previously described, extends to the prolongation, which is here indicated with 24 but is identical with the prolongation 13 already described with reference to fig. 1. Apart from presence of two inlet channels 6', 6" instead of one, the embodiment of fig. 2C preferably presents the features disclosed above for the embodiment according to fig. 1A-1H.

[0048] The embodiment in fig. 2D differs from that in fig. 2C in that the prolongation 25 has the shape of a half-sphere and that the intermediate wall 26 extends to the bottom of said half-sphere (instead of to a dividing wall like the dividing wall 16 in fig. 1H).

[0049] Fig. 2E shows an embodiment in which the gas flow chamber 4 is delimited by parallel opposite lateral walls 28, 29, a curved bottom wall and an intermediate wall 30 which is parallel with said lateral walls 28, 29, such that the prolongation 27 has the shape of two parallel parts of a cylinder, here two half cylinders. Apart from the different shape of the prolongation 27, the em-

bodiment of fig. 2E preferably presents the further features disclosed above for the embodiment according to fig. 1A-1H.

[0050] Fig. 2F shows an alternative embodiment according to which there is not provided any intermediate wall. The prolongation of the chamber corresponds to that shown in fig. 2B, but could be any one within the claimed scope of the invention, such as any one of the other prolongations shown in figs. 2A-2E. It should thus be noted that also such solutions without intermediate wall are conceived and possible within the initially claimed scope of the invention. In case the length of a straight inlet channel is sufficient to generate a very uniform flow, for example in the order of 5-10 times the diameter of the inlet channel, solutions without intermediate wall may be conceived. Apart from the absence of an intermediate wall and the different shape of the prolongation thereof, the embodiment of fig. 2F preferably presents the further features disclosed above for the embodiment according to fig. 1A-1H. It should also be mentioned that further solutions, in which an intermediate wall, like the ones described previously, may be provided only in the region of the outlet and/or the region of the prolongation, and not extending through a region of the chamber between said inlet and prolongation regions are also feasible.

[0051] Fig. 3 is a schematic representation of an internal combustion engine 31, showing different preferred applications for a gas flow unit according to the invention.

[0052] According to the invention, the gas flow unit forms part of a gas treatment device comprising said gas flow unit and a gas treatment element positioned downstream of the gas flow outlet. According to a main aspect of the invention, the combustion engine comprises an exhaust gas recycling circuit in which said gas treatment device is arranged and the gas treatment element forms a cooler 32 for recycled exhaust gas in said exhaust gas recycling circuit. In fig. 3 the cooler element is indicated with "EGR cooler", and a gas flow unit 1 according to the invention is connected thereto.

[0053] Fig. 3 also shows other applications. Accordingly, an embodiment in which a gas flow unit 201 is connected to a gas treatment element formed by a silencer is indicated in fig. 3, as well as an embodiment in which a flow unit 101 according to the invention is connected to a turbo compressor. The flow units 1, 101 and 201 may be identical or may be adapted to their respective applications and the specific conditions to be expected there, such as gas temperature, pressure and flow velocity.

Claims

1. A gas flow unit comprising

- a gas flow inlet (2),
- a gas flow outlet and (3)
- a gas flow chamber (4) configured to convey a gas flow from the inlet (2) to the outlet (3), wherein the gas flow inlet (2) is configured to convey the gas flow in a first direction (11) into the gas flow chamber (4) and wherein the gas flow outlet (3) is configured to convey the gas flow in a second direction (12) from the gas flow chamber (4), wherein the second direction (12) is angular in relation to the first direction (11), and wherein the gas flow inlet (2) is an inlet into the gas flow chamber (4) and the gas flow outlet (3) is an outlet from the gas flow chamber (4), wherein , in the first gas flow direction (11), the gas flow chamber (4) extends beyond a projection of an outer periphery of the gas flow outlet (3) and defines a prolongation (13; 27) configured for conveying a first part (14) of the gas flow such that it enters the gas flow outlet (3) from a different direction than a second part (15) of the gas flow entering the gas flow outlet (3) without passing through said prolongation (13;27) **characterised in that** said prolongation (13) has the shape of two part spheres and that there is provided a dividing wall (16) between said part spheres.

2. A gas flow unit according to claim 1, **characterised in that** said prolongation (13; 27) forms a rounded end portion of the gas flow chamber (4).

3. A gas flow unit according to claim 1 or 2, **characterised in that** said prolongation (13; 27) has a volume and a geometry such that the amount of said first part (14) of the gas flow is in the range of 10-50% of the amount of said second part (15) of the gas flow.

4. A gas flow unit according to any preceding claim, **characterised in that** the gas flow inlet (2) and the gas flow outlet (3) are configured such that the second direction (12) is angular within the range of 45°-135° in relation to the first direction (11), preferably in the range of 75°-120°, and more preferably in the range of 85°-95°.

5. A gas flow unit according to any preceding claim, **characterised in that** the gas flow inlet (2) comprises an inlet channel (6; 6', 6") which extends in said first direction (11) in a region in which it enters the gas flow chamber (4), and that the gas flow outlet (3) comprises an outlet channel (8) that extends in said second direction (12) in a region in which it exits from the gas flow chamber (4).

6. A gas flow unit according to any preceding claim, **characterised in that** the gas flow outlet (3) has a substantially circular cross sectional shape.

7. A gas flow unit according to any preceding claim,

characterised in that the gas flow chamber (4) is configured such that the second part (15) of the gas flow enters the gas flow outlet (3) in a portion of the gas flow outlet (3) closer to the gas flow inlet (2) than a portion of the gas flow outlet (3) receiving the first part (14) of the gas flow.

8. A gas flow unit according to any preceding claim, **characterised in that** the gas flow chamber (4) is substantially wider than a projection of an outer periphery of the gas flow outlet (3) in a direction perpendicular to the first gas flow direction (11).

9. A gas flow unit according to any preceding claim, **characterised in that** the gas flow chamber (4) comprises a substantially flat wall positioned opposite the gas flow outlet (3).

10. A gas flow unit according to any preceding claim, **characterised in that** the gas flow chamber (4) is configured for conveying said first part (14) of the gas flow and said second part (15) of the gas flow such that they meet in the gas flow outlet (3) and achieve a substantially uniform flow distribution in said second gas flow direction (12).

11. A gas treatment device comprising

- a gas flow unit (1) according to any preceding claim and
- a gas treatment element (5) positioned downstream of the gas flow outlet (3).

12. A gas treatment device according to claim 11, **characterised in that** the gas treatment element (5) is a gas cooler element or a silencer device.

13. An internal combustion engine comprising a combustion chamber (4), from which exhaust gas is emitted, **characterised in that** it comprises a gas treatment device according to any one of claim 11-12 for the treatment of exhaust gas emitted from the combustion chamber (4) or inlet air to said combustion chamber (4).

14. An internal combustion engine according to claim 13, **characterised in that** it comprises an exhaust gas recycling circuit in which said gas treatment device is arranged and the gas treatment element (5) forms a cooler for recycled exhaust gas in said exhaust gas recycling circuit.

15. An internal combustion engine according to claim 13, **characterised in that** it comprises a silencer device through which said exhaust gas is conducted and that said gas treatment device forms a part of said silencer device.

Patentansprüche

1. Gasleitendes Bauteil, umfassend

- einen Gasleitungseinlass (2),
- einen Gasleitungsauslass (3) und
- eine Gasleitungskammer (4), die so konfiguriert ist, dass sie eine Gasströmung von dem Einlass (2) zu dem Auslass (3) leitet, wobei der Gasleitungseinlass (2) so konfiguriert ist, dass er die Gasströmung in einer ersten Richtung (11) in die Gasleitungskammer (4) leitet, und wobei der Gasleitungsauslass (3) so konfiguriert ist, dass er die Gasströmung in einer zweiten Richtung (12) von der Gasleitungskammer (4) leitet, wobei die zweite Richtung (12) bezüglich der ersten Richtung (11) in einem Winkel verläuft und wobei der Gasleitungseinlass (2) ein Einlass in die Gasleitungskammer (4) ist und der Gasleitungsauslass (3) ein Auslass aus der Gasleitungskammer (4) ist, wobei in der ersten Gasleitungsrichtung (11) die Gasleitungskammer (4) sich über eine Projektion einer äußeren Peripherie des Gasleitungsauslasses (3) hinaus erstreckt und eine Verlängerung (13; 27) bildet, die dafür konfiguriert ist, einen ersten Teil (14) der Gasströmung so zu leiten, dass er in den Gasleitungsauslass (3) aus einer anderen Richtung als ein zweiter Teil (15) der Gasströmung eintritt, der in den Gasleitungsauslass (3) eintritt, ohne die Verlängerung (13; 27) zu durchlaufen,

dadurch gekennzeichnet, dass die Verlängerung (13) die Form zweier Teilkugeln hat und eine Trennwand (16) zwischen den Teilkugeln vorgesehen ist.

2. Gasleitendes Bauteil nach Anspruch 1, **dadurch gekennzeichnet, dass** die Verlängerung (13; 27) einen gerundeten Endabschnitt der Gasleitungskammer (4) bildet.

3. Gasleitendes Bauteil nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Verlängerung (13; 27) ein Volumen und eine Geometrie hat, die so sind, dass die Menge des ersten Teils (14) der Gasströmung im Bereich von 10-50% der Menge des zweiten Teils (15) der Gasströmung liegt.

4. Gasleitendes Bauteil nach einem der vorigen Ansprüche, **dadurch gekennzeichnet, dass** der Gasleitungseinlass (2) und der Gasleitungsauslass (3) so konfiguriert sind, dass die zweite Richtung (12) in einem Winkel im Bereich von 45°-135° bezüglich der ersten Richtung (11) verläuft, bevorzugt im Bereich von 75°-120°, und stärker bevorzugt im Bereich von 85°-95°.

5. Gasleitendes Bauteil nach einem der vorigen An-

sprüche, **dadurch gekennzeichnet, dass** der Gasleitungseinlass (2) einen Einlasskanal (6; 6'; 6") umfasst, der sich in der ersten Richtung (11) in einem Bereich erstreckt, in dem er in die Gasströmungskammer (4) eintritt, und dass der Gasleitungsauslass (3) einen Auslasskanal (8) umfasst, der sich in der zweiten Richtung (12) in einem Bereich erstreckt, in dem er aus der Gasleitungskammer (4) austritt.

6. Gasleitendes Bauteil nach einem der vorigen Ansprüche, **dadurch gekennzeichnet, dass** der Gasleitungsauslass (3) einen im Wesentlichen kreisförmigen Querschnitt hat.

7. Gasleitendes Bauteil nach einem der vorigen Ansprüche, **dadurch gekennzeichnet, dass** die Gasleitungskammer (4) so konfiguriert ist, dass der zweite Teil (15) der Gasströmung in einem Abschnitt des Gasleitungsauslasses (3) in den Gasleitungsauslass (3) eintritt, der näher an dem Gasleitungseinlass (2) ist als ein Abschnitt des Gasleitungsauslasses (3), der den ersten Teil (14) der Gasströmung aufnimmt.

8. Gasleitendes Bauteil nach einem der vorigen Ansprüche, **dadurch gekennzeichnet, dass** die Gasleitungskammer (4) wesentlich breiter als eine Projektion einer äußeren Peripherie des Gasleitungsauslasses (3) in einer Richtung senkrecht zu der ersten Gasleitungsrichtung (11) ist.

9. Gasleitendes Bauteil nach einem der vorigen Ansprüche, **dadurch gekennzeichnet, dass** die Gasleitungskammer (4) eine im Wesentlichen flache Wand aufweist, die gegenüber dem Gasleitungsauslass (3) positioniert ist.

10. Gasleitendes Bauteil nach einem der vorigen Ansprüche, **dadurch gekennzeichnet, dass** die Gasleitungskammer (4) dafür konfiguriert ist, den ersten Teil (14) der Gasströmung und den zweiten Teil (15) der Gasströmung so zu leiten, dass sie sich in dem Gasleitungsauslass (3) treffen und eine im Wesentlichen gleichmäßige Strömungsverteilung in der zweiten Gasleitungsrichtung (12) erreichen.

11. Gasbehandlungsvorrichtung, umfassend:

- ein gasleitendes Bauteil (1) nach einem der vorigen Ansprüche und
- ein Gasbehandlungselement (5), das stromabwärts des Gasleitungsauslasses (3) positioniert ist.

12. Gasbehandlungsvorrichtung nach Anspruch 11, **dadurch gekennzeichnet, dass** das Gasbehandlungselement (5) ein Gaskühlerelement oder eine Schalldämpfervorrichtung ist.

13. Verbrennungsmotor, umfassend eine Verbrennungskammer (4), aus der Abgas ausgestoßen wird, **dadurch gekennzeichnet, dass** er eine Gasbehandlungsvorrichtung nach einem der Ansprüche 11 bis 12 zur Behandlung von Abgas, das aus der Verbrennungskammer (4) ausgestoßen wird, oder von in die Verbrennungskammer (4) eingelassener Luft umfasst.

14. Verbrennungsmotor nach Anspruch 13, **dadurch gekennzeichnet, dass** er einen Abgas-Rückgewinnungs-Kreislauf umfasst, bei dem die Gasbehandlungsvorrichtung angeordnet ist und das Gasbehandlungselement (5) einen Kühler für bei dem Abgas-Rückgewinnungs-Kreislauf rückgewonnenes Abgas bildet.

15. Verbrennungsmotor nach Anspruch 13, **dadurch gekennzeichnet, dass** er eine Schalldämpfervorrichtung umfasst, durch die das Abgas geführt wird, und dass die Gasbehandlungsvorrichtung einen Teil der Schalldämpfervorrichtung bildet.

Revendications

1. Unité d'écoulement de gaz comprenant :

- une entrée d'écoulement de gaz (2),
- une sortie d'écoulement de gaz (3), et
- une chambre d'écoulement de gaz (4) configurée pour faire circuler un écoulement de gaz depuis l'entrée (2) vers la sortie (3), dans laquelle l'entrée d'écoulement de gaz (2) est configurée pour faire circuler l'écoulement de gaz selon une première direction (11) vers la chambre d'écoulement de gaz (4) et dans laquelle la sortie d'écoulement de gaz (3) est configurée pour faire circuler l'écoulement de gaz selon une deuxième direction (12) depuis la chambre d'écoulement de gaz (4), dans laquelle la deuxième direction (12) forme un angle avec la première direction (11), et dans laquelle l'entrée d'écoulement de gaz (2) est une entrée dans la chambre d'écoulement de gaz (4) et la sortie d'écoulement de gaz (3) est une sortie depuis la chambre d'écoulement de gaz (4), dans laquelle, dans la première direction d'écoulement de gaz (11), la chambre d'écoulement de gaz (4) s'étend au-delà d'une saillie d'une périphérie externe de la sortie d'écoulement de gaz (3) et définit un prolongement (13 ; 27) configuré de sorte à faire circuler une première partie (14) de l'écoulement de gaz d'une manière telle que la première partie (14) pénètre dans la sortie d'écoulement de gaz (3) selon une direction différente d'une deuxième partie (15) de l'écoulement de gaz pénétrant dans la sortie d'écoule-

ment de gaz (3) sans passer à travers ledit prolongement (13 ; 27), **caractérisée en ce que** ledit prolongement (13) a la forme de deux sphères partielles et **en ce qu'**une paroi de séparation (16) est prévue entre lesdites sphères partielles.

2. Unité d'écoulement de gaz selon la revendication 1, **caractérisée en ce que** ledit prolongement (13 ; 27) forme une portion d'extrémité arrondie de la chambre d'écoulement de gaz (4).

3. Unité d'écoulement de gaz selon la revendication 1 ou 2, **caractérisée en ce que** ledit prolongement (13 ; 27) a un volume et une géométrie tels que la quantité de ladite première partie (14) de l'écoulement de gaz se trouve dans la plage allant de 10 à 50 % de la quantité de ladite deuxième partie (15) de l'écoulement de gaz.

4. Unité d'écoulement de gaz selon l'une quelconque des revendications précédentes, **caractérisée en ce que** l'entrée d'écoulement de gaz (2) et la sortie d'écoulement de gaz (3) sont configurées de sorte que la deuxième direction (12) forme un angle compris dans la plage allant de 45° à 135° par rapport à la première direction (11), de préférence dans la plage allant de 75° à 120°, et plus préférablement dans la plage allant de 85° à 95°.

5. Unité d'écoulement de gaz selon l'une quelconque des revendications précédentes, **caractérisée en ce que** l'entrée d'écoulement de gaz (2) comprend un canal d'entrée (6 ; 6', 6") qui s'étend dans ladite première direction (11) dans une zone dans laquelle il pénètre dans la chambre d'écoulement de gaz (4), et **en ce que** la sortie d'écoulement de gaz (3) comprend un canal de sortie (8) qui s'étend dans ladite deuxième direction (12) dans une zone dans laquelle il sort de la chambre d'écoulement de gaz (4).

6. Unité d'écoulement de gaz selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la sortie d'écoulement de gaz (3) a une forme de section transversale sensiblement circulaire.

7. Unité d'écoulement de gaz selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la chambre d'écoulement de gaz (4) est configurée de sorte que la deuxième partie (15) de l'écoulement de gaz pénètre dans la sortie d'écoulement de gaz (3) dans une portion de la sortie d'écoulement de gaz (3) plus proche de l'entrée d'écoulement de gaz (2) qu'une portion de la sortie d'écoulement de gaz (3) recevant la première partie (14) de l'écoulement de gaz.

8. Unité d'écoulement de gaz selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la chambre d'écoulement de gaz (4) est sensiblement plus large que la saillie d'une périphérie externe de la sortie d'écoulement de gaz (3) dans une direction perpendiculaire à la première direction d'écoulement de gaz (11).

9. Unité d'écoulement de gaz selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la chambre d'écoulement de gaz (4) comprend une paroi sensiblement plate positionnée à l'opposé de la sortie d'écoulement de gaz (3).

10. Unité d'écoulement de gaz selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la chambre d'écoulement de gaz (4) est configurée de sorte à faire circuler ladite première partie (14) de l'écoulement de gaz et ladite deuxième partie (15) de l'écoulement de gaz de sorte qu'elles se réunissent dans la sortie d'écoulement de gaz (3) et réalisent une distribution d'écoulement sensiblement uniforme selon ladite deuxième direction d'écoulement de gaz (12).

11. Dispositif de traitement de gaz comprenant :

- une unité d'écoulement de gaz (1) selon l'une quelconque des revendications précédentes, et
- un élément de traitement de gaz (5) positionné en aval de la sortie d'écoulement de gaz (3).

12. Dispositif de traitement de gaz selon la revendication 11, **caractérisé en ce que** l'élément de traitement de gaz (5) est un élément de refroidissement de gaz ou un dispositif de silencieux.

13. Moteur à combustion interne comprenant une chambre de combustion (4), à partir de laquelle un gaz d'échappement est émis, **caractérisé en ce qu'**il comprend un dispositif de traitement de gaz selon l'une quelconque des revendications 11-12 pour le traitement du gaz d'échappement émis par la chambre de combustion (4) ou de l'air d'entrée vers ladite chambre de combustion (4).

14. Moteur à combustion interne selon la revendication 13, **caractérisé en ce qu'**il comprend un circuit de recyclage de gaz d'échappement dans lequel ledit dispositif de traitement de gaz est agencé et l'élément de traitement de gaz (5) forme un dispositif de refroidissement pour un gaz d'échappement recyclé dans ledit circuit de recyclage de gaz d'échappement.

15. Moteur à combustion interne selon la revendication 13, **caractérisé en ce qu'**il comprend un dispositif de silencieux à travers lequel ledit gaz d'échappement est conduit, et que ledit dispositif de traitement

de gaz constitue une partie dudit dispositif de silencieux.

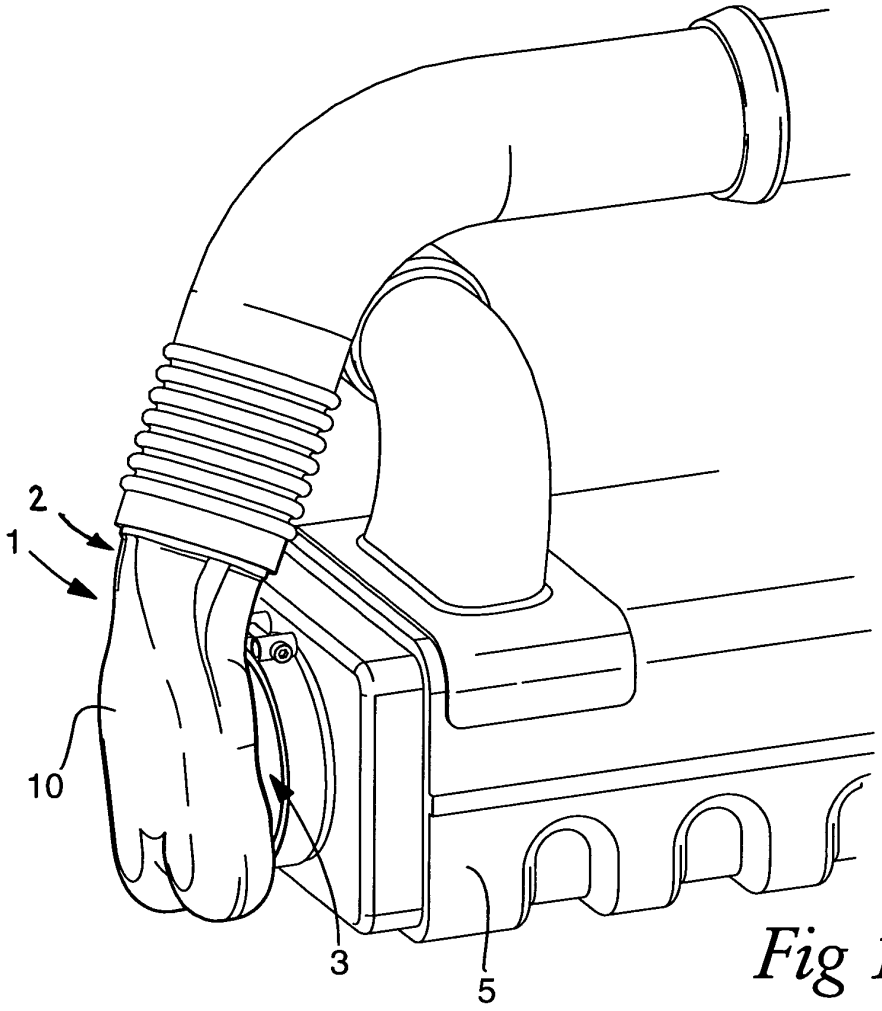


Fig 1A

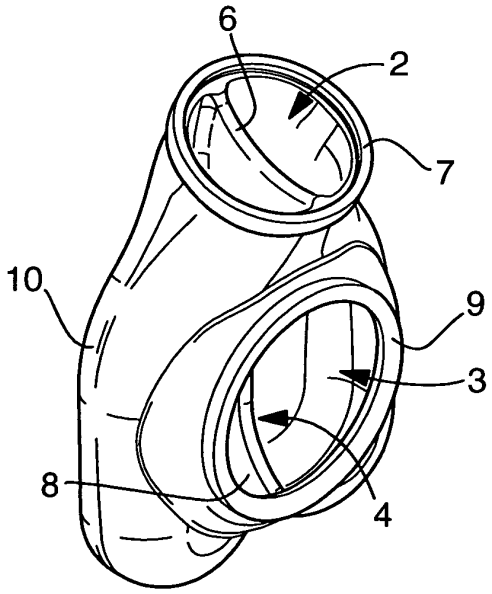


Fig 1B

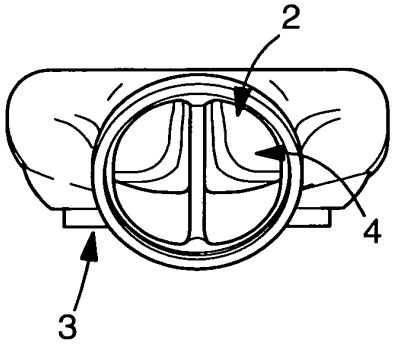


Fig 1C

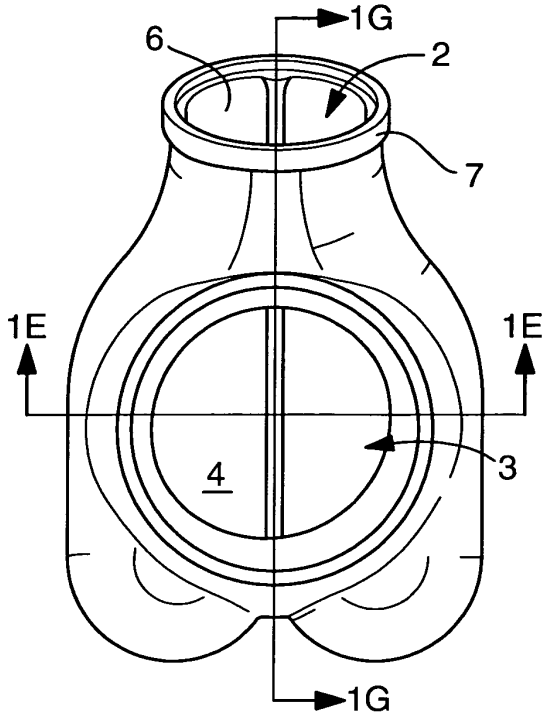


Fig 1D

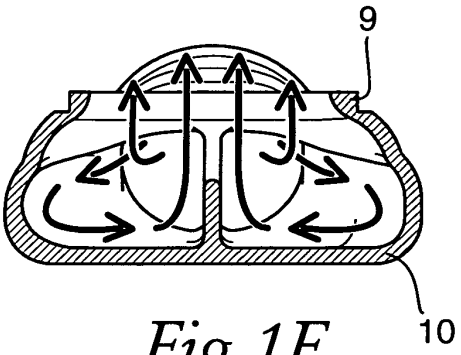


Fig 1E

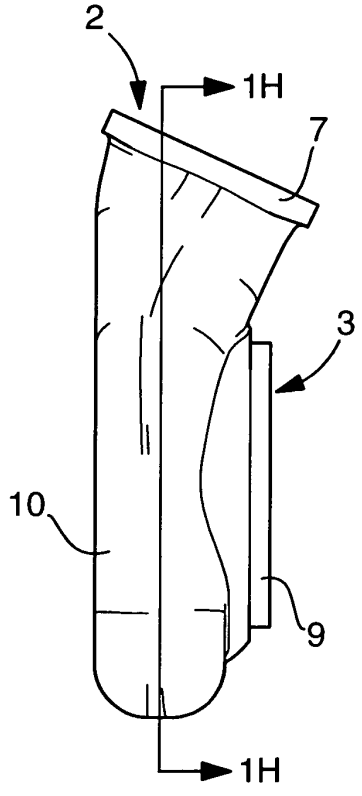


Fig 1F

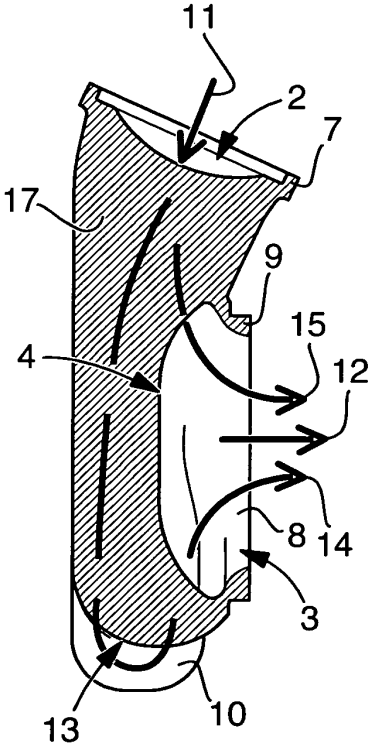


Fig 1G

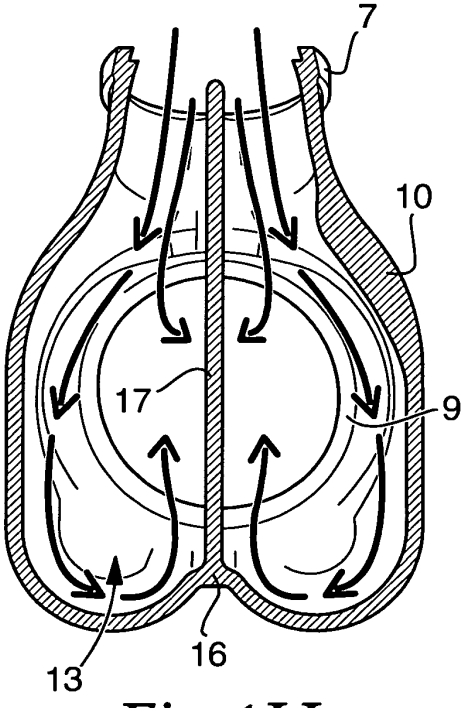


Fig 1H

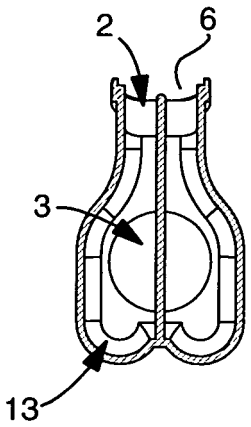


Fig 2A

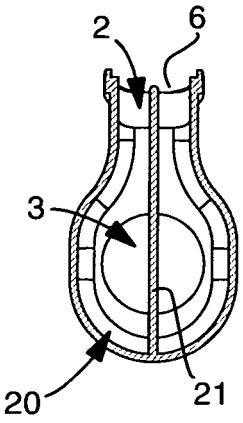


Fig 2B

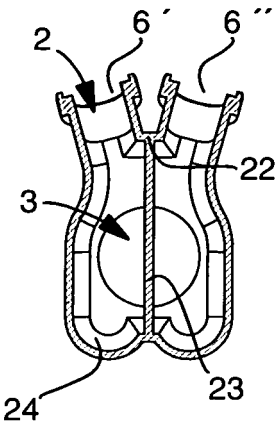


Fig 2C

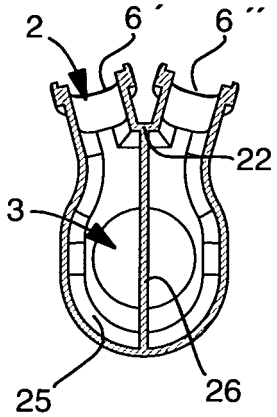


Fig 2D

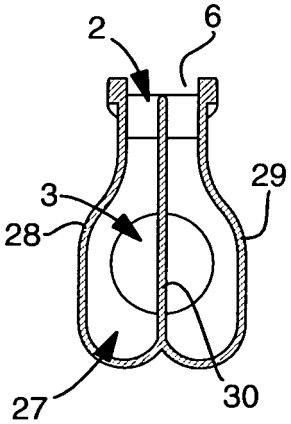


Fig 2E

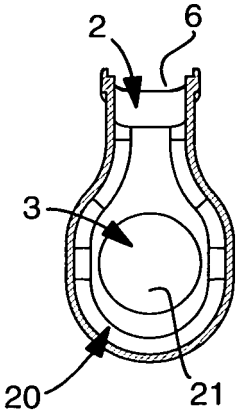


Fig 2F

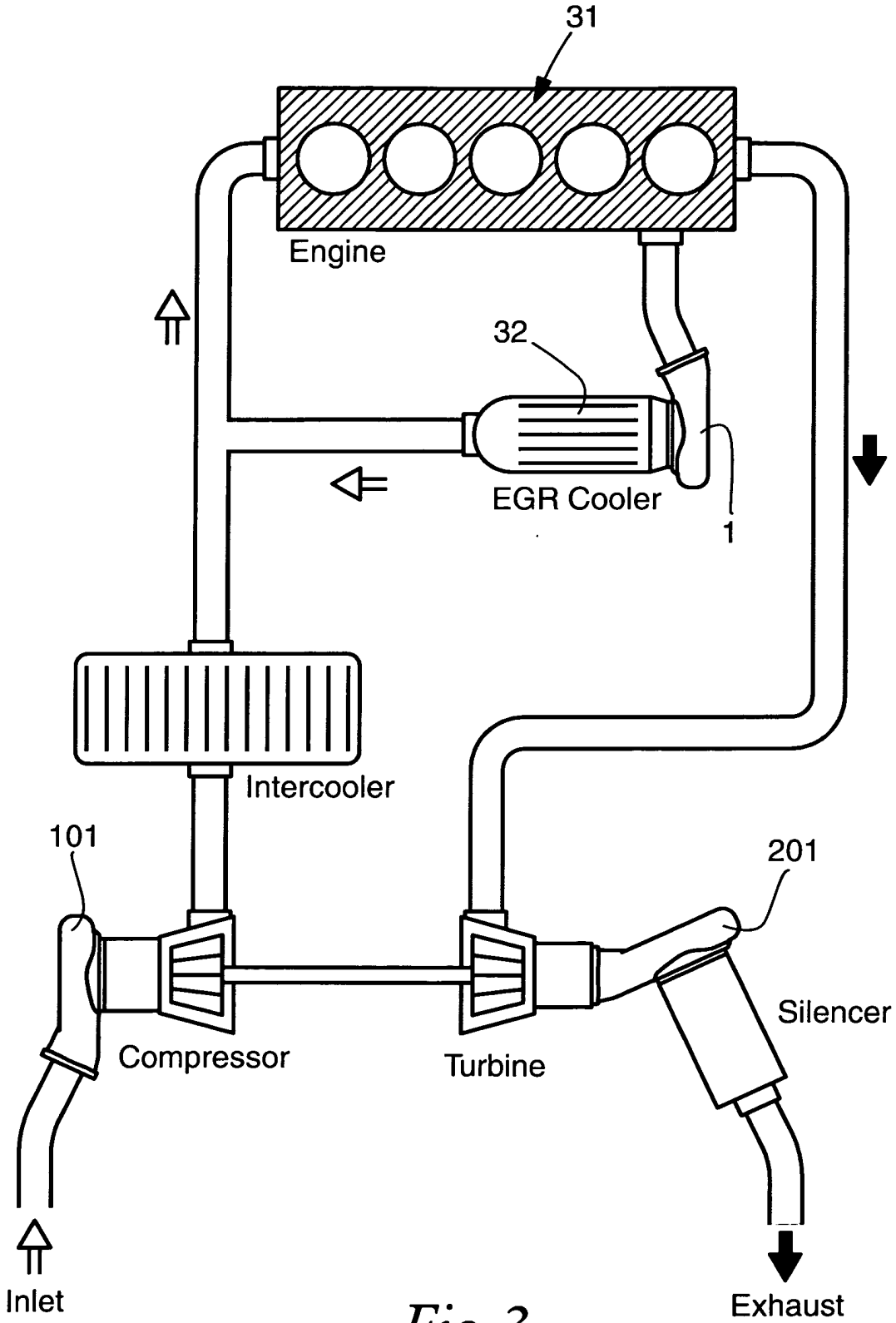

31
Engine
32
EGR Cooler
1
Intercooler
101
201
Compressor
Turbine
Silencer
Inlet
Exhaust

Fig 3

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 2358732 A **[0009]**
- EP 2343440 A **[0010]**
- JP 2007211663 A **[0011]**