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

(11) EP 1 580 421 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
18.06.2008 Bulletin 2008/25

(51) Int Cl.:
F02M 25/07 *(2006.01)*

(21) Application number: **05102243.2**

(22) Date of filing: **21.03.2005**

(54) Device for mixing exhaust gases to be recirculated to an engine with the intake air and a method for recirculating exhaust gases

Vorrichtung zum Beimischen von rückgeführtem Abgas zur Ansaugluft eines Motors und Verfahren zur Abgasrückführung

Dispositif pour mélanger les gas d'échappement recyclés à l'air d'admission d'un moteur et procédé pour recycler les gaz d'échappement

(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 MC NL PL PT RO SE SI SK TR

(30) Priority: **23.03.2004 IT MI20040564**

(43) Date of publication of application:
28.09.2005 Bulletin 2005/39

(73) Proprietor: **IVECO S.p.A.**
10156 Torino (IT)

(72) Inventors:
- **VERONESE, Riccardo**
  10024, MONCALIERI (IT)
- **GROSSO, Paolo**
  10043, ORBASSANO (IT)

(74) Representative: **Borsano, Corrado et al**
Notarbartolo & Gervasi S.p.A.
Corso di Porta Vittoria, 9
20122 Milano (IT)

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Description

SCOPE OF THE INVENTION

[0001] This invention relates to a device for mixing exhaust gases that are to be recirculated in an internal combustion engine, more specifically in a compression ignition engine, for example a diesel engine of an industrial vehicle.

PRIOR ART

[0002] Exhaust gas recirculation, or EGR, is common practice in the field of internal combustion engines. In this system a portion of the exhaust gases from the engine are recirculated upstream of such engine into the air intake system and reintroduced into the combustion chambers with the intake air. This results in a lower combustion temperature, which leads to a reduced formation of nitrogen oxides, one of the main pollutants in internal combustion engine emissions.

[0003] The exhaust gases are usually recirculated by means of a specific line that picks up the exhaust gases downstream of the engine, for example from the exhaust gas manifold, and then reintroduces the gases into the intake manifold; the line may incorporate a number of devices, such as a recirculation compressor, to overcome any differences between the intake and exhaust pressures, a control valve, a cooling system, to reduce the temperature of the recirculating gases.

[0004] Direct introduction into the intake manifold is not a satisfactory solution, as it does not guarantee good mixing of the exhaust gases with the intake air. As a result, the gaseous mixture entering the various cylinders does not always contain the same percentage of recirculated gases. This reduces the efficiency of the recirculation system as far as its ability to limit the formation of harmful pollutants is concerned, leads to a deterioration of combustion performance and, since the intake air-recirculating gas ratio is not the same in all the cylinders, the cylinders present different levels of wear and corrosion due to the different concentrations of the corrosive elements, which are always present in exhaust gas fumes, being supplied to the cylinders.

[0005] These phenomena, that may be hardly noticeable when small amounts of gas are recirculated, become more important when, also in view of the need to comply with stricter emissions standards, higher exhaust gas recirculation rates are required (for example, in diesel engines for industrial vehicles, where the exhaust gas recirculation rate may be as high as 50%). In that case, it is clear that supplying mixtures with different levels of intake air and recirculating gases to the various cylinders can constitute a serious problem.

[0006] DE 35 11 094 discloses a device for introducing a gas into the intake channel of an Otto engine. The gas is introduced tangentially into the stream of intake air and the device is suited to be applied to the carburettor of said engine and its construction is rather complex.

[0007] JP 08 319901 discloses an exhaust recirculation device. The intake passage, in correspondence of the introduction point of the exhaust gas, features an enlargement, wherein a element is movable in order to enlarge or restrict the passage, in order to vary the Venturi effect. The device is very bulky and has a complex structure.

[0008] JP 2001 304 050 discloses another device for mixing recirculated exhaust gases to the intake air of an internal combustion engine.

[0009] There is thus a need for a system that can enhance the mixing of the recirculated gases and air fed to the motor, while avoiding the use of complex space-consuming and expensive equipment, and ensuring ease of maintenance and constant efficiency during operation.

SUMMARY OF THE INVENTION

[0010] The problems described above have now been solved with a mixing device according to appended claim 1.

[0011] According to one aspect of the invention, the openings of the channels in the wall of the duct are arranged on a plane that is perpendicular to a longitudinal axis of the duct. Such openings are preferably arranged uniformly along the perimeter of the section on such plane; if there are two channels, they may be arranged with the relative openings the maximum distance apart along such perimeter. In that case the gases are preferably introduced in the opposite directions.

[0012] Such duct preferably incorporates an elbow upstream of the openings of the channels. The device may also incorporate an appropriate seat to house a control valve, for example a butterfly valve, upstream of such openings and, if present, of such elbow.

[0013] This invention also relates to a method for recirculating exhaust gases in an engine, by means of the above mentioned device.

[0014] This invention refers in particular to that set forth in the claims, which are attached hereto.

LIST OF DRAWINGS

[0015] This invention will now be illustrated through a detailed description of the preferred but not exclusive embodiments, furnished merely by way of example, with the aid of the drawings attached, of which:

figure 1 is a schematic perspective view of a device according to this invention;
figure 2 schematically shows another perspective view of the device in figure 1;
figure 3 schematically shows a further perspective view of the device in figure 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0016] The device according to the present invention is now described with reference to the drawings attached hereto. There is a duct 1 through which the intake air can flow to an internal combustion engine in the direction indicated by the arrow A. In correspondence with a cross-section 2 of the duct, preferably at one end, there are a plurality of channels 3 and 3', for example two, that terminate in the duct 1 through the openings 4 and 4' in the wall of the duct. According to a preferred embodiment of the invention, the ducts are suitable for introducing a gaseous flow perpendicularly, in relation to the current of gas flowing through the duct. The respective openings are preferably arranged uniformly along the perimeter of a cross-section of the duct; in the case shown in the drawing, in which there are two openings, these may be arranged opposite one another in relation to the cross-section of the duct.

[0017] The direction of introduction is substantially perpendicular to the wall of the duct, and may be incident with a longitudinal axis of symmetry of the duct, if the latter has one.

[0018] There may be a common inlet 5 through which the recirculated gas is introduced. Such inlet communicates with the various channels 3, 3'. The channels may be of any appropriate shape and connect an exhaust gas recirculation line, preferably through the inlet 5. According to a specific aspect of the invention, the channels and the inlet may be made integral with the device; they may be delimited by walls that are integral with the device, or be partly delimited by other structures, to which the device must be secured. The device illustrated in the drawings, for example, is to be attached directly to the intake manifold of an engine, in correspondence with a suitable opening on the manifold, and have a shape corresponding to the section of the duct 1 at the end 2, for example by means of suitable fastening devices, for example, screws placed through the holes 6. The structure 7 acts as a flange for securing the device to the manifold and also houses the channels 3, 3' and the inlet 5. This and other construction solutions may be carried out according to specific requirements. In the embodiment illustrated in the drawing, the device is secured by means of a gasket that is placed between the structure 7 and the intake manifold, in order to ensure tightness while at the same time closing the side of the channels 3 and 3' facing towards the end 2, and thus towards the intake manifold once the device and manifold have been assembled. Other suitable means may be used instead of a gasket, for example, adhesive paste.

[0019] According to a preferred embodiment of the invention, the openings 4, 4' number between two and six, two being a particularly preferred number.

[0020] The inlet 5 must be appropriately connected to a gas recirculation line, that picks up the exhaust gases, for example from the engine exhaust manifold.

[0021] The openings may be of any suitable shape, for example they may be round, rectangular, rectangular with all or some corners rounded ...

[0022] In vehicle engines, it is often necessary, due to lack of space or in view of other construction requirements, to install an elbow in the air supply line immediately upstream of the intake manifold (for example between the outlet from an intake air cooling unit, located after an intake air compression stage, and the intake manifold). Such elbow may be an integral part of the device according to this invention, upstream of the section containing the openings of the channels. Considering (figure 3) a longitudinal axis 9 of the duct 1 immediately downstream of such elbow in the duct 1 (that may be in the area that includes the openings 4, 4') and a longitudinal axis 10 of the duct 1 immediately upstream of such elbow 8, the angle α between such axes preferably ranges from between 0 and 90° (where 0 is the condition in which the two axes are aligned and the pipe is straight).

[0023] The area of the perpendicular cross-section of the duct may be variable or constant and is preferably substantially constant for the entire length of the device. The shape, which may advantageously be round or almost round, may also be of another appropriate type.

[0024] Should it be necessary to include the elbow as described above, whether such elbow is an integral part of the device or located immediately upstream of such device, the inside of the elbow must preferably have a certain radius of curvature and must not form a sharp corner; this has been found to ensure good mixing even in the presence of such elbow. If D is the average equivalent inside diameter of the duct, and R is the minimum inside radius of curvature of the duct, that in figure 3 is the minimum radius of curvature of the dotted line 11, (which represents the longitudinal section of the inside wall of the duct in the inside part of the elbow), according to a preferred aspect of the invention the following is true: $DR/\alpha > 15\ mm^2/°$. Furthermore, if a is the total area of the exhaust gas inlets, obtained from the sum of all the areas of the various openings 4, 4' of the channels 3, 3', and n is the number of such openings, preferably 1 mm < a/nD < 10 mm, and more preferably 3 mm < a/nD < 6 mm.

[0025] The higher the rate of exhaust gas recirculation, in order to reduce polluting emissions, the more important it is to control the amount of air being supplied to the engine. If deemed necessary, the device may incorporate a seat for a control valve, preferably a butterfly valve. Such seat is preferably located upstream of the openings through which the recirculated exhaust gases are introduced, more preferably upstream of the elbow if present. The integration of the valve seat in the device according to this invention may be advantageous, both in order to reduce the size and complexity of the system, thus facilitating assembly, and also to ensure the correct location of the control valve in relation to the other parts that make up the device and compliance with project specifications, in order to enhance mixing. The drawings illustrate a de-

vice with such seat 12 made integral with the device; they also illustrate an opening 13 for a valve of an appropriate shape and type, and the means 14 for securing such valve. Such seat is preferably located on a straight section of the duct, upstream of the elbow 8. It is, of course, possible to provide a device that does not incorporate such seat, if the valve is already incorporated in the air supply line upstream of the actual device. As an alternative, a valve body, preferably of the butterfly type, may be connected to the device, for example by means of an appropriate flange at the end at which the inlet 15 of the duct 1 is located, or in any other way that is known.

[0026] The centers of gravity of the areas of the openings of the ducts are preferably on the same plane perpendicular to the axis of the duct 1, and arranged uniformly along the perimeter of the duct.

[0027] If the elbow is present, there is also preferably a straight duct portion between the end of such elbow and the openings of the ducts. In that case, if L is the length of a straight duct portion extending from the end section of such elbow to a transverse plane on which the centers of gravity of the areas of such openings lie (which defines a perpendicular section of the duct that is also called the mixing section), according to a preferred embodiment of the invention, the following is true: $LD/\alpha > 5$ $mm^2/°$, more preferably >10 $mm^2/°$. Irrespectively or, preferably, in addition to that established by the ratios set forth above, according to a preferred embodiment of the invention: $nLDR/\alpha > 500$ $mm^3/°$.

[0028] If the elbow is not present, there is preferably a straight duct portion between the valve seat, if present, and the mixing section. The straight duct portion may, of cause, be omitted if the device, with no elbow or valve seat, is to be connected to conduits, upstream of the duct 1, with a straight duct portion whereby the same results can be achieved.

[0029] If the centers of gravity, as specified above, do not lie on the same perpendicular plane, the length L is calculated from the perpendicular plane containing the center of gravity furthest upstream.

[0030] The device according to this invention can be installed in all internal combustion engines with compression ignition or controlled ignition, for example, diesel engines, but is also suitable for use in petrol engines or other types of engines, in which a portion of the exhaust gases are recirculated. The device may advantageously be installed on the intake line of the engine. In case of a supercharged engine, it may be installed between the compressor and the intake manifold, preferably downstream of the intake air cooling system, if present. The recirculation system connected via the exhaust gas inlet to the device may be fitted with valves to regulate the flow of the recirculating gases, flow compressors and/or cooling systems, according to the specific requirements.

Claims

1. Mixing device comprising:

   a duct (1) through which a current of gas can flow;
   at least two lateral channels (3, 3') that open out into a wall of such duct through the respective openings (4, 4');
   in which such channels are suitable for introducing a flow of gas perpendicularly, in relation to such duct, into the introduction section (2) and substantially perpendicularly to the wall of the duct at the point of introduction, **characterised in that** $1\ mm<a/nD<10\ mm$ where D is the average equivalent inside diameter of the duct, a the sum of the areas and n the number of said openings.

2. Device according to the previous claim **characterised in that** the openings of the channels in the wall of the duct are arranged on a plane (2) that is perpendicular to a longitudinal axis (9) of the duct.

3. Device according to claim 2 **characterized in that** such opening (4,4') are arranged uniformly along the perimeter of the section on such plane (2).

4. Device according to any of the previous claims **characterized in that** such channels (3,3') number between two and six.

5. Device according to claims 3 and 4 **characterized in that** there are two channels (3,3'), placed so that their respective openings (4,4') are the maximum distance apart from each other on such perimeter.

6. Device according to any of the previous claims **characterized in that** such duct has an elbow (8) upstream of the openings of the channels.

7. Device according to claim 6 **characterized in that** the angle (α) between a longitudinal axis (9) of the duct (1) immediately downstream of such elbow in such duct and a longitudinal axis (10) of the duct (1) immediately upstream of such elbow, is between 0 and 90°.

8. Device according to any of the previous claims **characterized by** comprising a seat (12) suitable for housing a control valve upstream of such openings.

9. Device according to claim 6 or 7 **characterized in that** $DR/\alpha > 15\ mm^2/°$ where D is the average equivalent inside diameter of the duct (1), and R is the minimum inside radius of curvature of the duct in correspondence with such elbow (8).

10. Device according to claim 7 **characterized by** comprising a straight portion of such duct (1) immediately upstream of a plane (2) that is perpendicular to the axis (9) of the duct on which the centers of gravity of the openings (4,4') lie and that $LD/\alpha > 5\ mm^2/°$ where L is the length of such straight portion.

11. Device according to any of the previous claims **characterized in that** 3 mm < a/nD < 6 mm, where a is the area of each opening (4, 4') of the channels (3, 3'), and n is the number of such openings.

12. Device according to claim 7 **characterized by** comprising a straight portion of such duct immediately upstream of a plane that is perpendicular to the axis of the duct on which the centers of gravity of the openings lie and that $nLDR/a > 500\ mm^3/°$ where L is the length of such straight section.

13. Device according to any of the previous claims **characterized in that** it can be installed on the intake line of an internal combustion engine.

14. Device according to claim 13 **characterized in that** it can be fitted to the intake manifold of an internal combustion engine.

15. Device according to any previous claim, wherein said duct has an axis of symmetry and the channels are suitable for introducing a flow of gas with a direction incident to said axis.

16. Device according to claim 14, wherein it is suitable for being fitted to said manifold by means of sealing means that also delimit a side of said channels.

17. Device according to claim 13 or 14 suitable for introducing a portion of exhaust gases into a current of intake air of said engine.

18. Method for recirculating exhaust gases in an engine, wherein a portion of the exhaust gases coming from such engine are picked up, **characterized by** comprising the division of such portion into at least two flows, and the introduction of such flows into a current of air that is supplied to such engine, transversely in relation to the direction of such current of air, upstream of the intake manifold of such engine, **characterized by** being carried out by means of a device according to any of the claims from 1 to 17 and that such flows are introduced through such channels (3, 3') into such current of air that flows through such duct (1).

Patentansprüche

1. Mischvorrichtung, die umfasst:

ein Rohr (1), durch das ein Gasstrom strömen kann;
wenigstens zwei Querkanäle (3, 3'), die durch die jeweiligen Öffnungen (4, 4') in eine Wand dieses Rohrs aufgeweitet sind;
wobei diese Kanäle geeignet sind, eine Gasströmung senkrecht in Bezug auf dieses Rohr in den Einleitungsschnitt (2) und im Wesentlichen senkrecht zu der Wand des Rohrs am Einleitungspunkt einzuleiten,

dadurch gekennzeichnet, dass 1 mm < a/nD < 10 mm ist, wobei D der mittlere äquivalente Innendurchmesser des Rohrs ist, a die Summe der Flächen ist und n die Anzahl der genannten Öffnungen ist.

2. Vorrichtung gemäß dem vorherigen Anspruch, **dadurch gekennzeichnet, dass** die Öffnungen der Kanäle in der Wand des Rohrs in einer Ebene (2) angeordnet sind, die senkrecht zu einer Längsachse (9) des Rohrs ist.

3. Vorrichtung gemäß Anspruch 2, **dadurch gekennzeichnet, dass** diese Öffnungen (4, 4') entlang des Umfangs des Schnitts in dieser Ebene (2) gleichmäßig angeordnet sind.

4. Vorrichtung gemäß einem vorherigen Anspruch, **dadurch gekennzeichnet, dass** die Anzahl dieser Kanäle (3, 3') zwischen zwei und sechs liegt.

5. Vorrichtung gemäß Anspruch 3 und 4, **dadurch gekennzeichnet, dass** es zwei Kanäle (3, 3') gibt, die so platziert sind, dass ihre jeweiligen Öffnungen (4, 4') auf diesem Umfang den maximalen Abstand voneinander haben.

6. Vorrichtung gemäß einem vorherigen Anspruch, **dadurch gekennzeichnet, dass** dieses Rohr auf der Einlassseite der Öffnungen der Kanäle einen Krümmer (8) aufweist.

7. Vorrichtung gemäß Anspruch 6, **dadurch gekennzeichnet, dass** der Winkel. □) zwischen einer Längsachse (9) des Rohrs (1) direkt auf der Auslassseite dieses Krümmers in diesem Rohr und einer Längsachse (10) des Rohrs (1) direkt auf der Einlassseite dieses Krümmers zwischen 0 und 90° liegt.

8. Vorrichtung gemäß einem vorherigen Anspruch, **dadurch gekennzeichnet, dass** sie einen Sitz (12) umfasst, der geeignet ist, ein Steuerventil auf der Einlassseite dieser Öffnungen aufzunehmen.

9. Vorrichtung gemäß Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** $DR/□ > 15\ mm^2/°$ ist, wobei D der mittlere äquivalente Innendurchmesser des Rohrs (1) ist und R der minimale Innenkrümmungs-

radius des Rohrs in Übereinstimmung mit diesem Krümmer (8) ist.

10. Vorrichtung gemäß Anspruch 7, **dadurch gekennzeichnet, dass** sie direkt auf der Einlassseite einer Ebene (2), die senkrecht zu der Achse (9) des Rohrs ist, in der die Schwerpunkte der Öffnungen (4, 4') liegen, einen geraden Abschnitt dieses Rohrs (1) umfasst und dass LD/□ > 5 mm^2/° ist, wobei L die Länge dieses geraden Abschnitts ist.

11. Vorrichtung gemäß einem vorherigen Anspruch, **dadurch gekennzeichnet, dass** 3 mm < a/nD < 6 mm ist, wobei a die Fläche jeder Öffnung (4, 4') der Kanäle (3, 3') und n die Anzahl dieser Öffnungen ist.

12. Vorrichtung gemäß Anspruch 7, **dadurch gekennzeichnet, dass** sie direkt auf der Einlassseite einer Ebene, die senkrecht zu der Achse des Rohrs ist, in der die Schwerpunkte der Öffnungen liegen, einen geraden Abschnitt dieses Rohrs umfasst und dass nLDR/□ > 500 mm^3/° ist, wobei L die Länge dieses geraden Abschnitts ist.

13. Vorrichtung gemäß einem vorherigen Anspruch, **dadurch gekennzeichnet, dass** sie an der Einlassleitung einer Brennkraftmaschine eingebaut werden kann.

14. Vorrichtung gemäß Anspruch 13, **dadurch gekennzeichnet, dass** sie am Saugrohr einer Brennkraftmaschine montiert werden kann

15. Vorrichtung gemäß einem vorherigen Anspruch, bei der das genannte Rohr eine Symmetrieachse aufweist und die Kanäle geeignet sind, eine Gasströmung mit einer auf die Achse auftreffenden Richtung einzuleiten.

16. Vorrichtung gemäß Anspruch 14, wobei sie geeignet ist, an dem Krümmer mittels Dichtungsmitteln montiert zu werden, die ebenfalls eine Seite der Kanäle begrenzen.

17. Vorrichtung gemäß Anspruch 13 oder 14, die geeignet ist, einen Teil der Abgase in einen Ansaugluftstrom des genannten Motors einzuleiten.

18. Verfahren zum Rückführen von Abgasen in einem Motor, wobei ein Teil der von diesem Motor kommenden Abgase aufgefangen werden, **dadurch gekennzeichnet, dass** es das Einteilen dieses Teils in wenigstens zwei Strömungen und das Einleiten dieser Strömungen in einen Luftstrom, der diesem Motor zugeführt wird, quer in Bezug auf die Richtung dieses Luftstroms auf der Einlassseite des Saugrohrs dieses Motors umfasst, **dadurch gekennzeichnet, dass** es mittels einer Vorrichtung gemäß einem der Ansprüche 1 bis 17 ausgeführt wird und dass diese Strömungen durch diese Kanäle (3, 3') in diesen Luftstrom eingeleitet werden, der durch dieses Rohr (1) strömt.

Revendications

1. Dispositif mélangeur comprenant :

un conduit (1) à travers lequel peut s'écouler un flux gazeux;
au moins deux voies latérales (3, 3') qui débouchent dans une paroi dudit conduit à travers des ouvertures respectives (4, 4') ;
dans lequel lesdites voies sont adaptées pour permettre d'introduire un flux gazeux, perpendiculairement audit conduit, dans la région d'introduction (2), et de manière sensiblement perpendiculaire à la paroi du conduit au point d'introduction ;

caractérisé en ce que 1 mm < a/nD < 10 mm, où D est le diamètre intérieur équivalent moyen du conduit, où a est la somme des surfaces et n est le nombre desdites ouvertures.

2. Dispositif selon la revendication précédente, **caractérisé en ce que** les ouvertures des voies dans la paroi du conduit sont agencées suivant un plan (2) qui est perpendiculaire à un axe longitudinal (9) du conduit.

3. Dispositif selon la revendication 2, **caractérisé en ce que** lesdites ouvertures (4, 4') sont ménagées uniformément le long du périmètre du plan de coupe sur ledit plan (2).

4. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le nombre desdites voies (3, 3') est compris entre deux et six.

5. Dispositif selon les revendication 3 et 4, **caractérisé en ce qu'**il existe deux voies (3, 3'), disposées de telle manière que leurs s ouvertures respectives (4, 4') soient le plus éloignées possible les unes des autres sur ledit périmètre.

6. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit conduit présente un coude (8) situé en amont des ouvertures des voies.

7. Dispositif selon la revendication 6, **caractérisé en ce que** l'angle (α) défini entre un axe longitudinal (9) du conduit (1) immédiatement en aval dudit coude dans ledit conduit et un axe longitudinal (10) du conduit (1) immédiatement en amont dudit coude, est

compris entre 0 et 90 °.

8. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il comprend un siège (12) adéquat pour y loger une soupape de commande en amont desdites ouvertures.

9. Dispositif selon la revendication 6 ou 7, **caractérisé en ce que** $DR/\alpha > 15\ mm^2/°$, où D est le diamètre intérieur équivalent moyen du conduit (1) et R est le rayon de courbure intérieur minimum du conduit en correspondance avec ledit coude (8).

10. Dispositif selon la revendication 7, **caractérisé en ce qu'**il comprend une partie rectiligne dudit conduit (1) immédiatement en aval d'un plan (2) qui est perpendiculaire à l'axe (9) du conduit sur lequel se trouvent les centres de gravité des ouverture (4, 4'), et **en ce que** $LD/\alpha > 5\ mm^2/°$, où L est la longueur de ladite partie rectiligne.

11. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** $3\ mm < a/nD < 6\ mm$, où a est la surface de chaque ouverture (4, 4') des voies (3, 3'), et n est le nombre desdites ouvertures.

12. Dispositif selon la revendication 7, **caractérisé en ce qu'**il comprend une partie rectiligne dudit conduit immédiatement en amont d'un plan qui est perpendiculaire à l'axe du conduit sur lequel se trouvent les centres de gravité des ouvertures et **en ce que** $nLDR/\alpha > 500\ mm^3/°$, où L est la longueur de ladite partie rectiligne.

13. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il peut être installé sur le tubulure d'admission d'un moteur à combustion interne.

14. Dispositif selon la revendication 13, **caractérisé en ce qu'**il peut être monté sur le collecteur d'admission d'un moteur à combustion interne

15. Dispositif selon l'une quelconque des revendications précédentes, dans lequel ledit conduit présente un axe de symétrie et les voies sont prévues pour permettre d'introduire un flux gazeux suivant une direction qui est en intersection avec ledit axe.

16. Dispositif selon la revendication 14, **caractérisé en ce qu'**il est adéquat pour être monté sur ledit collecteur à l'aide de moyens d'étanchéité qui délimitent également une face desdites voies.

17. Dispositif selon la revendication 13 ou 14, adéquat pour permettre d'introduire une partie des gaz d'échappement présents dans un flux d'air d'admission dudit moteur.

18. Procédé pour recycler les gaz d'échappement dans un moteur, dans lequel une partie des gaz d'échappement provenant dudit moteur sont prélevés, **caractérisé en ce que** ladite partie est subdivisée en au moins deux flux, et par l'introduction desdits flux dans un flux d'air qui est fourni audit moteur, de manière transversale par rapport à la direction dudit flux d'air, en amont du collecteur d'admission dudit moteur, et **caractérisé en ce qu'**il est mis en oeuvre au moyen d'un dispositif selon l'une quelconque des revendications 1 à 17 et **en ce que** lesdits flux sont introduits à travers lesdites voies (3, 3') dans ledit flux d'air qui s'écoule à travers ledit conduit (1).

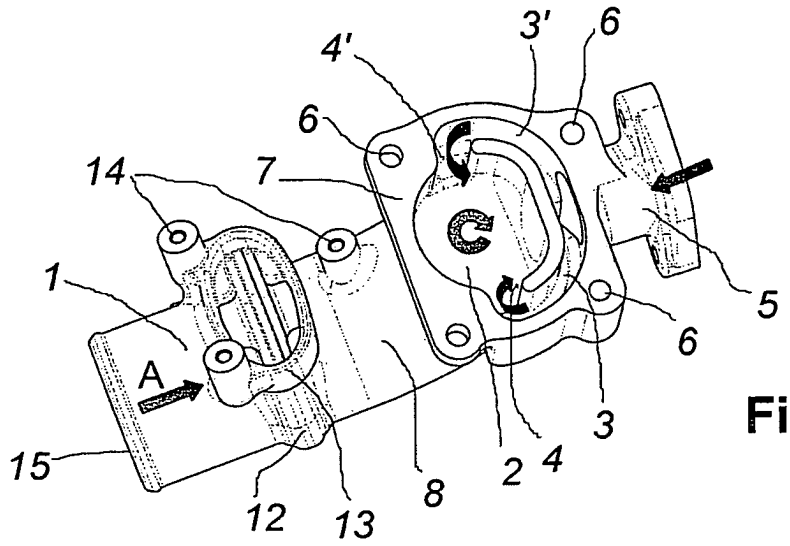

Fig. 1

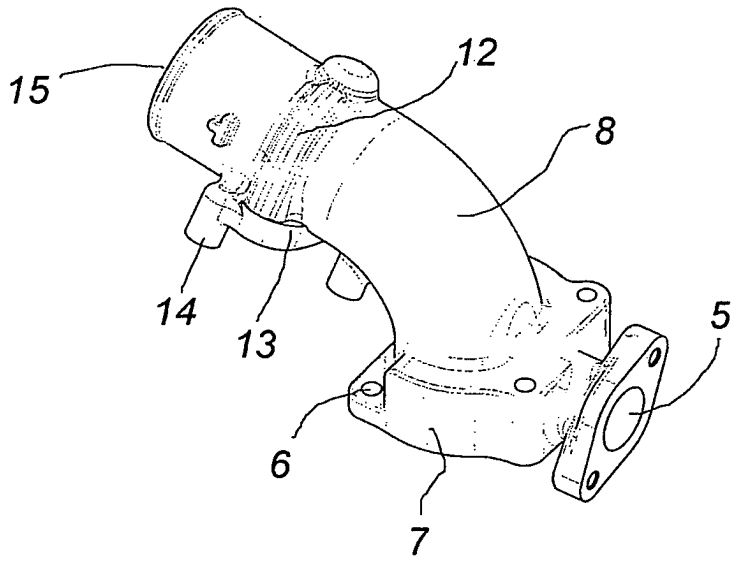

Fig. 2

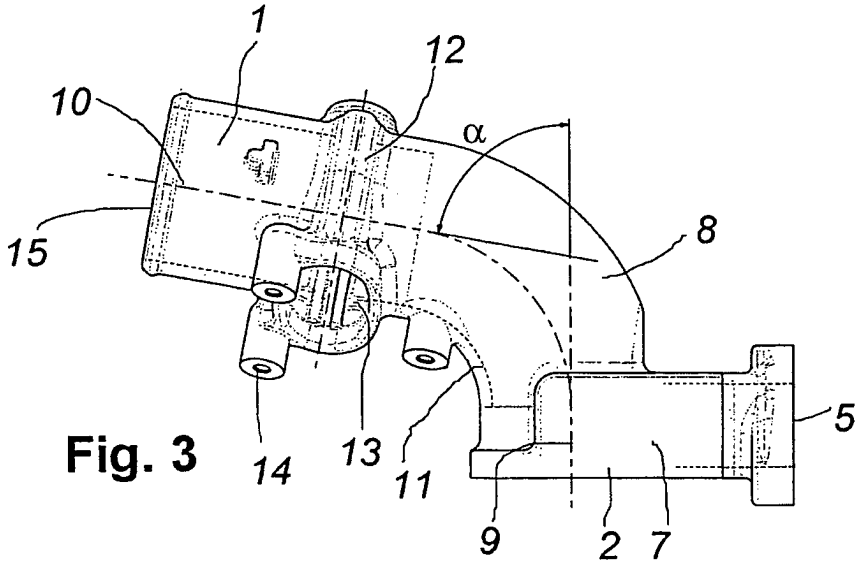

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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