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

(11) **EP 1 867 844 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
17.02.2010 Bulletin 2010/07

(51) Int Cl.:
F01N 1/16 *(2006.01)*

(21) Application number: **06380160.9**

(22) Date of filing: **12.06.2006**

(54) **Silencer provided with exhaust gas control valve**

Schalldämpfer mit einem Abgasregelventil

Silencieux pourvue d'une vanne de régulation de gaz d'échappement

(84) Designated Contracting States:
DE ES IT

(43) Date of publication of application:
19.12.2007 Bulletin 2007/51

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EP 1 867 844 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to an exhaust gas control valve for an exhaust muffler of the semi-active type, i.e. for a muffler in which the exhaust gases output by an internal combustion engine may follow two courses of different length controlled by a valve to optimise either noise abatement, in one case, or engine efficiency, in the other case.

[0002] The valve controlling the exhaust gas flow is arranged within the muffler along one of the two courses and comprises a valve seat and a shutter, which is movable to open/close the valve seat, and therefore the course to which it is associated.

[0003] There are known solutions in which the shutter is shifted by an actuator within the muffler and controlled, for example, pneumatically or electrically. This type of valve requires non negligible room for installing the actuator outside the muffler and complex devices for ensuring gas exhaust tightness of the external wall of the muffler.

[0004] Furthermore, changes to the external wall of the muffler are required in order to install this type of valve in standard mufflers without semi-active control: such changes require heavy variations in normally used machines and dies, with consequent high costs for production conversion.

[0005] As an alternative to external actuation, there are known valves arranged completely within the muffler and having a shutter defined by a flap turning about a hinge axis under the opposite bias of the exhaust gas pressure and the elastic bias of a torsion spring.

[0006] The opening and closing of the valve seat by the turning flap occurs according to the features of the torsion spring (stiffness, pre-load, etc.) and the engine revolutions.

[0007] This type of valve has a relatively simple structure, and does not have the drawbacks of the solutions illustrated above.

[0008] However, also the latter valve type is not completely satisfactory, because it is difficult to rapidly couple the hinge of the flap in fixed and stable position and to rapidly fit the torsion spring about the hinge axis of the flap.

[0009] Therefore, it is felt a need to simplify the assembly of the valve controlling the exhaust gas flow within the muffler. In particular, it is felt a need to fit the same valve either at a hole made in a flat partition wall dividing the two chambers within the muffler or at the end of a tube putting the two chambers into communication.

[0010] EP-A2-1130226 corresponds to the preamble of claim 1 and discloses a cap-like valve body fitted on an end portion of a pipe, that provides a communication between a plurality of silencing chambers formed in a muffler main body. A compressed coil spring is mounted between a flange of the pipe and a flange of the valve body. Communication holes are formed in a cylindrical portion of the valve body. When the valve body receives the pressure of the exhaust gases and moves along the axial direction against the biasing force of the spring, the exhaust gases within the pipe flow out of the communication holes to the outside of the valve body.

[0011] DE10106589C1 discloses a valve comprising a shutter movable for opening/closing a valve seat. The shutter has a stem, axially guided by a sleeve, and a head, which moves to and from the valve seat inside a housing. The housing is provided with radial slits and is defined by the end of a pipe.

[0012] JP11013451 discloses a flow rate control valve, which adjusts the flow of exhaust gas to an expansion room. The flow rate control valve has a body urged against a stopper by a spring, which is located between such body and a bottom plate provided at the end of the pipe.

[0013] It is an object of the present invention to make an exhaust gas control valve which allows to simply and cost-effectively solve the needs presented above and, preferably, has a relatively robust structure.

[0014] According to the present invention, a semi-active exhaust muffler is made as defined in claim 1.

[0015] For a better understanding of the present invention, it will now be described a preferred embodiment only by way of non-limitative example, and with reference to the accompanying drawings, in which:

- figures 1 and 2 show, schematically and in cross section, a preferred embodiment of the semi-active exhaust muffler according to the present invention, in two different functional conditions;
- figure 3 shows a perspective and magnified view of a detail in figure 2; and
- figure 4 shows a variant of the position in which a control valve of the previous figures may be fitted in the exhaust muffler.

[0016] In figures 1 and 2, number 1 indicates an exhaust muffler forming part of an exhaust system of an internal combustion engine (not shown) and comprising an external casing 2, of the intrinsically known type and not described in detail, which defines an inlet 3 communicating, in use, with the exhaust of an engine and an outlet 4 communicating, in use, with the external environment.

[0017] The casing 2 extends along a longitudinal direction 5 and has an internal volume which is divided into a plurality of chambers 6,7,8,9 by partitions 10,11,12, which extend transversally with respect to direction 5 and are fluid-tightly coupled with the internal side surface 13 of the casing 2.

[0018] Chambers 6,7,8,9 communicate with each other via passages which define two possible courses 15,16 of the exhaust gases flowing from inlet 3 to outlet 4. In particular, chamber 7 receives the exhaust gas from inlet 3 and through tube 17 which crosses chamber 6 and the fluid-tight partition 10. Chamber 7 communicates, on one side, with chamber 6 by means of a tube 18 which fluid-

tightly crosses partition 10, and on the other side, with chamber 8 through a circular hole 19, made in the partition 11 along direction 5.

[0019] Chamber 6, in turn, communicates with chamber 8 through a tube 21 which fluid-tightly crosses partition 10, chamber 7 and partition 11, while chamber 8 communicates with outlet 4 by means of a tube 22 which fluid-tightly crosses partition 12. Chamber 9 houses a perforated portion 23 of tube 22 and a soundproofing textile material 24 arranged about portion 23.

[0020] In brief, course 15 comprises tube 17, chamber 7, tube 18, chamber 6, tube 21, chamber 8 and tube 22, to optimise noise abatement; passage 16, instead, comprises tube 17, chamber 7, hole 19, chamber 8 and tube 22, creating a lower counterpressure for gases exhausted by the internal combustion engine, thus optimising the efficiency of the engine itself.

[0021] To control the gas glow flowing in courses 15, 16, the muffler 1 comprises a valve 25, which is completely accommodated within chamber 8.

[0022] With reference to figure 3, valve 25 comprises a cup-shaped body 26 which defines a guide seat 27, which extends along a straight axis 28 parallel to direction 5 and has an axial inlet 29 for exhaust gases.

[0023] In particular, body 26 comprises a cylindrical side wall 31, which radially delimits seat 27, and a bottom wall 32, which axially delimits seat 27 from the opposite part of the inlet 29.

[0024] The side wall 31 has two through slots 35, which are diametrically opposite to each other, constitute an exhaust gas outlet from valve 25, and extend from the edge of the body 26. The slots 35 are made between two sectors or edges 36 of the wall 31, which are integrally connected, for example by welding, to a portion 38 of the partition 11, in distanced and coaxial position with respect to the edge of the hole 19.

[0025] Valve 25 then comprises a shutter 39, which is defined by a piston axially sliding in the seat 27, under the guide of the side wall 31 and under two opposite biases generated by the pressure of the exhaust gases and, respectively, by a spring 40, for opening/closing a valve seat defined by the hole 19.

[0026] In the closed position of hole 19 (figure 1), the shutter 39 is adjacent to the inlet 29 and is abuttingly and fluid-tightly arranged against portion 38; when the hole 19 is open (figure 3), the shutter 39 is distanced from the inlet 29 and lets the exhaust gases flow towards the slots 35.

[0027] In particular, the shutter 39 is cup-shaped and comprises: a circular flat wall 41 (figure 1) facing the inlet 29 and orthogonal to axis 28; and a cylindrical wall 42 which faces the bottom wall 32, is axially guided from seat 27, and covers the slots 35 when the shutter 39 is arranged in closed position. Spring 40, instead, is cylindrical helical, accommodated in seat 27, and axially and abuttingly arranged against bottom wall 32, on one side, and against the wall 41, on the other side.

[0028] In use, the wall 41 of the shutter 39 is subjected to the axial bias generated by the difference of pressure between chambers 7 and 8, on one side, and by the axial bias of spring 40, on the other side.

[0029] When the bias generated by the pressure exceeds the pre-load of the spring 40, the shutter 39 retracts in seat 27 towards the wall 32 to open the valve 25, i.e. to let the exhaust gas through towards course 16.

[0030] The pressure threshold and, consequently, the revolution speed of the engine at which the valve 25 opens essentially depends on the pre-load of the spring 40, while the degree of opening of the valve 25 increases with the speed of revolution of the engine according to the elastic constant of the spring 40 itself. In other words, at low revolutions of the engine, the gas pressure in chamber 7 is relatively low, and therefore shutter 39 remains in closed position (figure 1) and the gases follow course 15. At high engine revolutions, the exhaust gas pressure in chamber 7 exceeds the action of the spring 40 and shifts the shutter 39 towards the open position, allowing the gases to follow course 16 and, consequently, bypassing part of the internal passages of the muffler 1 to provide a lower counterpressure to the gases exhausted by the engine.

[0031] According to the variant shown in figure 4, the sectors 36 are integrally connected to the ends 45 of a tube housed in cases 2, in position coaxial to the tube itself. Similarly to that shown in figures 1 and 2, at slow engine revolutions, the gas pressure within the tube is relative low, so that the shutter 39 closes the opening defined by end 45. At high engine revolutions, the gas pressure inside the tube exceeds the bias of spring 40 and retracts the shutter 39 towards the open position, letting the gases flow from the end 45 towards the slots 35.

[0032] When the valve 25 is fitted in the muffler 1, it is sufficient to fix the sectors 36 of wall 31 to portion 38 of wall 11, to the end 45 of the tube. In other words, no additional preparatory jobs are required either on the portion 38 of wall 11 or on end 45 for welding the wall 31.

[0033] From the above, it is therefore evident how assembly operations of the valve 25 are extremely simple and fast, and therefore cost-effective, and how it is possible to install the valve 25 also in mufflers of the standard type without upsetting the normally envisaged production lines.

[0034] Furthermore, valve 25 is small in size and low in cost, since it works according to the exhaust gas pressure let into chamber 7 without needing external actuators, and is extremely versatile, as it may be fitted both to a flat internal partition and to the end 45 of a tube with no variations in tools and/or assembly steps.

[0035] Furthermore, spring 40 is fitted in an extremely rapid manner, thanks to its position in seat 27, while the structure of shutter 39 and of body 26, reciprocally sliding, is extremely robust, as concerns resistance to fatigue.

[0036] It is finally apparent that changes and variations can be made to the muffler 1 described and illustrated without departing from the scope of protection as defined

in the accompanying claims.

[0037] In particular, position, number and conformation of the slots 35 may differ from those indicated by way of example and/or valve 25 may be installed in a muffler different from that described and illustrated.

Claims

1. A semi-active exhaust muffler (1) comprising:

- an inlet (3);
- an outlet (4);
- an external casing (2) having an internal volume, which is divided into a plurality of chambers (6,7,8,9) by partitions (10,11,12); said chambers reciprocally communicating through passages defining two different courses (15,16) for exhaust gases from said inlet (3) to said outlet (4); and
- a control valve (25) associated to one of said passage for varying the exhaust gas flow rate flowing through said two courses (15,16); the control valve being completely accommodated within one of said chambers (8) and comprising:

a) elastic means (40),
b) a valve seat (19),
c) a valve outlet for said exhaust gases,
d) a movable shutter (39) for opening/closing the valve seat (19); the shutter being subjected to the axial bias generated by the difference of pressure between two chambers (7,8), on one side, and by the axial bias of the elastic means (40), on the other side;

characterised in that said control valve comprises a guide seat (27), which extends along a straight axis (28), has an axial inlet (29) for said exhaust gases, and is defined in radial direction by a side wall (31); wherein said side wall (31) has at least one slot (35), which radially crosses through said side wall (31), defines said valve outlet, axially extends from an annular wall portion (38;45) defining said valve seat (19), and is delimited in circumferential direction by a wall sector fixedly coupled to said annular wall portion (38;45); and wherein said shutter (39) axially slides in said guide seat (27) under the guide of said side wall (31) and retracts in said guide seat (27) starting from a closed position, in which it is adjacent to said axial inlet (29) and closes said valve seat (19), to let the exhaust gas flow from said axial inlet (29) through said slot (35) when the bias generated by said difference of pressure exceeds a pre-load of said elastic means (40).

2. A semi-active exhaust muffler according to claim 1, **characterised in that** said side wall (31) comprises a plurality of slots (35), which are equally and reciprocally distanced about said axis (28).

3. A semi-active exhaust muffler according to any of the preceding claims, **characterised in that** said elastic means (40) are accommodated in said guide seat (27).

4. A semi-active exhaust muffler according to claim 3, **characterised in that**, on the opposite side of said axial inlet (29), said guide seat (27) is axially delimited by a bottom wall (32); said elastic means (40) being abuttingly arranged against said bottom wall (32) and against said shutter (39).

5. A semi-active exhaust muffler according to anyone of the preceding claims, **characterised in that** said annular wall portion (38) is part of a partition (11) defining a hole (19), which puts two said chambers into reciprocal communication; said axial inlet (29) being coaxial with said hole (19); said sector (36) being integrally connected to said partition (11).

6. A semi-active exhaust muffler according to anyone of claims from to 4, **characterised in that** said annular wall portion (45) is the axial end of a tube, which puts two said chambers into reciprocal communication; said axial inlet (29) being coaxial to said tube; said sector (36) being integrally connected to said axial end (45).

Patentansprüche

1. Halbaktiver Abgasschalldämpfer (1), der Folgendes aufweist:

einen Einlass (3);
einen Auslass (4);
ein Außengehäuse (2) mit einem inneren Volumen, welches in eine Vielzahl von Kammern (6, 7, 8, 9) durch Unterteilungen (10, 11, 12) aufgeteilt ist; wobei die Kammern reziprok durch Durchlässe in Verbindung stehen, welche zwei unterschiedliche Wege (15, 16) für Abgase von dem Einlass (3) zum Auslass (4) definieren; und ein Steuerventil (25), welches mit einem der Durchlässe assoziiert ist, um die Abgasflussrate zu variieren, welche durch die zwei Wege (15, 16) fließt; wobei das Steuerventil vollständig in einer der Kammern (8) aufgenommen ist und Folgendes aufweist:

a) elastische Mittel (40),
b) einen Ventilsitz (19),
c) einen Ventilauslass für die Abgase,
d) einen bewegbaren Verschluss (39) zum Öffnen/Schließen des Ventilsitzes (19); wo-

bei der Verschluss auf der einen Seite der axialen Vorspannung unterworfen ist, die durch die Differenz des Druckes zwischen zwei Kammern (7, 8) erzeugt wird, und auf der anderen Seite durch die axiale Vorspannung der elastischen Mittel (40);

dadurch gekennzeichnet, dass das Steuerventil einen Führungssitz (27) aufweist, welcher sich entlang einer geraden Achse (28) erstreckt, einen Einlass (29) für die Abgase hat und in radialer Richtung durch eine Seitenwand (31) definiert ist; wobei die Seitenwand (31) mindestens einen Schlitz (35) hat, der radial durch die Seitenwand (31) verläuft, einen Ventilauslass definiert, sich axial von einem ringförmigen Wandteil (38; 45) erstreckt, welcher den Ventilsitz (19) definiert, und in Umfangsrichtung durch einen Wandsektor eingeschränkt ist, der fest mit dem ringförmigen Wandteil (38; 45) gekoppelt ist; und wobei der Verschluss (39) axial in dem Führungssitz (27) unter der Führung der Seitenwand (31) gleitet und sich in dem Führungssitz (27) beginnend von einer geschlossenen Position zurückzieht, in der er benachbart zum axialen Einsatz (29) ist und den Ventilsitz (19) schließt, um das Abgas aus dem axialen Einsatz (29) durch den Schlitz (35) fließen zu lassen, wenn die von der Druckdifferenz erzeugte Vorspannung eine Vorspannung der elastischen Mittel (40) übersteigt.

2. Halbaktiver Abgasdämpfer nach Anspruch 1, **dadurch gekennzeichnet, dass** die Seitenwand (31) eine Vielzahl von Schlitzen (35) aufweist, die gleich und reziprok um die Achse (28) beabstandet sind.

3. Halbaktiver Abgasdämpfer nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die elastischen Mittel (40) in dem Führungssitz (27) aufgenommen sind.

4. Halbaktiver Abgasdämpfer nach Anspruch 3, **dadurch gekennzeichnet, dass** auf der gegenüberliegenden Seite des axialen Einlasses (29) der Führungssitz (27) axial durch eine untere Wand (32) begrenzt ist; wobei die elastischen Mittel (40) im Wesentlichen anliegend an der unteren Wand (32) und an dem Verschluss (39) angeordnet sind.

5. Halbaktiver Abgasdämpfer nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der ringförmige Wandteil (38) ein Teil einer Unterteilung (11) ist, die ein Loch (19) definiert, welches zwei der Kammern in reziproke Verbindung bringt; wobei der axiale Einlass (29) koaxial mit dem Loch (19) ist; wobei der Sektor (36) integral mit der Unterteilung (11) verbunden ist.

6. Halbaktiver Abgasdämpfer nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** der ringförmige Wandteil (45) das axiale Ende eines Rohrs ist, welches zwei der Kammern in reziproke Verbindung setzt; wobei der axiale Einlass (29) koaxial mit dem Rohr ist; wobei der Sektor (36) integral mit dem axialen Ende (45) verbunden ist.

Revendications

1. Silencieux d'échappement semi-actif (1) comprenant :

une entrée (3) ;
une sortie (4) ;
un carter externe (2) ayant un volume interne, qui est divisé en une pluralité de chambres (6, 7, 8, 9) par des cloisons (10, 11, 12) ; lesdites chambres communiquant selon un mouvement de va et vient par des passages définissant deux trajectoires différentes (15, 16) pour les gaz d'échappement de ladite entrée (3) à ladite sortie (4) ; et
une soupape de régulation (25) associée à l'un desdits passages pour modifier le débit des gaz d'échappement s'écoulant par lesdites deux trajectoires (15, 16) ; la soupape de régulation étant complètement logée dans l'une desdites chambres (8) et comprenant :

a) des moyens élastiques (40),
b) un siège de soupape (19),
c) une sortie de soupape pour lesdits gaz d'échappement,
d) un obturateur mobile (39) pour ouvrir / fermer le siège de soupape (19) ; l'obturateur étant soumis à la sollicitation axiale générée par la différence de pression entre les deux chambres (7, 8), d'un côté et par la sollicitation axiale des moyens élastiques (40) de l'autre côté ;

caractérisé en ce que ladite soupape de régulation comprend un siège de guidage (27) qui s'étend le long d'un axe droit (28), a une entrée axiale (29) pour lesdits gaz d'échappement, et est défini dans la direction radiale par une paroi latérale (31) ; dans lequel ladite paroi latérale (31) a au moins une fente (35), qui traverse de manière radiale ladite paroi latérale (31), définit ladite sortie de soupape, s'étend de manière axiale à partir d'une partie de paroi annulaire (38 ; 45) définissant ledit siège de soupape (19) et est délimitée dans la direction circonférentielle par un secteur de paroi couplé de manière fixe à ladite partie de paroi annulaire (38 ; 45) ; et dans lequel ledit obturateur (39) coulisse de manière axiale dans ledit siège de guidage (27) sous le guide de ladite paroi latérale (31) et se rétracte dans ledit siè-

ge de guidage (27) en commençant par une position fermée, dans laquelle il est adjacent à ladite entrée axiale (29) et ferme ledit siège de soupape (19) pour laisser les gaz d'échappement s'écouler à partir de ladite entrée axiale (29) en passant par ladite fente (35) lorsque la sollicitation générée par ladite différence de pression dépasse une précharge desdits moyens élastiques (40).

2. Silencieux d'échappement semi-actif selon la revendication 1, **caractérisé en ce que** ladite paroi latérale (31) comprend une pluralité de fentes (35) qui sont à égale distance et distance réciproque dudit axe (28).

3. Silencieux d'échappement semi-actif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdits moyens élastiques (40) sont logés dans ledit siège de guidage (27).

4. Silencieux d'échappement semi-actif selon la revendication 3, **caractérisé en ce que**, sur le côté opposé de ladite entrée axiale (29), ledit siège de guidage (27) est délimité de manière axiale par une paroi inférieure (32) ; lesdits moyens élastiques (40) étant agencés en butée contre ladite paroi inférieure (32) et contre ledit obturateur (39).

5. Silencieux d'échappement semi-actif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ladite partie de paroi annulaire (38) fait partie d'une cloison (11) définissant un trou (19) qui met lesdites deux chambres en communication réciproque ; ladite entrée axiale (29) étant coaxiale avec ledit trou (19) ; ledit secteur (36) étant raccordé de manière solidaire à ladite cloison (11).

6. Silencieux d'échappement semi-actif selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** ladite partie de paroi annulaire (45) est l'extrémité axiale d'un tube, qui met lesdites deux chambres en communication réciproque ; ladite entrée axiale (29) étant coaxiale audit tube ; ledit secteur (36) étant raccordé de manière solidaire à ladite extrémité axiale (45).

FIG. 1

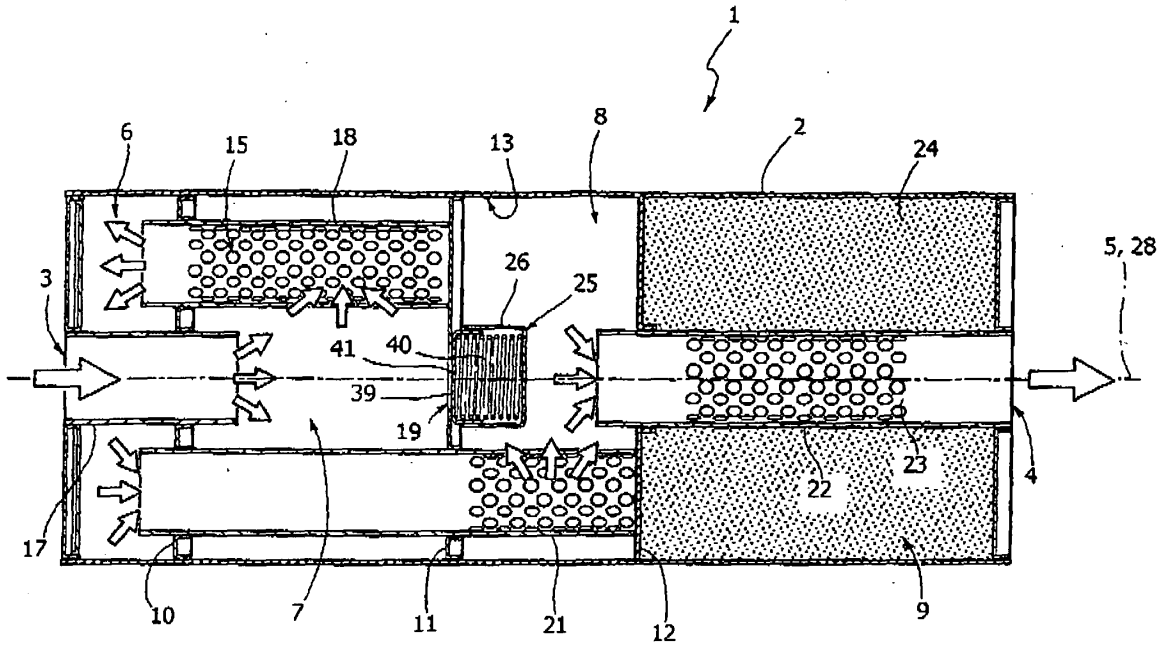
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FIG. 2

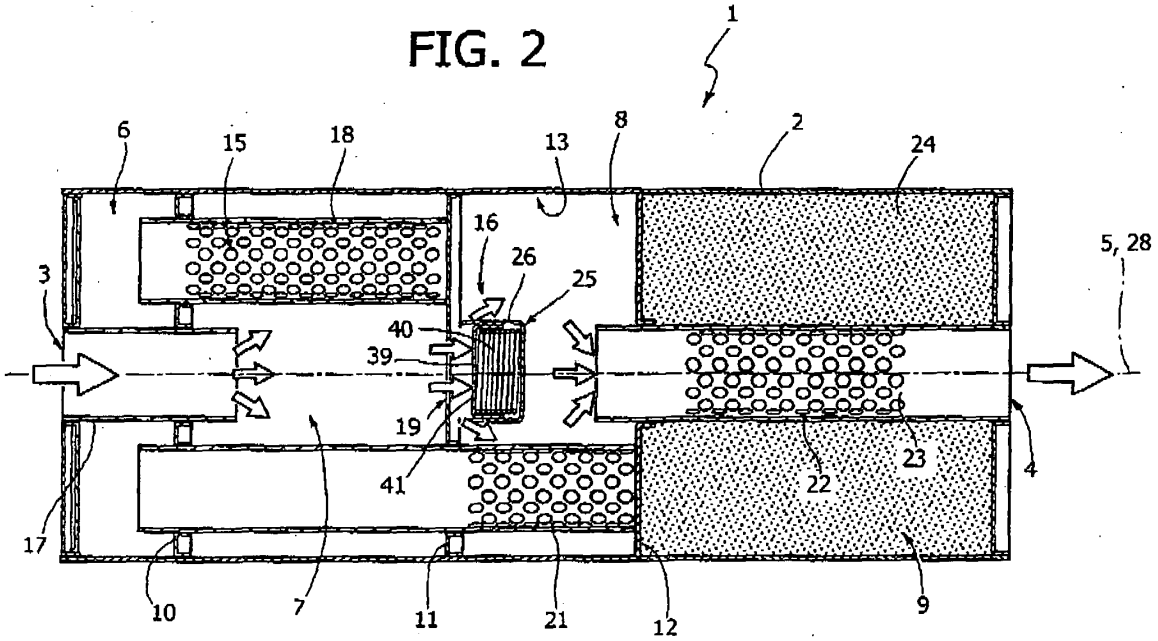
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FIG. 3

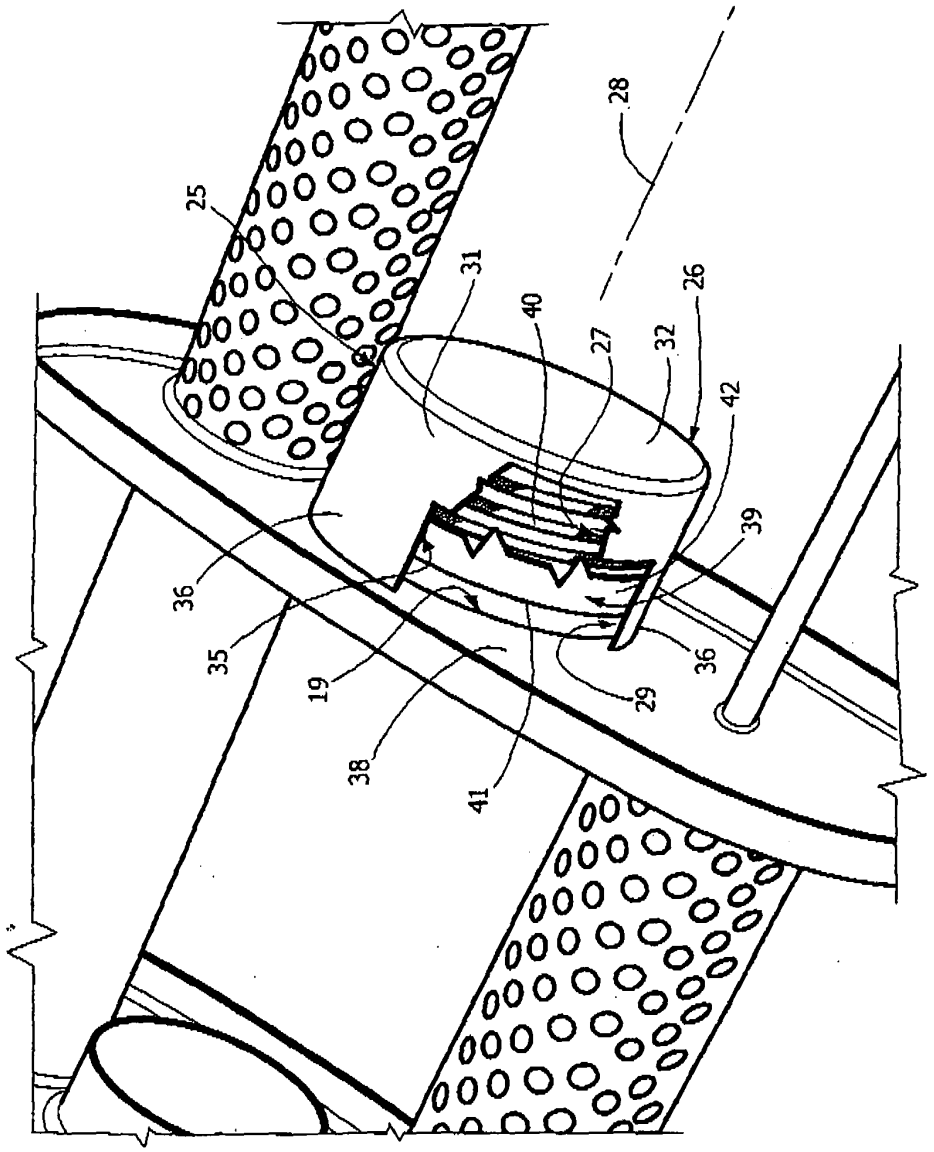
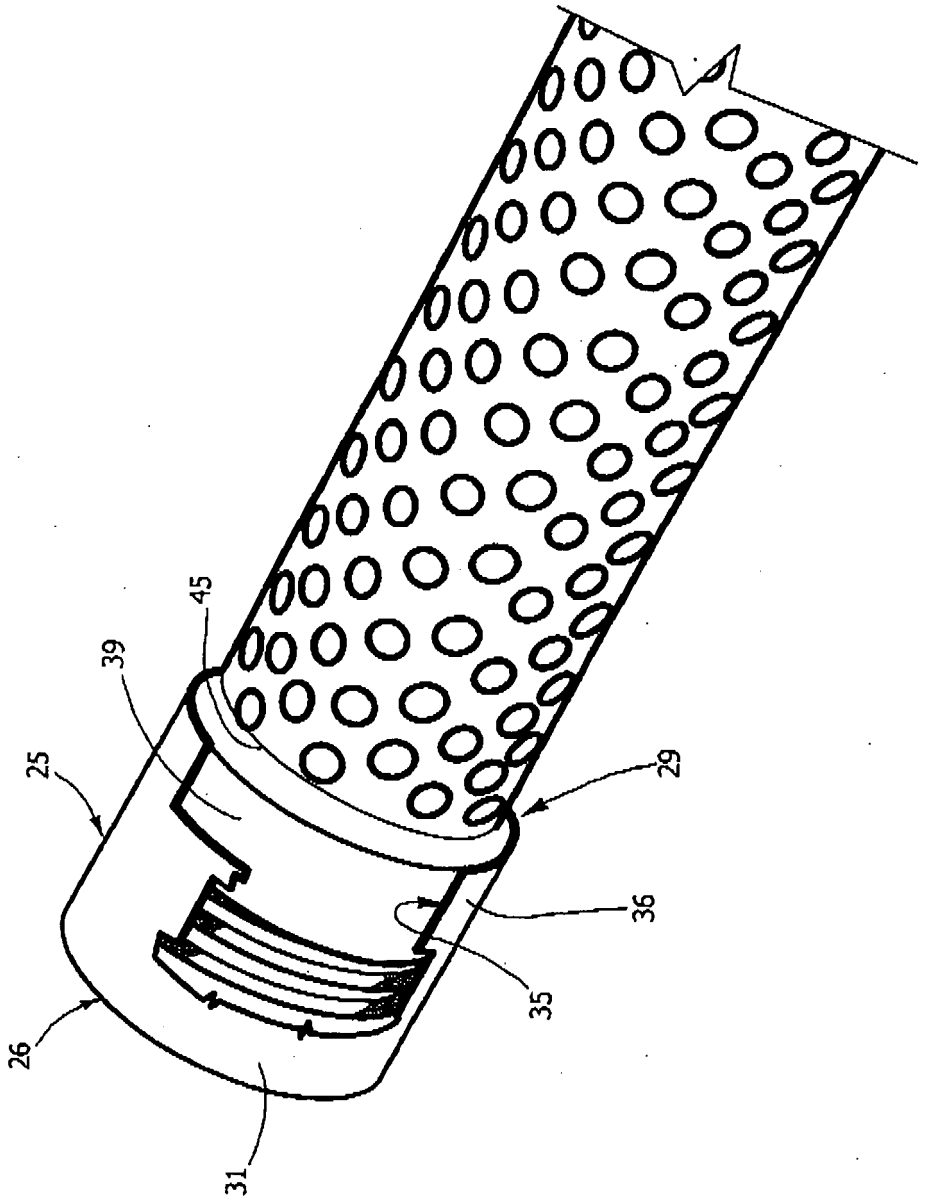


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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- JP 11013451 B **[0012]**