

(19)



(11)

**EP 2 098 697 B2**

(12)

**NEW EUROPEAN PATENT SPECIFICATION**

After opposition procedure

(45) Date of publication and mention  
of the opposition decision:  
**20.05.2015 Bulletin 2015/21**

(51) Int Cl.:  
**F01N 3/20** (2006.01)  
**B01F 5/04** (2006.01)  
**B01F 3/04** (2006.01)

**F01N 3/28** (2006.01)  
**B01F 5/06** (2006.01)

(45) Mention of the grant of the patent:  
**01.09.2010 Bulletin 2010/35**

(21) Application number: **08425083.6**

(22) Date of filing: **12.02.2008**

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(54) **Exhaust system of an internal combustion engine**

Abgassystem eines Verbrennungsmotors

Système d'échappement d'un moteur à combustion interne

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(84) Designated Contracting States:  
**DE ES FR GB IT**

(43) Date of publication of application:  
**09.09.2009 Bulletin 2009/37**

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**EP 2 098 697 B2**

## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to an exhaust system of an internal combustion engine provided with an exhaust gas after-treatment arrangement.

**[0002]** The present invention is advantageously intended for use in an exhaust system of an internal combustion engine provided with an exhaust gas after-treatment arrangement to which the following description specifically refers but without loss of generality.

### BACKGROUND ART

**[0003]** Next generation international standards limiting pollutant emissions by motor vehicles (the so-called "Euro5" and "Euro6" emission standards) will set very low thresholds for NO<sub>x</sub> emissions.

**[0004]** Compliance with such limits is particularly critical especially for diesel engines; for this reason, a solution has been proposed which consists of providing exhaust systems of diesel engines with an additional NO<sub>x</sub> SCR (Selective Catalytic Reduction) system suitable to convert molecules of NO<sub>x</sub> (NO<sub>2</sub> or NO) into nitrogen (N<sub>2</sub>), which is an inert gas, and water (H<sub>2</sub>O). It is difficult to convert NO<sub>x</sub> molecules into nitrogen (N) without the use of an adequate reducing agent. Ammonia (NH<sub>3</sub>) is generally used for this purpose. The reducing agent must be introduced into the exhaust system and upstream of the SCR catalyst in order to mix with the exhaust gas before it enters the SCR catalyst.

**[0005]** However, storing ammonia inside a motor vehicle is not recommended for evident safety reasons relating to the fact that ammonia is toxic. Consequently, other solutions have been proposed which consist of storing and introducing an aqueous urea solution, as the urea is converted into ammonia due to the effect of the heat of the exhaust gas and also in part due to the catalytic effect.

**[0006]** A problem associated with introducing an aqueous urea solution into the exhaust system is that the decomposition of the urea also results in the formation of isocyanic acid (HNCO), which tends to thicken and polymerize, building up on the inside walls of the exhaust system and resulting in the formation of solid deposits that are difficult to remove. To prevent the polymerization of the isocyanic acid generated from the decomposition of the urea, there have been proposals to arrange a mixer in the exhaust system close to the point in which the urea is introduced. Said mixer generates turbulence in the exhaust gas flow which prevents the localized thickening of the isocyanic acid and thus prevents the polymerization of said isocyanic acid. The presence of a mixer that generates turbulence in the exhaust gas flow immediately before said exhaust gas flow enters the SCR catalyst clearly also improves the efficiency of the SCR catalyst since it results in a more uniform distribution of the re-

ducing agent (i.e. the ammonia) in the exhaust gas.

**[0007]** Patent application EP1514591A1 describes a mixer, which is arranged in an exhaust system of an internal combustion engine immediately upstream of an SCR catalyst into which the hot exhaust gas mixed with reducing agents is fed. Similarly, patent applications EP1022048A1, DE10060808A1, WO0107763A1, WO9913972A1, WO9905402A1, WO9905401A1, EP1748162A1, DE10248294A1, WO0009869A1, WO2005073524A1, WO0112301A1, EP0526392A1, EP0894523A1 describe exhaust systems provided with mixers arranged close to reducing agent feeder devices.

**[0008]** However, the known mixers of the type described above have the drawback of not achieving an ideal balance between the opposing needs for effectiveness (i.e. to guarantee adequate mixing of the exhaust gas) and efficiency (i.e. to limit loss of pressure in the exhaust gas). In other words, known mixers of the type described above are either low in effectiveness (i.e. they do not guarantee adequate mixing of the exhaust gas) or low in efficiency (i.e. they cause high losses of pressure in the exhaust gas).

**[0009]** WO2007127529A2 discloses an exhaust after-treatment system including injection of chemical species; the system has a mixer provided by a stamped muffler flange and arranged in the exhaust pipe between the injector and the aftertreatment element.

**[0010]** DE 102008017395 is the closest prior art and discloses an exhaust system according to the pre-characterizing portion of independent claim 1.

### DISCLOSURE OF INVENTION

**[0011]** The purpose of the present invention is to provide an exhaust system of an internal combustion engine, said exhaust system overcoming the drawbacks described above and, in particular, being easy and inexpensive to produce.

**[0012]** According to the present invention an exhaust system of an internal combustion engine is produced according to that set forth in the appended claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0013]** The present invention will now be described with reference to the attached drawings, illustrating some non-limiting embodiments thereon, in which:

- figure 1 is a schematic view of an exhaust system of an internal combustion engine provided with an exhaust gas after-treatment arrangement and produced according to the present invention; and
- figure 2 is a schematic perspective view of a mixer of the exhaust system of figure 1 that is not part of the present invention;
- figure 3 is a front view of the mixer of figure 2;
- figure 4 is a side cross-sectional view along the line IV-IV of the mixer of figure 2; and

- figure 5 is a schematic perspective view of an alternative embodiment of the mixer of figure 2 according to the present invention;

#### PREFERRED EMBODIMENTS OF THE INVENTION

**[0014]** In figure 1, number 1 indicates an overall exhaust system of a diesel cycle internal combustion engine 2 (i.e. an engine that runs on diesel or similar types of fuel).

**[0015]** The exhaust system 1 discharges the exhaust gas into the atmosphere and comprises an exhaust duct 3 which originates from an exhaust manifold 4 of the internal combustion engine 2. An oxidation catalyst 5 and a particulate filter 6 are arranged on the exhaust duct 3; in figure 1 the oxidation catalyst 5 and the particulate filter 6 are arranged in series inside a single common tubular container.

**[0016]** Moreover, an SCR (Selective Catalytic Reduction) system 7 for after-treatment of NO<sub>x</sub> (NO and NO<sub>2</sub>) molecules is arranged on the exhaust duct 3 and downstream of the oxidation catalyst 5. The SCR catalytic system 7 can comprise a single SCR catalyst 7 as illustrated in figure 1, or a series of catalysts (usually three) that together optimize the SCR function for after-treatment of NO<sub>x</sub> molecules.

**[0017]** Immediately upstream of the catalytic system 7, a feeder device 8 is connected to the exhaust duct 3, said device 8 being suitable to feed a reducing agent and in particular an aqueous urea solution (i.e. a solution of urea and water) into said exhaust duct 3. In use, due to the effect of the heat of the exhaust gas present in the exhaust duct 3, the urea fed into said exhaust duct 3 spontaneously decomposes into isocyanic acid (HNCO) and ammonia (NH<sub>3</sub>), said ammonia acting as a reducing agent in the catalytic system 7 to facilitate the conversion of the NO<sub>x</sub> molecules into nitrogen (N<sub>2</sub>) and water (H<sub>2</sub>O).

**[0018]** A static mixer 9 is arranged on the exhaust duct 3, in correspondence with the feeder device 8. The function of said mixer 9 is to generate turbulence in the exhaust gas in the exhaust duct 3 in order to prevent the localized thickening of the isocyanic acid (which forms during the decomposition of the urea) and thus prevent the polymerization of said isocyanic acid and improve the efficiency of the catalytic system 7 by distributing the ammonia more uniformly in the exhaust gas. In the embodiment illustrated in figure 1, the static mixer 9 is arranged downstream of the feeder device 8 (i.e. between the feeder device 8 and the catalytic system 7); alternatively, the static mixer 9 could be arranged upstream of the feeder device 8. According to an alternative embodiment which is not illustrated, two static mixers 9 could be provided and arranged respectively upstream and downstream of the feeder device 8.

**[0019]** As illustrated in figures 2, 3 and 4, the static mixer 9 comprises a cylindrical tubular body 10, which has a central axis of symmetry 11 and two opposing annular edges 12, and two groups 13 of tabs 14 arranged

on opposite sides of the tubular body 10.

**[0020]** In each group 13, the tabs 14 extend towards the outside of the tubular body 10 starting from a respective annular edge 12 of said tubular body 10, they are arranged at a distance from one another so as to leave an empty space 15 between two successive tabs 14, and slope towards the central axis of symmetry 11 so as to converge towards said central axis of symmetry 11. Each tab 14 of the static mixer 9 has substantially the shape of an isosceles trapezium with a longer base 16 arranged over the respective annular edge 12 of the tubular body 10 and a shorter base 17 which is free.

**[0021]** The two groups 13 of tabs 14 are staggered so that each tab 14 of one group 13 is longitudinally aligned along the central axis of symmetry 11 with an empty space 15 between two successive tabs 14 of the other group 13.

**[0022]** In correspondence with the respective annular edge 12 of the tubular body 10 each tab 14 extends for the equivalent of the extension of an empty space 15 between two successive tabs 14; for example in the embodiment that is illustrated there are four tabs 14 each having an angular extension of 45° and alternating with four empty spaces 15 each having an angular extension of 45°.

**[0023]** The ratio between the diameter D of the circumference defined by the longer bases 16 of the tabs 14 and the diameter d of the circumference defined by the shorter bases 17 of the tabs 14 is between 2 and 4 and preferably about 3. Moreover, each tab 14 forms an angle  $\alpha$  of between 30° and 60° and preferably of approximately 45° with the tubular body 10. The tubular body 10 preferably extends longitudinally along the central axis of symmetry 11 by at least 10 mm.

**[0024]** In the preferred embodiment illustrated in the attached drawings, each group 13 has four tabs 14 (and thus four empty spaces 15 arranged alternately with respect to the tabs 14); more generally, each group 13 is made up of between 3 and 6 tabs 14.

**[0025]** According to an alternative embodiment which is not illustrated, the static mixer 9 only comprises a single group 13 of tabs 14 arranged along an annular edge 12 of the tubular body 10.

**[0026]** According to the alternative embodiment illustrated in figure 5 that is part of the present invention, the static mixer 9 comprises a number of fastening brackets 18, which extend parallel to the central axis of symmetry 11 starting from an annular edge 12 of the tubular body 10 and are arranged in correspondence with the empty space 15 between two successive tabs 14. The fastening brackets 18 are welded or riveted to a side wall of the exhaust duct 3 so that the static mixer 9 is integral with the exhaust duct 3; according to the embodiment in figures 2-4 in which the static mixer 9 is not provided with the fastening brackets 18, the static mixer 9 is fastened to the exhaust duct 3 by welding or riveting the tubular body 10 to the side wall of the exhaust duct 3.

**[0027]** The static mixer 9 can be made by die-forming

a flat metal sheet to define the tabs 14 (and, where applicable, the brackets 18), and then folding the die-formed sheet round a cylindrical core to give said die-formed sheet a tubular shape which is stabilized by means of welding or riveting; the tabs 14 are then folded towards the central axis of symmetry 11 to give them the shape described above. Alternatively, the static mixer 9 can be made by die-forming a tubular body of sheet metal to define the tabs 14 (and, where applicable, the brackets 18) and then folding the tabs 14 towards the central axis of symmetry 11 to give the tabs 14 the shape described above.

**[0028]** According to an alternative embodiment which is not illustrated, the feeder device 8 is arranged upstream of the oxidation catalyst 5 to feed the fuel (for example diesel) into the exhaust duct 3, so that said fuel is burnt in the oxidation catalyst 5 to increase the temperature inside said oxidation catalyst 5 during a regeneration process of the particulate filter 6. In this case, the static mixer 9 is arranged upstream of the oxidation catalyst 5.

**[0029]** The static mixer 9 described above has numerous advantages, in that it is simple and inexpensive to produce, is particularly robust (and thus has a long working life and very low risk of breaking) and above all it achieves an ideal balance between the opposing needs for effectiveness (i.e. to guarantee adequate mixing of the exhaust gas) and efficiency (i.e. to cause limited loss of pressure in the exhaust gas). In other words, the static mixer 9 described above achieves high effectiveness (i.e. it guarantees adequate mixing of the exhaust gas) and high efficiency (i.e. it causes limited loss of pressure in the exhaust gas).

## Claims

1. Exhaust system (1) of an internal combustion engine (2); the exhaust system (1) comprises:

an exhaust duct (3) which originates from an exhaust manifold (4) of the internal combustion engine (2);

at least one catalytic system (7; 5) arranged on the exhaust duct (3);

a feeder device (8), which is connected to the exhaust duct (3) immediately upstream of the catalytic system (7; 5) to feed an additive into said exhaust duct (3); and

at least one static mixer (9), which is arranged on the exhaust duct (3) in correspondence with the feeder device (8), is arranged upstream or downstream of the feeder device (8), and comprises a tubular body (10) which has a central axis of symmetry and two opposing annular edges (12) and at least one group (13) of tabs (14), which extend towards the outside of the tubular body (10) starting from a respective annular

edge (12) of said tubular body (10), are arranged at a circumferentially distance from one another so as to leave a circumferential empty space (15) between two successive tabs (14), and slope from the annular edge (12) towards the central axis of symmetry (11) so as to converge towards said central axis of symmetry (11);

wherein the static mixer (9) comprises two groups (13) of tabs (14) arranged along the two opposing annular edges (12) of the tubular body (10); and

wherein the two groups (13) of tabs (14) are circumferentially staggered so that each tab (14) of one group (13) is longitudinally aligned along the central axis of symmetry (11) with an empty space (15) between two successive tabs (14) of the other group (13);

the exhaust system (1) being **characterized in that** the static mixer (9) comprises a number of fastening brackets (18), which extend parallel to the central axis of symmetry (11) starting from an annular edge (12) of the tubular body (10) and are arranged in correspondence with the empty space (15) between two successive tabs (14).

2. Exhaust system (1) according to claim 1, wherein each tab (14) of the static mixer (9) has substantially the shape of an isosceles trapezium having a longer base (16) arranged over the respective annular edge (12) of the tubular body (10) and a shorter base (17) which is free.
3. Exhaust system (1) according to claim 2, wherein the ratio between the diameter of the circumference defined by the longer bases (16) of the tabs (14) and the diameter of the circumference defined by the shorter bases (17) of the tabs (14) is between 2 and 4.
4. Exhaust system (1) according to claim 3, wherein the ratio between the diameter of the circumference defined by the longer bases (16) of the tabs (14) and the diameter of the circumference defined by the shorter bases (17) of the tabs (14) is approximately 3.
5. Exhaust system (1) according to one of the claims from 1 to 4, wherein in correspondence with the respective annular edge (12) of the tubular body (10) each tab (14) extends for the equivalent of an empty space (15) between two successive tabs (14).
6. Exhaust system (1) according to one of the claims from 1 to 5, wherein each tab (14) forms an angle of between 30° and 60° with the tubular body (10).
7. Exhaust system (1) according to claim 6, wherein each tab (14) forms an angle of approximately 45° with the tubular body (10).

8. Exhaust system (1) according to one of the claims from 1 to 7, wherein each group (13) has between 3 and 6 tabs (14).
9. Exhaust system (1) according to claim 8, wherein each group (13) has 4 tabs (14). 5
10. Exhaust system (1) according to one of the claims from 1 to 9, wherein the tubular body (10) extends longitudinally along the central axis of symmetry (11) by at least 10 mm. 10
11. Exhaust system (1) according to one of the claims from 1 to 10, wherein the fastening brackets (18) are welded or riveted to a side wall of the exhaust duct (3). 15
12. Exhaust system (1) according to one of the claims from 1 to 11, wherein the catalytic system (7; 5) comprises: 20
- an oxidation catalyst (5) arranged on the exhaust duct (3); and
- an SCR catalytic system (7) arranged on the exhaust duct (3) downstream of the oxidation catalyst (5) and downstream of the feeder device (8). 25
13. Exhaust system (1) according to one of the claims from 1 to 12, wherein the catalytic system (7; 5) comprises an oxidation catalyst (5) arranged on the exhaust duct (3) downstream of the feeder device (8). 30

#### Patentansprüche 35

1. Abgassystem (1) einer Brennkraftmaschine (2), wobei das Abgassystem (1) umfasst:
- ein Abgasrohr (3), das von einem Abgaskrümm- 40  
er (4) der Brennkraftmaschine (2) ausgeht;  
wenigstens ein katalytisches System (7; 5), das  
an dem Abgasrohr (3) angeordnet ist;  
eine Einleitungsvorrichtung (8), die in Strö- 45  
mungsrichtung direkt vor dem katalytischen  
System (7; 5) mit dem Abgasrohr (3) verbunden  
ist, um in das Abgasrohr (3) ein Additiv einzu-  
leiten; und
- wenigstens einen statischen Mischer (9), der an 50  
dem Abgasrohr (3) entsprechend der Einlei-  
tungsvorrichtung (8) angeordnet ist, vor oder  
hinter der Einleitungsvorrichtung (8) angeordnet  
ist und einen rohrförmigen Körper (10) aufweist,  
der eine mittige Symmetrieachse und zwei ge- 55  
genüberliegende ringförmige Kanten (12) und  
wenigstens eine Gruppe (13) von Ansätzen (14)  
besitzt, die sich beginnend bei einer jeweiligen  
ringförmigen Kante (12) des rohrförmigen Kör-

pers (10) zur Außenseite des rohrförmigen Kör-  
pers (10) erstrecken, in Umfangsrichtung in ei-  
nem Abstand voneinander angeordnet sind, um  
zwischen zwei aufeinander folgenden Ansätzen  
(14) einen leeren Raum (15) zu lassen, und von  
der ringförmigen Kante (12) zu der mittigen  
Symmetrieachse (11) so geneigt sind, dass sie  
zur mittigen Symmetrieachse (11) zusammen-  
laufen;

wobei der statische Mischer (9) zwei Gruppen  
(13) von Ansätzen (14) umfasst, die längs der  
zwei gegenüberliegenden ringförmigen Kanten  
(12) des rohrförmigen Körpers (10) angeordnet  
sind; und

wobei die zwei Gruppen (13) von Ansätzen (14)  
in Umfangsrichtung zueinander versetzt sind, so  
dass jeder Ansatz (14) einer Gruppe (13) longi-  
tudinal längs der mittigen Symmetrieachse (11)  
auf einen leeren Raum (15) zwischen zwei auf-  
einander folgenden Ansätzen (14) der anderen  
Gruppe (13) ausgerichtet ist;

wobei das Abgassystem (1) **dadurch gekenn-  
zeichnet ist, dass** der statische Mischer (9) ei-  
ne Anzahl Befestigungsträger (18) umfasst, die  
sich parallel zu der mittigen Symmetrieachse  
(11) erstrecken und von einer ringförmigen Kan-  
te (12) des rohrförmigen Körpers (10) ausgehen  
und entsprechend dem Leerraum (15) zwischen  
zwei aufeinander folgenden Ansätzen (14) an-  
geordnet sind.

2. Abgassystem (1) nach Anspruch 1, wobei jeder An-  
satz (14) des statischen Mischers (9) im Wesentli-  
chen die Form eines gleichschenkligen Trapezes  
besitzt, dessen längere Basis (16) über der jewei-  
ligen ringförmigen Kante (12) des rohrförmigen Kör-  
pers (10) angeordnet ist und dessen kürzere Basis  
(17) frei ist.
3. Abgassystem (1) nach Anspruch 2, wobei das Ver-  
hältnis zwischen dem Durchmesser des durch die  
längeren Basen (16) der Ansätze (14) definierten  
Umfangs und dem Durchmesser des durch die kür-  
zeren Basen (17) der Ansätze (14) definierten Um-  
fangs zwischen 2 und 4 liegt.
4. Abgassystem (1) nach Anspruch 3, wobei das Ver-  
hältnis zwischen dem Durchmesser des durch die  
längeren Basen (16) der Ansätze (14) definierten  
Umfangs und dem Durchmesser des durch die kür-  
zeren Basen (17) der Ansätze (14) definierten Um-  
fangs etwa 3 beträgt.
5. Abgassystem (1) nach einem der Ansprüche 1 bis  
4, wobei entsprechend der jeweiligen ringförmigen  
Kante (12) des rohrförmigen Körpers (10) jeder An-  
satz (14) sich als Äquivalent zu einem leeren Raum  
(15) zwischen zwei aufeinander folgenden Ansätzen

- (14) erstreckt.
6. Abgassystem (1) nach einem der Ansprüche 1 bis 5, wobei jeder Ansatz (14) einen Winkel im Bereich von 30° bis 60° zu dem rohrförmigen Körper (10) bildet. 5
7. Abgassystem (1) nach Anspruch 6, wobei jeder Ansatz (14) einen Winkel von etwa 45° zu dem rohrförmigen Körper (10) bildet. 10
8. Abgassystem (1) nach einem der Ansprüche 1 bis 7, wobei jede Gruppe (13) zwischen 3 und 6 Ansätzen (14) besitzt. 15
9. Abgassystem (1) nach Anspruch 8, wobei jede Gruppe (13) 4 Ansätze (14) besitzt.
10. Abgassystem (1) nach einem der Ansprüche 1 bis 9, wobei sich der ringförmige Körper (10) in Längsrichtung längs der mittigen Symmetrieachse (11) über wenigstens 10 mm erstreckt. 20
11. Abgassystem (1) nach einem der Ansprüche 1 bis 10, wobei die Befestigungsträger (18) mit einer Seitenwand des Abgasrohrs (3) verschweißt oder vernietet sind. 25
12. Abgassystem (1) nach einem der Ansprüche 1 bis 11, wobei das katalytische System (7; 5) umfasst: 30
- einen Oxidationskatalysator (5), der an dem Abgasrohr (3) angeordnet ist; und
- ein katalytisches SCR-System (7), das an dem Abgasrohr (3) in Strömungsrichtung hinter dem Oxidationskatalysator (5) und hinter der Einleitungs- 35
- vorrichtung (8) angeordnet ist.
13. Abgassystem (1) nach einem der Ansprüche 1 bis 12, wobei das katalytische System (7; 5) einen Oxidationskatalysator (5) umfasst, der an dem Abgasrohr (3) in Strömungsrichtung hinter der Einleitungs- 40
- vorrichtung (8) angeordnet ist. 45

## Revendications

1. Système d'échappement (1) d'un moteur à combustion interne (2); le système d'échappement (1) comprenant : 50
- un conduit d'échappement (3) qui a son origine dans un collecteur d'échappement (4) du moteur à combustion interne (2);
- au moins un système catalytique (7; 5) disposé 55
- sur le conduit d'échappement (3);
- un dispositif de délivrance (8), qui est connecté au conduit d'échappement (3) immédiatement

en amont du système catalytique (7; 5) pour délivrer un additif dans ledit conduit d'échappement (3); et

au moins un mélangeur statique (9), qui est disposé sur le conduit d'échappement (3) en correspondance avec le dispositif d'échappement (8) est disposé en amont ou en aval du dispositif d'échappement (8), et qui comprend un corps tubulaire (10) qui a un axe central de symétrie et qui comporte deux bords annulaires opposés (12) et au moins un groupe (13) de pattes (14), qui s'étendent vers l'extérieur du corps tubulaire (10) à partir d'un bord annulaire respectif (12) dudit corps tubulaire (10), qui sont disposées à une certaine distance les unes des autres de façon à laisser un espace vide (15) entre deux pattes successives (14), et qui sont en pente du bord annulaire (12) vers l'axe central de symétrie (11) de façon à converger vers ledit axe central de symétrie (11);

le mélangeur statique (9) comprend deux groupes (13) de pattes (14) disposées le long des deux bords annulaires opposés (12) du corps tubulaire (10);

les deux groupes (13) de pattes (14) sont étagés de telle sorte que chaque patte (14) d'un groupe (13) soit longitudinalement alignée le long de l'axe central de symétrie (11) avec un espace vide (15) entre deux pattes successives (14) de l'autre groupe (13); et

le système d'échappement (1) étant **caractérisé en ce que** le mélangeur statique (9) comprend une pluralité d'étriers de fixation (18) qui s'étendent parallèlement à l'axe central de symétrie (11) à partir d'un bord annulaire (12) du corps tubulaire (10) et sont disposés en correspondance avec l'espace vide (15) entre deux pattes successives (14).

2. Système d'échappement (1) selon la revendication 1, dans lequel chaque patte (14) du mélangeur statique (9) a sensiblement la forme d'un trapèze isocèle ayant une base plus longue (16) disposée sur le bord annulaire respectif (12) du corps tubulaire (10) et une base plus courte (17) qui est libre. 45
3. Système d'échappement (1) selon la revendication 2, dans lequel le rapport entre le diamètre de la circonférence définie par les bases plus longues (16) des pattes (14) et le diamètre de la circonférence définie par les bases plus courtes (17) des pattes (14) est compris entre 2 et 4.
4. Système d'échappement (1) selon la revendication 3, dans lequel le rapport entre le diamètre de la circonférence définie par les bases plus longues (16) des pattes (14) et le diamètre de la circonférence définie par les bases plus courtes (17) des pattes

(14) est d'approximativement 3.

5. Système d'échappement (1) selon l'une des revendications 1 à 4, dans lequel, en correspondance avec le bord annulaire respectif (12) du corps tubulaire (10), chaque patte (14) s'étend sur l'équivalent d'un espace vide (15) entre deux pattes successives (14). 5
6. Système d'échappement (1) selon l'une des revendications 1 à 5, dans lequel chaque patte (14) forme un angle compris entre 30° et 60° avec le corps tubulaire (10). 10
7. Système d'échappement (1) selon la revendication 6, dans lequel chaque patte (14) forme un angle d'approximativement 45° avec le corps tubulaire (10). 15
8. Système d'échappement (1) selon l'une des revendications 1 à 7, dans lequel chaque groupe (13) comporte entre 3 et 6 pattes (14). 20
9. Système d'échappement (1) selon la revendication 8, dans lequel chaque groupe (13) comporte 4 pattes (14). 25
10. Système d'échappement (1) selon l'une des revendications 1 à 9, dans lequel le corps tubulaire (10) s'étend longitudinalement le long de l'axe central de symétrie (11) d'au moins 10 mm. 30
11. Système d'échappement (1) selon l'une des revendications 1 à 10, dans lequel les étriers de fixation (18) sont soudés ou rivetés à une paroi latérale du conduit d'évacuation (3). 35
12. Système d'échappement (1) selon l'une des revendications 1 à 11, dans lequel le système catalytique (7 ; 5) comprend :
  - un catalyseur à oxydation (5) disposé sur le conduit d'échappement (3) ; et 40
  - un système catalytique à réduction catalytique sélective (7) disposé sur le conduit d'échappement (3) en aval du catalyseur à oxydation (5) et en aval du dispositif de délivrance (8). 45
13. Système d'échappement (1) selon l'une des revendications 1 à 12, dans lequel le système catalytique (7 ; 5) comprend un catalyseur à oxydation (5) disposé sur le conduit d'échappement (3) en aval du dispositif de délivrance (8). 50

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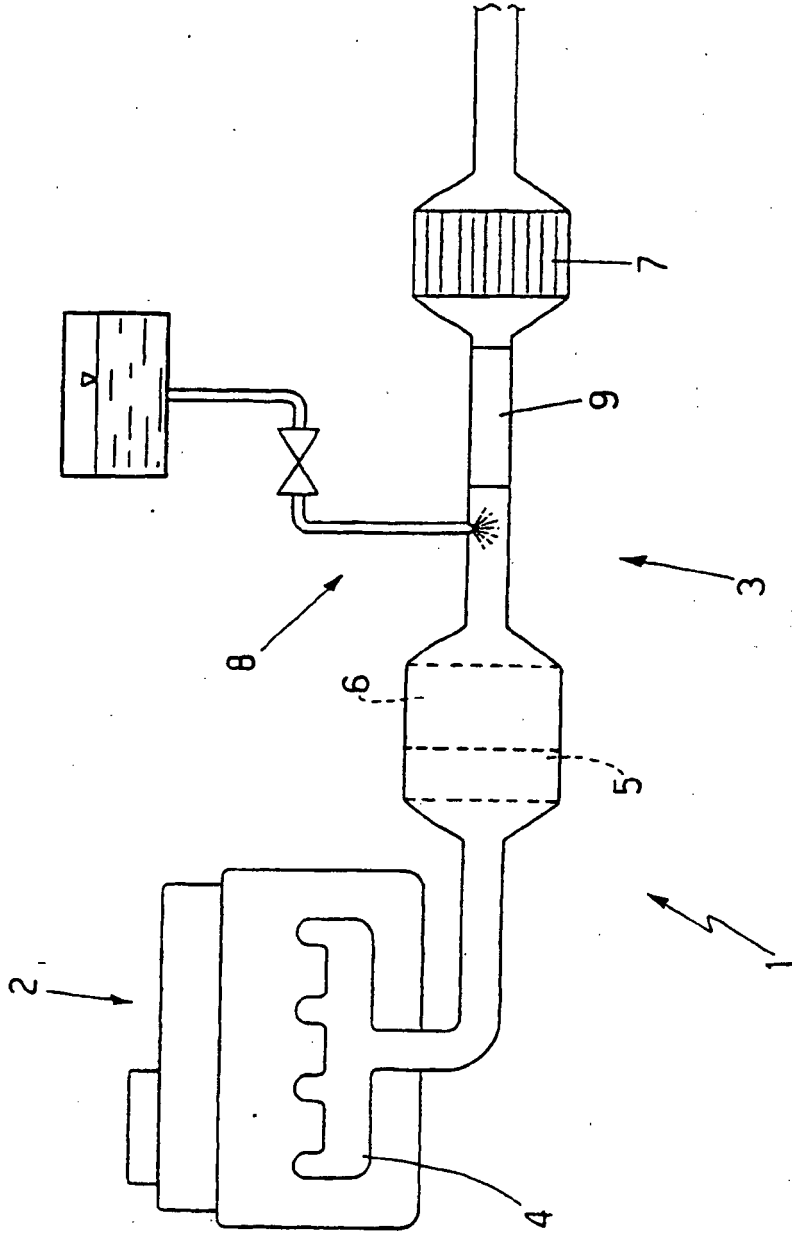
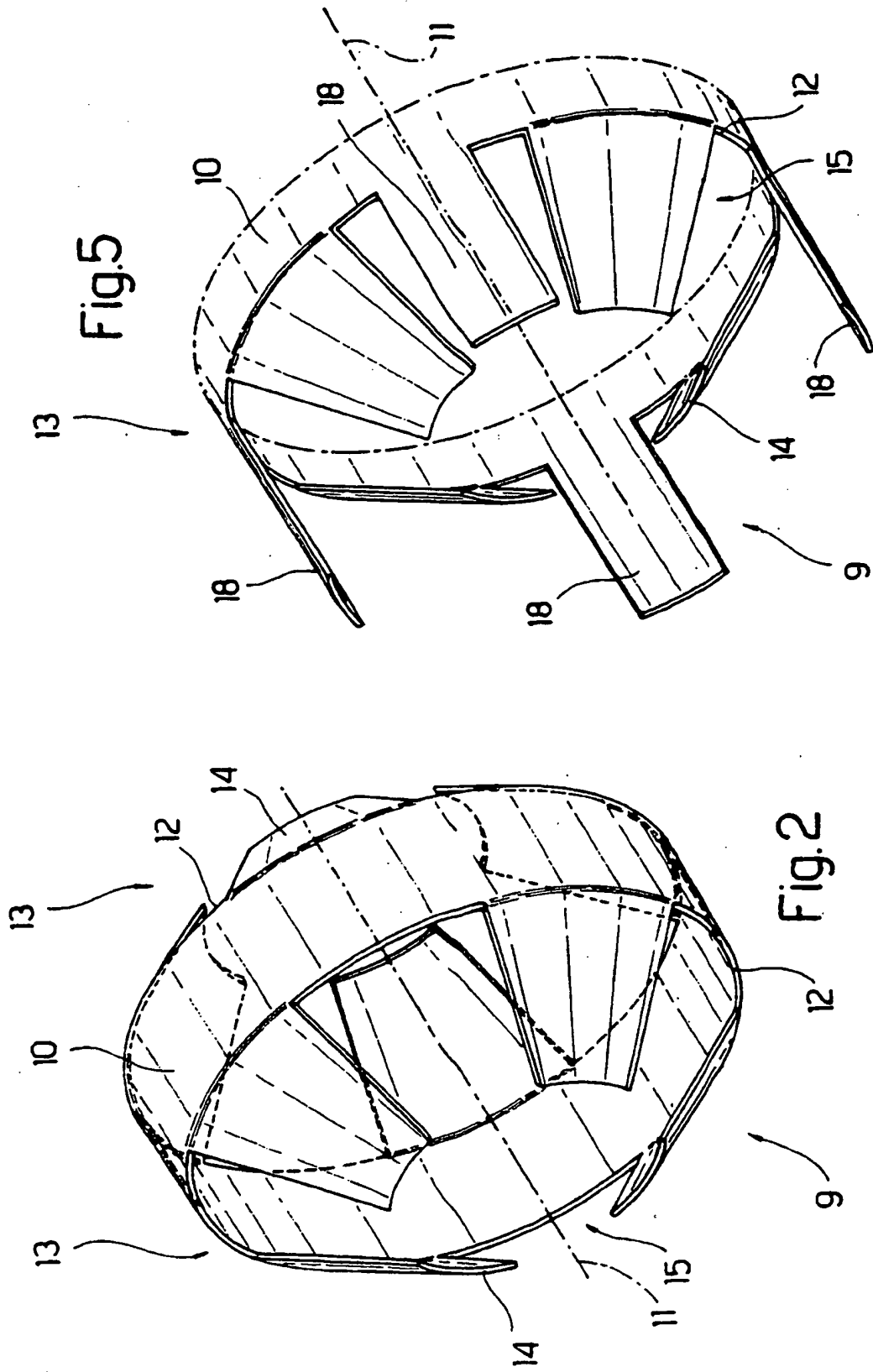


Fig.1



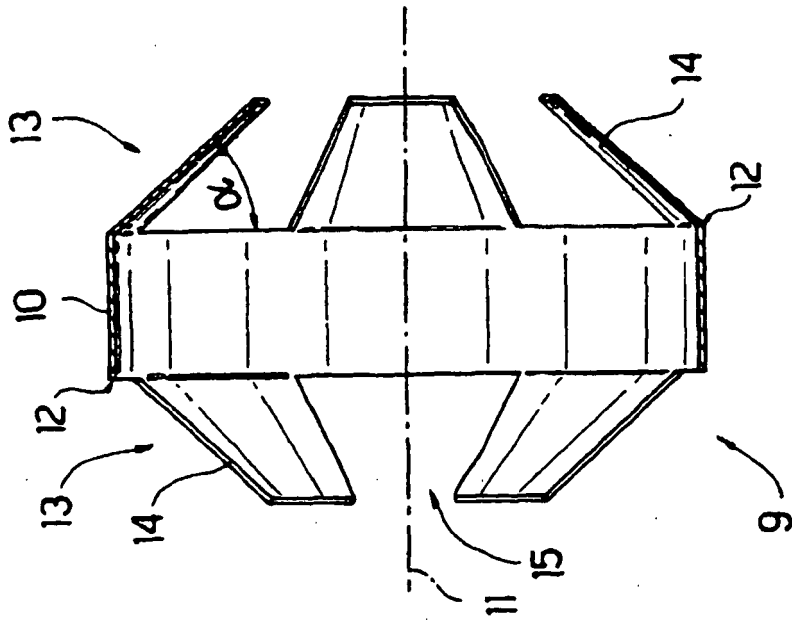


Fig.4

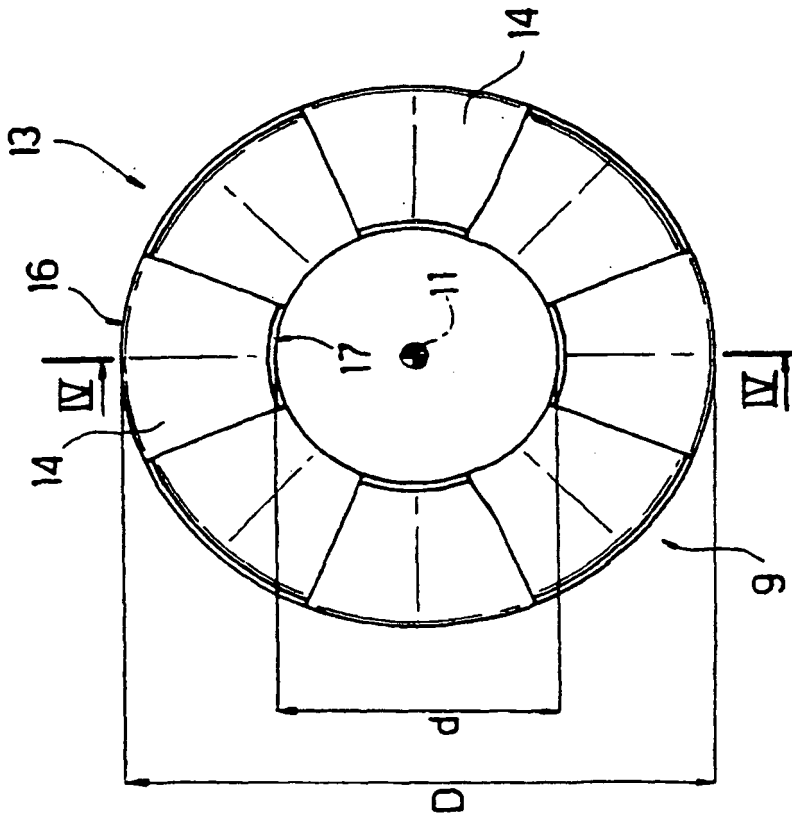


Fig.3

**REFERENCES CITED IN THE DESCRIPTION**

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