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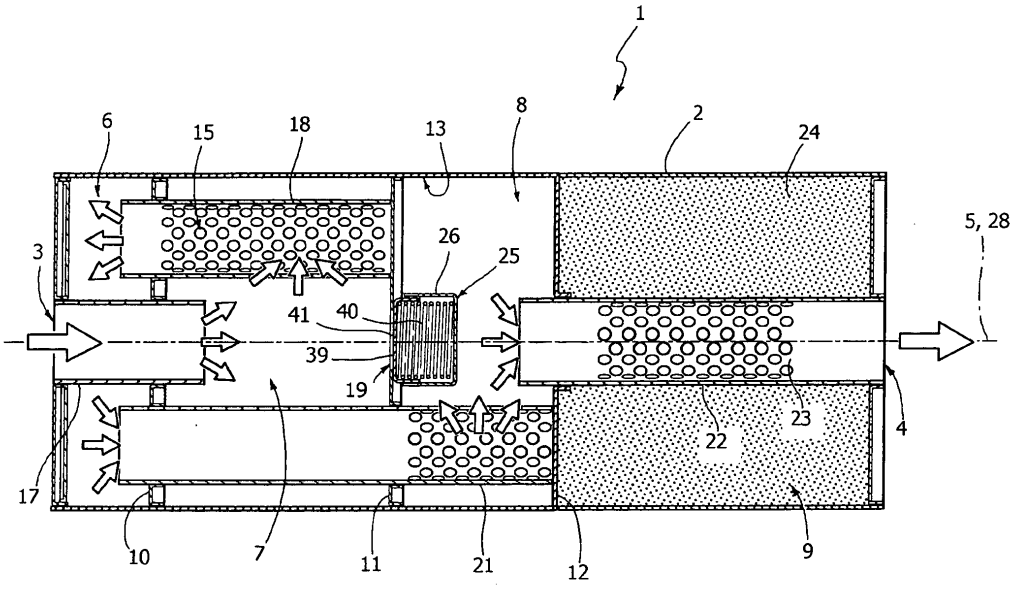
(54) **Exhaust gas control valve, and silencer provided with said control valve**

(57) An exhaust gas control valve (25) varies the exhaust gas flow rate flowing through two different courses (15,16) in an exhaust muffler of the semi-active type (1); the valve is provided with a shutter (39), which slides along a straight axis (28) in a guide seat (27) between a closed position, in which it is adjacent to an axial inlet (29) of the guide seat (27) and closes a valve seat (19), and an open position, in which it is distanced from such axial inlet (29) and leaves the valve seat (19) open; the shutter (39) is subject to the opposite actions defined by the pressure of the exhaust gases and by a spring (40) accommodated within the guide seat (27); the guide seat (27) is defined by a side wall (31) having at least one slot (35), through which the exhaust gases exit when the shutter is in open position.

FIG. 1



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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] 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.

[0011] According to the present invention, it is made an exhaust gas control valve for varying the exhaust gas flow rate flowing through two different courses of an exhaust muffler; the valve comprising elastic means, and a movable shutter for opening/closing the valve seat under the dual opposite bias generated by the pressure of said exhaust gases and by said elastic means, respectively; characterised in that it comprises a guide seat extending along a straight axis and having an axial inlet for said exhaust gases; and in that said shutter axially slides in said guide seat between a closed position, in which it is adjacent to said axial inlet and closes said valve seat, and an open position, in which it is axially distanced from said axial inlet and leaves said valve seat open.

[0012] According to the present invention, it is also made a semi-active exhaust muffler comprising:

- an inlet,
- an outlet,
- a plurality of internal chambers reciprocally separated by partitions reciprocally communicating through passages defining two different courses for exhaust gases from said inlet to said outlet, and
- a control valve associated to said passage for varying the exhaust gas flow rate flowing through said two courses; the control valve comprising:
    - o a valve seat,
    - o elastic means, and
    - o a movable shutter for opening/closing said valve seat under the dual opposite bias generated by said exhaust gases, and by said elastic means respectively;

characterised in that said control valve comprises a guide seat extending along a straight axis and having an axial inlet for said exhaust gases; and in that said shutter axially slides in said guide seat between a closed position, in which it is adjacent to said axial inlet and closes said valve seat, and an open position, in which it is axially distanced from said axially inlet and leaves said valve open.

[0013] 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 exhaust gas control valve according to the present invention, in two different functional conditions within an exhaust muffler;
- 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 the control valve of the previous figures may be fitted in an exhaust muffler.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] To control the gas glow flowing in courses 15, 16, the muffler 1 comprises a valve 25, which is completely accommodated within chamber 8.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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. An exhaust gas control valve (25) for varying the exhaust gas flow rate flowing through two different courses (15,16) in an exhaust muffler (1); the valve comprising elastic means (40), and a movable shutter (39) for opening/closing the valve seat (19) under the dual opposite bias generated by the pressure of said exhaust gases and by said elastic means (40), respectively; **characterised in that** it comprises a guide seat (27) extending along a straight axis (28) and having an axial inlet (29) for said exhaust gases; and **in that** said shutter (39) axially slides in said guide seat (27) between a closed position, in which it is adjacent to said axial inlet (29) and closes said valve seat (19), and an open position, in which it is axially distanced from said axial inlet (29) and leaves said valve seat open (19).

2. A valve according to claim 1, **characterised in that** said guide seat (27) is defined in radial direction by a side wall (31) comprising at least one slot (35) defining a passage for said exhaust gases.

3. A valve according to claim 2, **characterised in that** said slot (35) is radially crossing through said side wall (31) and defines an outlet of said exhaust gases.

4. A valve according to claim 2 or 3, **characterised in that** said slot (35) extends from an edge delimiting said axial inlet (29).

5. A valve according to any of the claims from 2 to 4, **characterised in that** said side wall (31) comprises a plurality of slots (35) equally and reciprocally distanced about said axis (28)

6. A valve according to any of the preceding claims, **characterised in that** said axial inlet (29) is defined by an edge fixedly coupled to an annular wall portion (38) defining said valve seat (19).

7. A valve according to any of the preceding claims, **characterised in that** said elastic means (40) are accommodated in said guiding seat (27).

8. A valve according to claim 7, **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).

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

   - an inlet (3),
   - an outlet (4),
   - a plurality of internal chambers (6,7,8,9) reciprocally separated by partitions (10,11,12) 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 said passage for varying the exhaust gas flow rate flowing through said two courses (15,16); the control valve comprising:

      a) a valve seat (19),
      b) elastic means (40), and
      c) a movable shutter (39) for opening/closing said valve seat (19) under the dual opposite bias generated by said exhaust gases and by said elastic means (40), respectively;

   characterised in that said control valve (25) comprises a guide seat (27) extending along a straight axis (28) and having an axial inlet (29) for said exhaust gases; and **in that** said shutter (39) axially slides in said guide seat (27) between a closed position, in which it is adjacent to said axial inlet (29) and closes said valve seat (19), and an open position, in which it is axially distanced from said axial inlet (29) and leaves said valve (19) open.

10. A muffler according to claim 9, **characterised in that** a partition (11) defines a hole (19) which puts said chambers into reciprocal communication, and **in that** said axial input (29) is coaxial with said hole (19) and is defined by an edge integrally connected to said partition (11).

11. A muffler according to claim 9, **characterised in that** it comprises a tube which puts said two chambers into reciprocal communication, and **in that** said axial inlet (29) is coaxial to said tube and is defined by an edge integrally connected to an axial end (45) of said tube.

FIG. 1

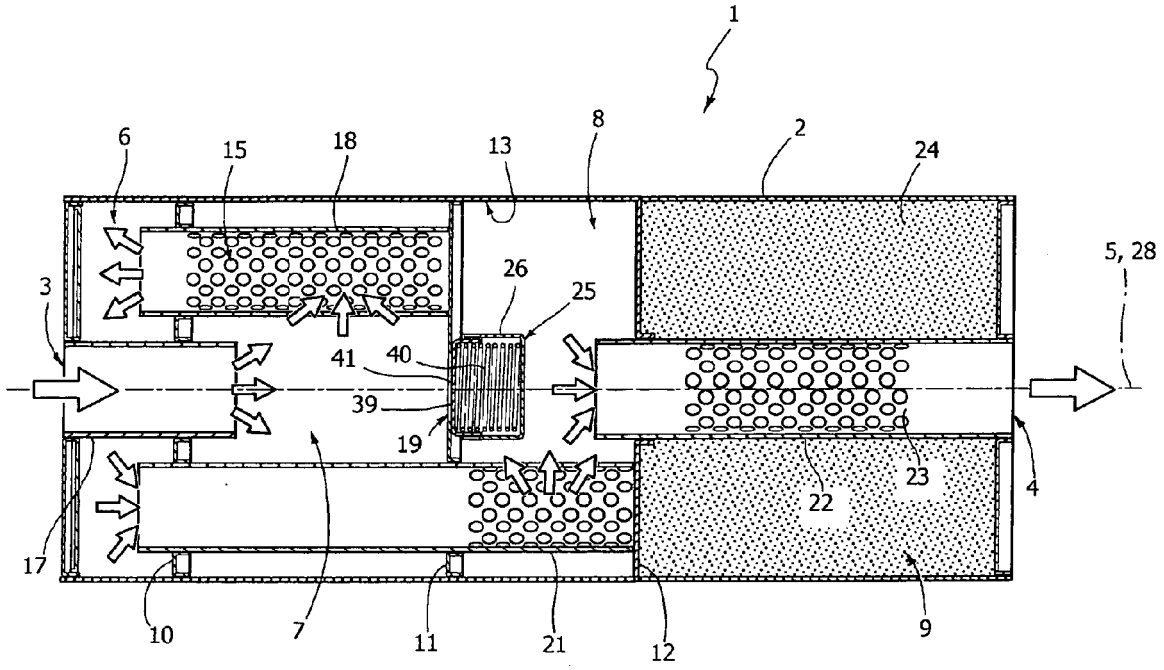
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FIG. 2

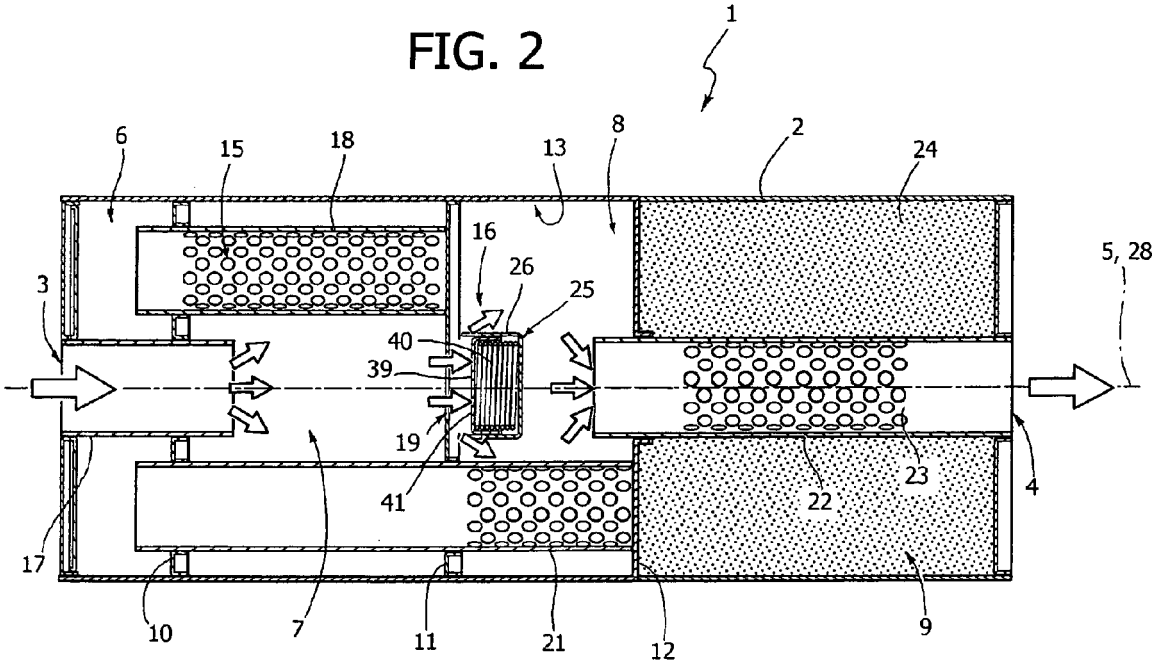
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FIG. 3

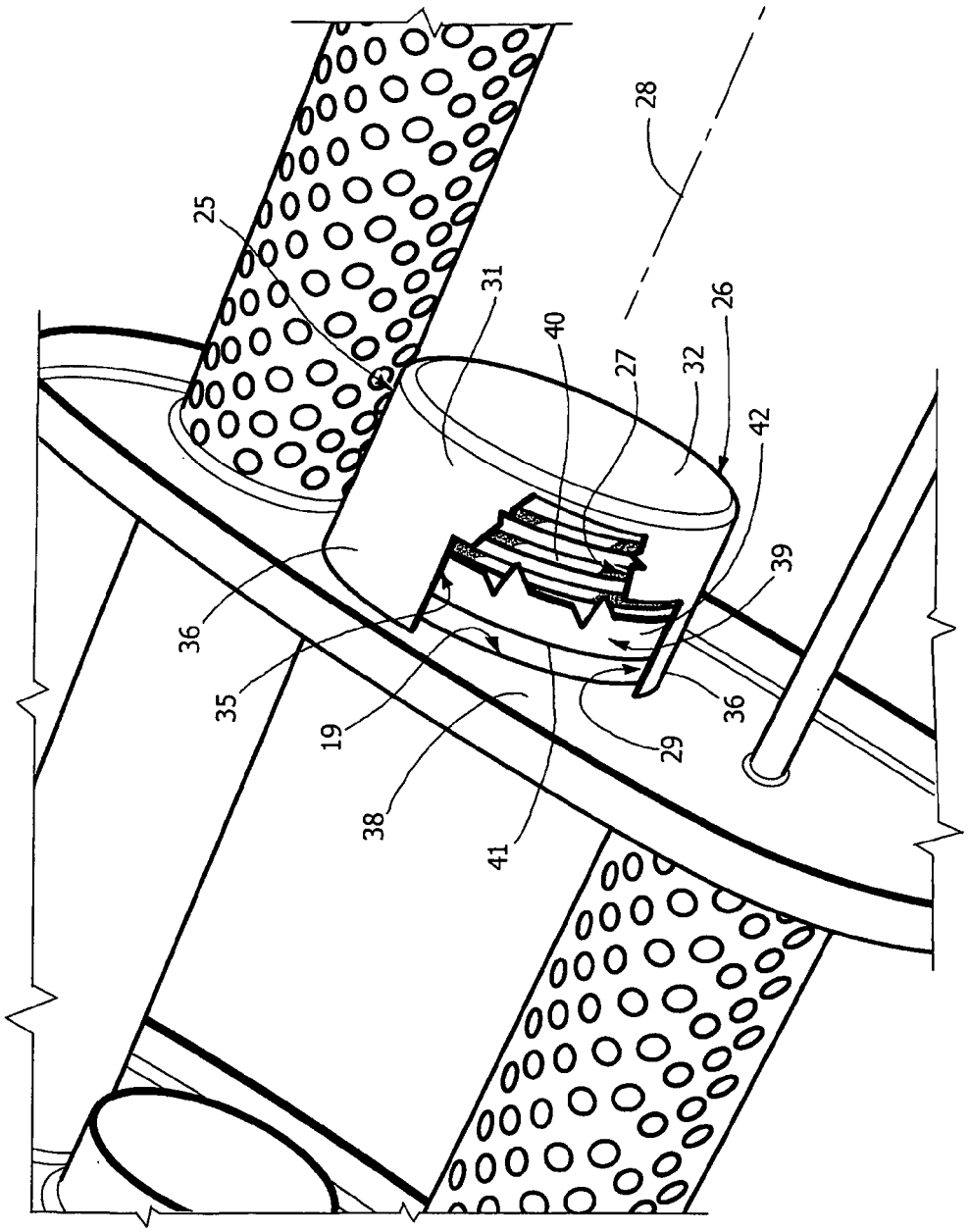
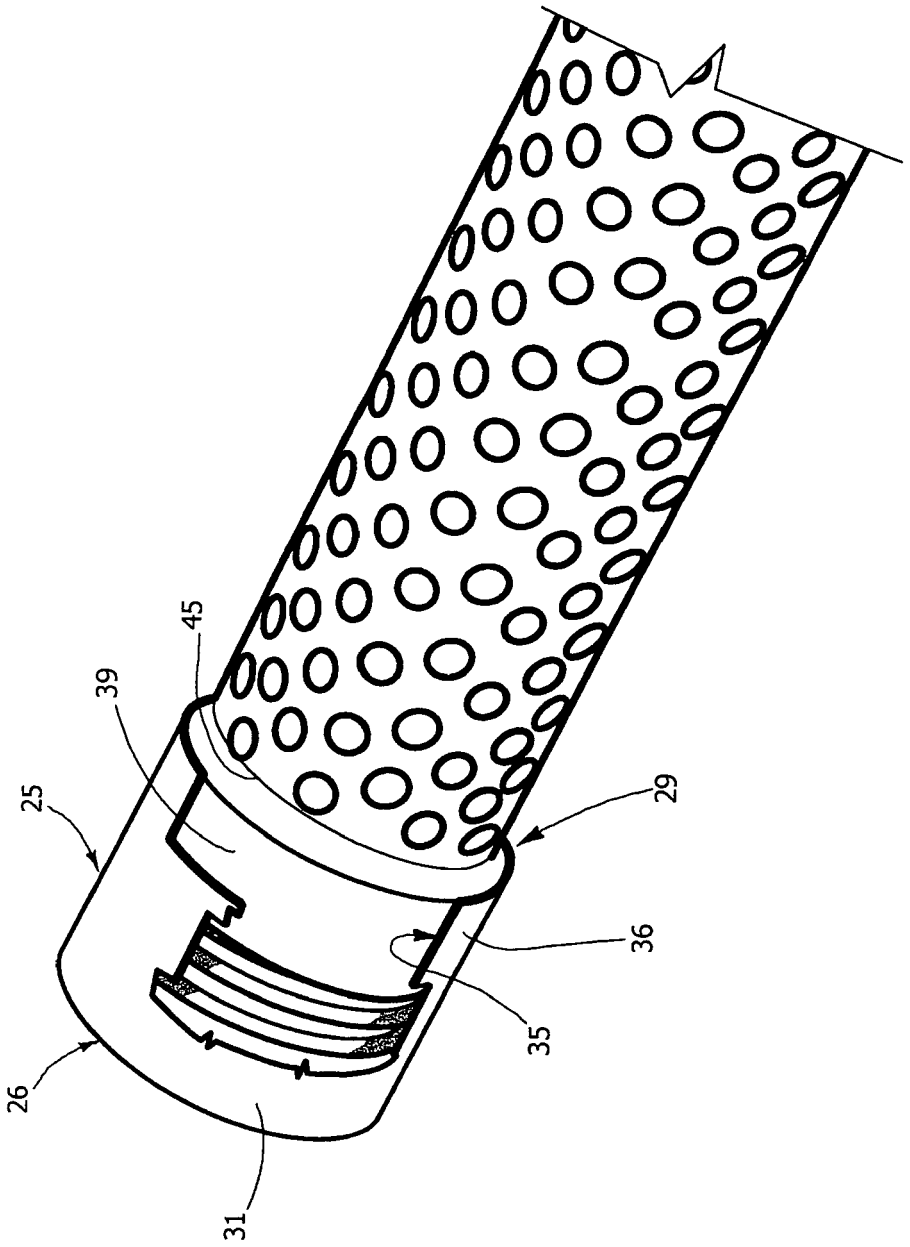


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 06 38 0160

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TECHNICAL FIELDS SEARCHED (IPC)

F01N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 November 2006	Torle, Erik

CATEGORY OF CITED DOCUMENTS

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