



(11)

EP 2 752 569 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.07.2014 Bulletin 2014/28

(51) Int Cl.:
F02D 9/10 (2006.01) **F02D 9/16** (2006.01)
F02D 9/04 (2006.01) **F02M 25/07** (2006.01)

(21) Application number: **13150306.2**

(22) Date of filing: **04.01.2013**

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

(72) Inventor: **Sieh, Jan Hendrik**
22769 Hamburg (DE)

(74) Representative: **Kramer - Barske - Schmidtchen**
Landsberger Strasse 300
80687 München (DE)

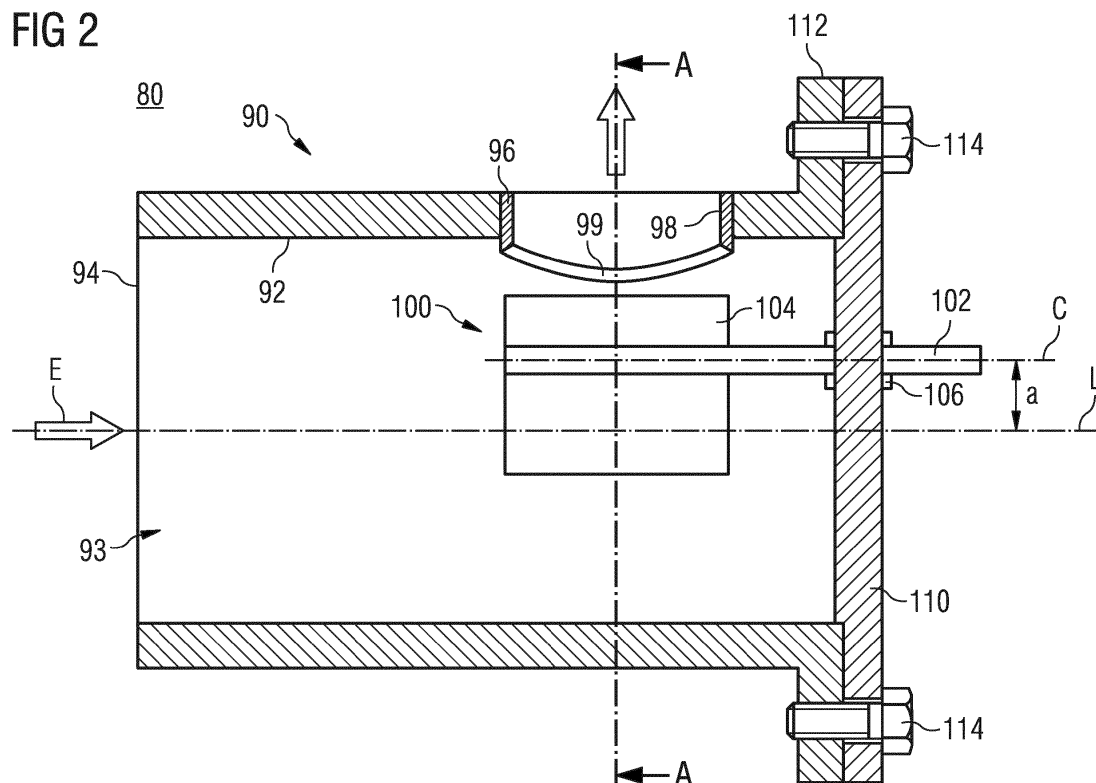
(71) Applicant: **Caterpillar Motoren GmbH & Co. KG**
24159 Kiel (DE)

(54) **Throttle valve for internal combustion engines**

(57) The present disclosure generally relates to a self-cleaning throttle valve (80) to be used in an internal combustion engine. The disclosed throttle valve (80) may comprise a valve housing (90) including a side wall (92), an inlet (94), and an outlet (96) extending through the side wall (92). The throttle valve (90) may further comprise a valve seat (98) disposed at the outlet (96) and at least partially protruding into the valve housing (96), and

a valve shut-off element (100) arranged within the valve housing (90) and being rotatable about a rotational axis (C) between a first position in which the valve shut-off element (100) is spaced apart from the valve seat (98) and a second position in which the valve shut-off element (100) engages the valve seat (98) and closes the outlet (96).

FIG 2



Description

Technical Field

[0001] The present disclosure generally refers to a throttle valve for an internal combustion engine and a method for controlling a throttle valve of an internal combustion engine. Specifically, the present disclosure relates to a self cleaning throttle valve of an internal combustion engine.

Background

[0002] Throttle valves may be employed as kind of "ON/OFF" valves, such that, for instance, a fluid flow through the throttle valve may be controlled. In an "ON" state, the fluid flow may pass the throttle valve, whereas in an "OFF" state, the fluid flow may be restricted from passing through the throttle valve. Furthermore, throttle valves may also infinitely adjust the amount of fluid passing through the throttle valve.

[0003] When being employed in an internal combustion engine, throttle valves may be used to control an exhaust gas flow. In some embodiments, throttle valves may be employed as wastegates, which may be configured to direct the exhaust gas flow around a turbine of a turbocharger of the internal combustion engine. In such case, the throttle valve is configured to control the amount of exhaust gas bypassing the turbine, and the amount of exhaust gas passing through the turbine, respectively.

[0004] Exhaust gas of, for example, large internal combustion engines may contain soot which may affect operation of, for instance, throttle valves disposed within an exhaust gas system of the internal combustion engine. Particularly, soot may accumulate within the throttle valve and, thus, may disturb proper operation of the throttle valve.

[0005] US 2011/0000209 A1 discloses a turbocharger comprising an actuator for opening and closing a wastegate duct.

[0006] US 4 492 519 A discloses a turbocharger exhaust by-pass valve for selectively by-passing exhaust gases from the turbine rotor. The by-pass arrangement includes a valve plate which by a sliding action covers and uncovers a port that is essentially the same area as the exhaust gas inlet to the turbine housing. The sliding motion has a shearing action on any exhaust deposits.

[0007] The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of prior systems.

Summary of the Disclosure

[0008] According to an aspect of the present disclosure, a throttle valve for an internal combustion engine may comprise a valve housing including a side wall, a first port, and a second port extending through the side wall. The throttle valve may further comprise a valve seat

disposed at the second port and at least partially protruding into the valve housing, and a valve shut-off element arranged within the valve housing. The valve shut-off element may be rotatable about a rotational axis between a first position in which the valve shut-off element is spaced apart from the valve seat and a second position in which the valve shut-off element seats against the valve seat and closes the second port. The first and second ports may form an inlet and an outlet of the throttle valve. The first port may be configured as the valve inlet and the second port may be configured as the valve outlet.

[0009] According to another aspect of the present disclosure, an internal combustion engine may comprise a turbine configured to be driven by exhaust gas produced by the internal combustion engine, a wastegate connection configured to direct the exhaust gas around the turbine, and a throttle valve according to the present disclosure disposed within the wastegate connection.

[0010] According to another aspect of the present disclosure, a method for removing deposits accumulated at a valve seat of a throttle valve to be used in an internal combustion engine may comprise rotating the valve shut-off element from a first position in which the valve shut-off element is spaced apart from the valve seat into a second position in which the valve shut-off element seats against the valve seat, and simultaneously removing any deposits accumulated on the valve seat by rotating the valve shut-off element from the first position into the second position.

[0011] In some embodiments, the valve shut-off element may be further configured to, when the valve shut-off element is rotated from the second position into the first position, remove any deposits accumulated at the valve seat.

[0012] According to an exemplary embodiment of a throttle valve, the valve shut-off element may include a valve body having an outer engaging surface configured to open and close the second port by engaging and disengaging the valve seat. The valve seat may be arcuate with a center of curvature and the outer engaging surface of the valve body may be arcuate. The curvature of the outer engaging surface may correspond to the curvature of the valve seat. The rotational axis of the valve shut-off element and the center of curvature of the valve seat are offset.

[0013] In some embodiments, the valve shut-off element may be eccentrically arranged within the valve housing. In such embodiments, the valve shut-off element may be rotatable about a rotational axis arranged parallel to a center axis of the valve housing, but spaced by a first offset. In some other embodiments, the rotational axis may be further arranged parallel to the center axis of the valve housing, but spaced by a second offset perpendicular to the first offset.

[0014] In some embodiments, the valve shut-off element may include a shaft and a valve body supported by the shaft, wherein the valve body may be configured to

open and close the outlet by engaging and disengaging the valve seat.

[0015] In some embodiments, the disclosed method may further comprise rotating the valve shut-off element from the second position into the first position, and simultaneously removing any deposits accumulated on the valve seat by rotating the valve shut-off element from the second position into the first position.

[0016] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0017]

Fig. 1 shows a schematic diagram of an internal combustion engine comprising an exemplary disclosed throttle valve;

Fig. 2 shows a longitudinal section of an exemplary disclosed throttle valve;

Fig. 3 shows a schematic perspective view of the throttle valve of Fig. 2; and

Fig. 4 shows a cross-section of the throttle valve of Fig. 2 taken along line A - A of Fig. 2.

Detailed Description

[0018] The following is a detailed description of exemplary embodiments of the present disclosure. The exemplary embodiments described therein and illustrated in the drawings are intended to teach the principles of the present disclosure, enabling those of ordinary skill in the art to implement and use the present disclosure in many different environments and for many different applications. Therefore, the exemplary embodiments are not intended to be, and should not be considered as, a limiting description of the scope of patent protection. Rather, the scope of patent protection shall be defined by the appended claims.

[0019] The present disclosure may be based in part on a combination of closing the passage of exhaust gas through the throttle valve and simultaneously removing at least partly any deposits accumulated at the valve seat. This may ensure proper operation of the throttle valve.

[0020] The present disclosure may be further based in part on the principle of rotating the valve shut-off element at regular periods of time, for example after a predetermined period of time. Consequently, the valve shut-off element may remove at least a part of any deposits accumulated at the valve seat within the predetermined period of time. Hence, a proper operation of the throttle valve may be maintained. The valve shut-off element may also be prevented from getting stuck within the valve housing during a stationary operation of the internal combustion engine. As a result, the lifetime of the throttle valve may be enhanced.

[0021] Referring now to the drawings, an internal com-

bustion engine 10 is illustrated in Fig. 1. The internal combustion engine 10 may include features not shown, such as fuel systems, air systems, cooling systems, peripherals, drive train components, control systems etc. For the purposes of the present disclosure, the internal combustion engine 10 is an internal combustion engine running on liquid fuel, such as diesel fuel or heavy fuel oil. One skilled in the art will recognize, however, that the internal combustion engine 10 may be any type of engine (turbine, gas, natural gas, propane, dual fuel, etc.) that utilizes a mixture of fuel and air for combustion. Further, in some types of combustion engines, the mixture of fuel and air may be supplied to the combustion engine via an intake manifold. In other types of combustion engines, only air may be supplied to the combustion engine via the intake manifold, and fuel may be separately injected into each cylinder prior to combustion.

[0022] The internal combustion engine 10 may be of any size, with any number of cylinders and in any configuration ("V", "in-line", etc.). The internal combustion engine 10 may be used to power any machine or other device, including locomotive applications, on-highway trucks or vehicles, off-highway machines, earth-moving equipment, generators, aerospace applications, marine applications, pumps, stationary equipment such as power plants, or other engine-powered applications.

[0023] Still referring to Fig. 1, the internal combustion engine 10 comprises an engine block 20 including a bank of cylinders 26A to 26D, at least one fuel tank (not shown), a turbocharger 40 associated with the cylinders 26A to 26D, and an intake assembly 12.

[0024] The engine block 20 includes a crankcase (not shown) within which a crankshaft 6 indicated by a dot-dashed line is supported. The crankshaft 6 is connected to pistons (not shown) that are movable within each of the cylinders 26A to 26D during operation of the internal combustion engine 10.

[0025] The intake assembly 12 comprises an intake manifold 22 and a plurality of intake ports 24A to 24D. The intake manifold 22 defines a flow direction of charge air in the intake manifold 22 (shown by an arrow in Fig. 1) and is fluidly connected to each of the cylinders 26A to 26D via a corresponding one of the inlet ports 24A to 24D of the cylinders 26A to 26D. The inlet ports 24A to 24D are configured to receive charge air from the intake manifold 22. Generally, the inlet ports 24A to 24D may be formed at least in part in respective cylinder heads or in a common cylinder head (not shown) of the cylinders 26A to 26D.

[0026] An exhaust manifold 28 is connected to each of the cylinders 26A to 26D. Each of the cylinders 26A to 26D is provided with at least one exhaust valve (not shown) configured to open and close a fluid connection between the combustion chamber of the corresponding cylinder and the exhaust manifold 28.

[0027] The turbocharger 40 is configured to use the heat and pressure of the exhaust gas of the internal combustion engine 10 to drive a compressor 44 for compress-

ing the charge air prior to being supplied to the cylinders 26A to 26D. Specifically, exhaust gas passing a turbine 42 of the turbocharger 40 rotates the turbine 42, thereby decreasing in pressure and temperature. The compressor 44 is rotatably connected to the turbine 42 via a common shaft 46 and driven by the turbine 42.

[0028] Charge air may be supplied to the compressor 42 via an air intake 14 fluidly connected to an air system (not shown). The compressor 42 may compress the charge air to 7 to 8 bar at 180°C and a cooler 23 may cool the charge air from about 180°C to 45°C. After combustion, the exhaust gas may have a pressure of about 5 to 6 bar at a temperature in the range from about 450°C to 500°C.

[0029] Generally, an outlet of the compressor 44 is fluidly connected to an inlet of the intake manifold 22 via a compressor connection 21. As shown in Fig. 1, an outlet of the compressor 44 is connected to the inlet of the intake manifold 22 via the cooler 23. A throttle valve 27 arranged downstream of the cooler 23 is configured to open or close the fluid connection between the compressor connection 21 and intake manifold 22, thereby enabling or restricting the flow of charge air from the compressor connection 21 into the intake manifold 22.

[0030] During operation of the internal combustion engine 10, charge air is accordingly compressed and cooled before charging of the cylinders 26A to 26D. Within the cylinders 26A to 26D, further compression and, therefore, heating of the charge air is caused through the movement of the pistons. Then, an appropriate amount of fuel, e.g. diesel oil, marine diesel oil, heavy fuel oil or a mixture thereof is injected into the cylinders 26A to 26D. Therein, the fuel is combusted with the compressed charged air and produce exhaust gases, which is discharged via the exhaust manifold 28.

[0031] An outlet of the exhaust manifold 28 is fluidly connected to an inlet of the turbine 42. An outlet of the turbine 42 is fluidly connected to, for example, an exhaust gas treatment system (not shown) configured to treat the exhaust gas.

[0032] As further shown in Fig. 1, the internal combustion engine 10 may be provided with a wastegate system including a throttle valve 80 (also called wastegate valve) fluidly connected to the exhaust manifold 28, and a wastegate connection 82 bypassing the turbine 42.

[0033] By controlling the throttle valve 80, the amount of exhaust gas passing the turbine 42 is controlled, which in turn controls the compression of charge air performed by the compressor 44.

[0034] Referring now to Fig. 2, the throttle valve 80 is illustrated in greater detail. Particularly, a longitudinal section of the throttle valve 80 is shown. The throttle valve 80 comprises a valve housing 90 and a valve shut-off element 100 rotatably disposed within the valve housing 90. In some embodiments, the valve housing 90 may be an exhaust gas pipe into which the valve shut-off element 100 may be inserted.

[0035] The valve housing 90 includes a side wall 92

being at least partially circumferential. The side wall 92 defines an exhaust gas passage 93 for directing exhaust gas through the valve housing 90. In the embodiment shown in Fig. 2, the side wall 92 comprises a circular cross-section.

[0036] The valve housing 90 further comprises an inlet 94 disposed at a first end of the valve housing 90. The inlet 94 is configured to receive exhaust gas from the exhaust manifold 28. A flow direction of the exhaust gas is indicated by an arrow E being substantially parallel to a center axis L of the valve housing 90.

[0037] The valve housing 90 comprises an outlet 96 which may be disposed at the side wall 92. The outlet 96 may be provided in the form of an opening extending through the side wall 92. It should be understood that the outlet 96 is configured to connect the first exhaust gas passage 93 with the outside of the throttle valve 80.

[0038] The valve shut-off element 100 is eccentrically disposed within the valve housing 90. Particularly, the valve shut-off element 100 is rotatable about a rotational axis C. The rotational axis C is arranged in parallel to the center axis L, but spaced by a first offset a.

[0039] The valve shut-off element 100 may include a shaft 102 and a valve body 104 attached to the shaft 102.

The shaft 102 may be supported by a bearing 106, for example, a friction bearing. The bearing 106 may be disposed within a cover 110 and configured to allow rotation of the valve shut-off element 100 relative to the valve housing 90. In some embodiments, the bearing 106 may be a roller bearing known in the art.

[0040] The cover 110 may be sealingly mounted to the housing via a flange 112. For example, screws 114 may be used for fixing the cover 110 to the valve housing 90. The cover 110 may be configured to support the bearing 106, such that a sealing between the exhaust gas passage 93 and the outside of the housing 90 is created.

[0041] One skilled in the art may recognize that the bearing 106 may also be disposed within the valve housing 90. In such embodiment, the cover 110 may, for instance, be integrally formed with the valve housing 90.

[0042] For rotating the valve shut-off element 100, a distal end of the shaft 102 may be actuated from the outside of the throttle valve 80 by an actuation means (not shown).

[0043] The throttle valve 80 further includes a valve seat 98. The valve seat 98 according to Fig. 2 is constituted by a cylindrical pipe. The valve seat 98 may be inserted into the outlet 96 and fixed to the valve housing 90 by, for example, pressure-fit. In some embodiments, the valve seat 98 may be attached to the opening by, for instance, welding, soldering, adhering, or any other suitable means for fixedly attaching the valve seat 98 to the valve housing 90, specifically to the outlet 96. In some other embodiments, the valve seat 98 may be integrally formed with the valve housing 90.

[0044] In some embodiments, the valve seat 98 may be constituted by any other means suitable for protruding into the exhaust gas passage 93 for providing a seat for

the valve body 104 to ensure that the outlet 96 can be completely closed. For example, the valve seat 98 may be a pipe inwardly attached to the circumferential wall 92 around the outlet 96.

[0045] The valve seat 98 may include an internal end face 99 protruding into the exhaust gas passage 93 and configured to correspond substantially to the outer shape of the valve body 104 (see also, for example, Fig. 4). As illustrated in Fig. 1, the internal end face 99 may be achieved by cutting, forming or otherwise providing an arcuate profile at the inner wall of a pipe (see Fig. 4).

[0046] The valve shut-off element 100 of Fig. 2 is in a first position in which the valve body 104 is spaced from the valve seat 98. In the first position of the valve shut-off element, exhaust gas is allowed to pass through the outlet 96. The valve shut-off element 100 is further configured to be rotated into a second position in which the valve body 104 sealingly seats against the valve seat 98. In the second position, exhaust gas is restricted from passing through the outlet 96.

[0047] When the valve shut-off element 100 is rotated within the valve housing 90 from the second position into the first position, such that the valve body 104 disengages the valve seat 98, the exhaust gas within the exhaust gas passage 93 is allowed to pass through the outlet 96 of the throttle valve 80, thereby bypassing the turbine 42 of Fig. 1 through the wastegate connection 82. The operational state in which the valve body 104 at least partially disengages the valve seat 98 may be also referred to as "ON state" of the throttle valve 80.

[0048] When the valve shut-off element 100 is rotated towards its first position such that the valve body 104 fully engages the valve seat 98, the exhaust gas within the exhaust gas passage 93 is restricted from passing through the outlet 96 and, therefore, passes through the turbine 42 and drives the same. The operational state in which the valve body 104 fully engages the valve seat 98 may be also referred to as "OFF state" of the throttle valve 80. In the OFF state, the valve body 104 may sealingly engage the valve seat 98, thereby completely restricting the exhaust gas to pass through the outlet 96.

[0049] In some operations, soot contained within the exhaust gas may accumulate at the protruding internal end face 99 of the valve seat 98. In some other operations, for example, during the OFF state of the throttle valve 80, the soot may accumulate at the interface of the valve body 104 engaging the valve seat 98. Such accumulated soot may cause the valve body 104 to get stuck at the valve seat 98 and, thus, may disturb proper operation of the throttle valve 80.

[0050] Referring to Fig. 3, a perspective view of the throttle valve 80 is shown. As illustrated, the valve shut-off element 100 is eccentrically disposed within the valve housing 90, and the valve seat 98 is inserted into the outlet 96. For rotating the valve shut-off element, the shaft 102 may be actuated from the end side extending out of the valve housing 90 and through the cover 110. It should be noted that Fig. 3 does not depict some of the elements

shown in Fig. 2. For example, the bearing 98 and the screws 114 are not illustrated in Fig. 3.

[0051] Referring now to Fig. 4, a cross-sectional view of the throttle valve 80 taken along a line A - A of Fig. 2 is shown. As depicted in Fig. 4, the rotational axis C of the valve shut-off element 100 is arranged within the valve housing 90 and has the first offset a with respect to the center axis L. The rotational axis C of the valve shut-off element 100 includes a second offset b with respect to the center axis L of the valve housing 90.

[0052] The valve body 104 has an abutment face for engaging the valve seat and which may be arcuate. In some embodiments, the valve body 104 may comprise at least a part of a cylinder. The valve body 104 includes an engaging surface 105 configured to engage the protruding internal end face 99 of the valve seat 98. For fully closing the outlet 96, the engaging surface 105 of the valve body 104 includes at least the same shape as the protruding internal end face 99 of the valve seat 98. The engaging surface and the valve seat may both be arcuate and may both have substantially the same radius of curvature.

[0053] In the embodiment shown in Figs. 3 and 4, the valve body 104 is a solid body. However, in some embodiments, the valve body 104 may be a hollow body.

Industrial Applicability

[0054] In the following, operation of the throttle valve 80 during operation of the internal combustion engine 10 is described with reference to Figs. 1 to 4.

[0055] After combustion of the fuel/air mixture within the cylinders 24A to 24D, the exhaust gas may be released into the exhaust manifold 28. An engine control unit (not shown) may be configured to control the rotational movement of the valve shut-off element 100 and, therefore, the amount of exhaust gas passing through or bypassing the turbine 42.

[0056] Particularly, when the exhaust gas shall be restricted to pass through the turbine 42, the valve shut-off element 100 is rotated into the ON state, such that the valve body 104 disengages the valve seat 98. It is noted that it may be possible infinitely to adjust the amount of exhaust gas passing through the throttle valve 80 by only partially disengaging the valve body 104 with the valve seat 98.

[0057] For example, when rotating the valve shut-off element 100 in a counter-clockwise direction in Fig. 4, i.e. from the first position into the second position, such that the throttle valve 80 is in the OFF state and the outlet 96 is closed, the engaging surface 105 may remove any deposits accumulated at the protruding internal end face 99 of the valve seat 98 due to the first and second offsets a, b. In a subsequent opening process, the detached deposits may be blown-off by the exhaust gas passing through the throttle valve 80.

[0058] For instance, when rotating the valve shut-off element 100 engaging the valve seat 98 in a clockwise

direction in Fig. 4, i.e. from the second position into the first position, such that the throttle valve 80 is in the ON state and the outlet 96 is opened, the engaging surface 105 also removes any deposits accumulated at the interface of the protruding internal end face 99 of the valve seat 98 and the engaging surface 105 of the valve body 104 due to the first and second offsets a, b.

[0059] Therefore, when the valve shut-off element 100 engages or disengages the valve seat 98, any accumulated deposits may be removed from the valve body 104 and/or the valve seat 98.

[0060] In the case that the internal combustion engine 10 is operated in a stationary operation mode, such that the valve shut-off element 100 may not be rotated for a longer period of time, it is proposed to at least partially rotate the valve shut-off element 100 to clean the valve seat 98 and/or the valve body 104. For example, after an operation time of, for example, about four hours in a stationary operation without any actuation of the valve shut-off element 100, the valve shut-off element 100 may be rotated for cleaning the throttle valve 80. Specifically, when the throttle valve 80 is in the ON state, the valve shut-off element 100 may be rotated from the first position into the second position for a short period of time for removing any deposits accumulated at the valve seat 98.

[0061] Similarly, when the throttle valve 80 is in the OFF state, the valve shut-off element 100 may be rotated from the second position into the first position for a short period of time for also removing any deposits accumulated at the valve seat 98 and the valve body 104. This may ensure proper operation of the throttle valve 80 and may prevent the valve shut-off element 100 from getting stuck in, for instance, the OFF state or the ON state. The self-cleaning throttle valve 80 is, therefore, able to enhance its lifetime.

[0062] The disclosed throttle valve 80 may be used at internal combustion engines or dual fuel internal combustion engines of middle to large size. In particular, the internal combustion engine 10 may be sized and configured to be used e.g. in vessels, larger ships, or in power plants. The disclosed throttle valve 80 may be effective in any applications where exhaust gases are produced, which contain any pollution including soot, such as heavy fuel oil applications.

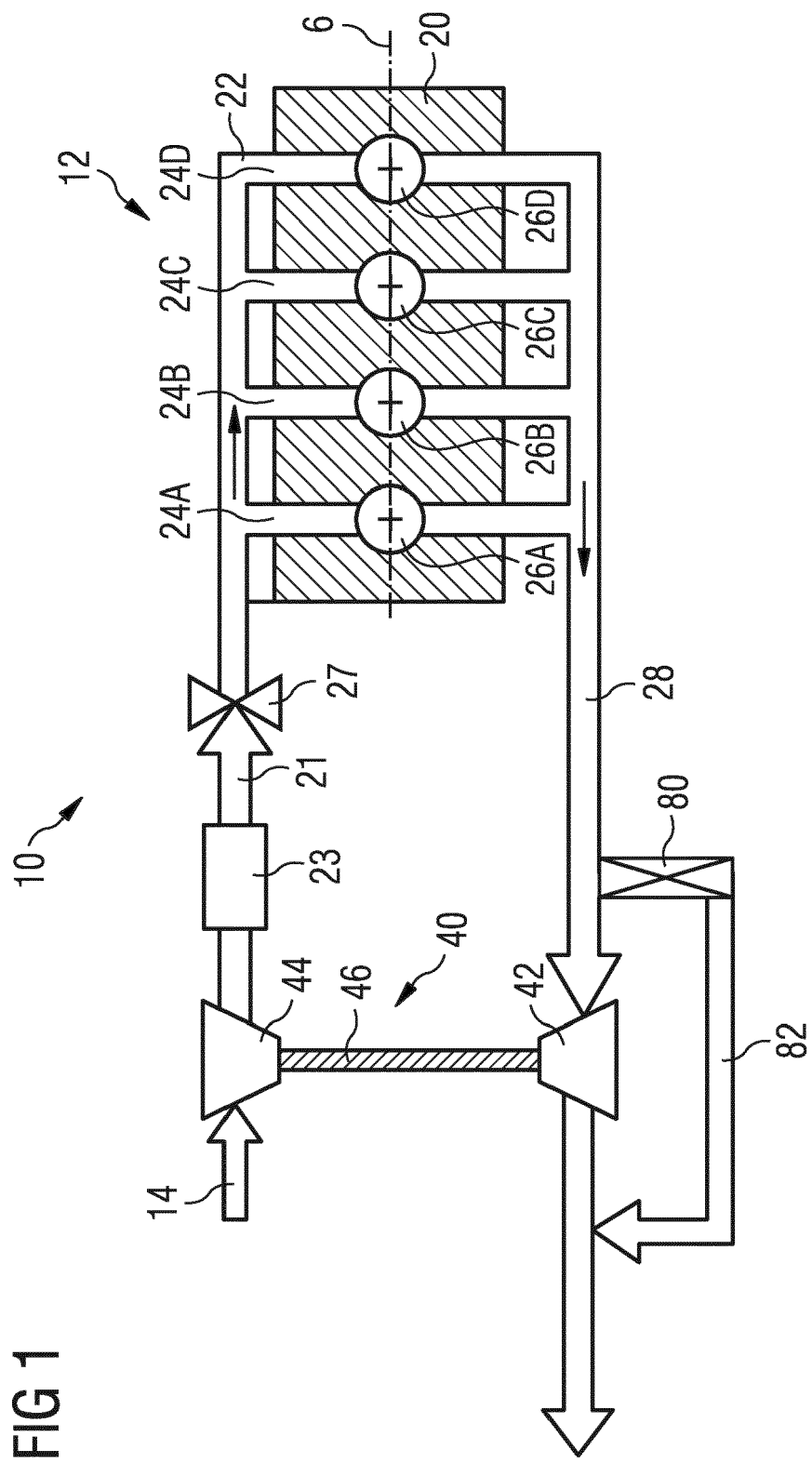
[0063] In addition, the term "internal combustion engine" as used herein is not specifically restricted and comprises any engine, in which the combustion of a fuel occurs with an oxidizer to produce high temperature and pressure gases, which are directly applied to a movable component of the engine, such as pistons or turbine blades, and move it over a distance thereby generating mechanical energy. Thus, as used herein, the term "internal combustion engine" comprises piston engines and turbines.

[0064] Although the preferred embodiments of this invention have been described herein, improvements and modifications may be incorporated without departing from the scope of the following claims.

Claims

1. A throttle valve (80) for an internal combustion engine (10), comprising:
 - a valve housing (90) including a side wall (92), a first port (94), and a second port (96) extending through the side wall (92);
 - a valve seat (98) disposed at the second port (96) and at least partially protruding into the valve housing (90); and
 - a valve shut-off element (100) arranged within the valve housing (90) and being rotatable about a rotational axis (C) between a first position in which the valve shut-off element (100) is spaced apart from the valve seat (98) and a second position in which the valve shut-off element (100) engages the valve seat (98) and closes the second port (96).
2. The throttle valve (80) of claim 1, wherein the valve shut-off element (100) includes a valve body (104) having an outer engaging surface (105) configured to open and close the second port (96) by engaging and disengaging the valve seat (98).
3. The throttle valve (80) of claim 2, wherein:
 - the valve seat (98) is arcuate with a center of curvature;
 - the outer engaging surface (105) of the valve body (104) is arcuate, wherein the curvature of the outer engaging surface (105) corresponds to the curvature of the valve seat (98);
 - the rotational axis (C) of the valve shut-off element (100) and the center of curvature of the valve seat (98) being offset.
4. The throttle valve (80) of any one of the preceding claims, wherein the valve shut-off element (100) is eccentrically arranged with respect to a center axis (L) of the valve housing (90).
5. The throttle valve (80) of claim 4, wherein the rotational axis (C) of the valve shut-off element (100) is arranged in parallel to the center axis (L) of the valve housing (90), but spaced by a first offset (a).
6. The throttle valve (80) of claim 5, wherein the rotational axis (C) of the valve shut-off element (100) is arranged in parallel to the center axis (L) of the valve housing (90), but spaced by a second offset (b) perpendicular to the first offset (a).
7. The throttle valve (80) of any one of claims 2 to 6, wherein the valve shut-off element (100) includes a shaft (102), the valve body (104) being supported by the shaft (102).

8. The throttle valve (80) of any one of claims 2 to 7, wherein the valve body (104) has at least a partially cylindrical shape.
9. The throttle valve (80) of claim 7, further comprising a bearing (106) configured to support the shaft (102) thereby enabling a rotational movement of the valve body (104) within the valve housing (90). 5
10. The throttle valve (80) of any one of the preceding claims, further comprising a cover (110) configured to be mounted to the valve housing (90), thereby closing the valve housing (90) at an end opposite to the first port (94), wherein the cover (110) is further configured to support the bearing (106). 10 15
11. The throttle valve (80) of any one of the preceding claims, wherein the valve seat (98) is a pipe inserted into the outlet (96). 20
12. The throttle valve (80) of any one of the preceding claims, wherein the valve shut-off element (100) is configured to, when the valve shut-off element (100) is rotated from the first position into the second position, remove any deposits accumulated at the valve seat (98) and, when the valve shut-off element (100) is rotated from the second position into the first position, remove any deposits accumulated at the valve seat (98). 25 30
13. An internal combustion engine (10) comprising:
- a turbine (42) configured to be driven by exhaust gas produced by the internal combustion engine (10); 35
 - a wastegate connection (82) configured to direct the exhaust gas around the turbine (42); and
 - a throttle valve (80) of any one of the preceding claims disposed within the wastegate connection (82). 40
14. A method for removing deposits accumulated at a valve seat (98) of a throttle valve (80) to be used in an internal combustion engine (10), the throttle valve (80) comprising a valve housing (90) and a valve shut-off element (100) rotatably arranged within the valve housing (90), the method comprising: 45
- rotating the valve shut-off element (100) from a first position in which the valve shut-off element (100) is spaced apart from the valve seat (98) into a second position in which the valve shut-off element (100) engages the valve seat (98); 50
 - and
 - simultaneously removing any deposits accumulated on the valve seat (98) by rotating the valve shut-off element (100) from the first position into the second position. 55
15. The method of claim 14, further comprising:
- rotating the valve shut-off element (100) from the second position into the first position; and
 - simultaneously removing any deposits accumulated on the valve seat (98) by rotating the valve shut-off element (100) from the second position into the first position.



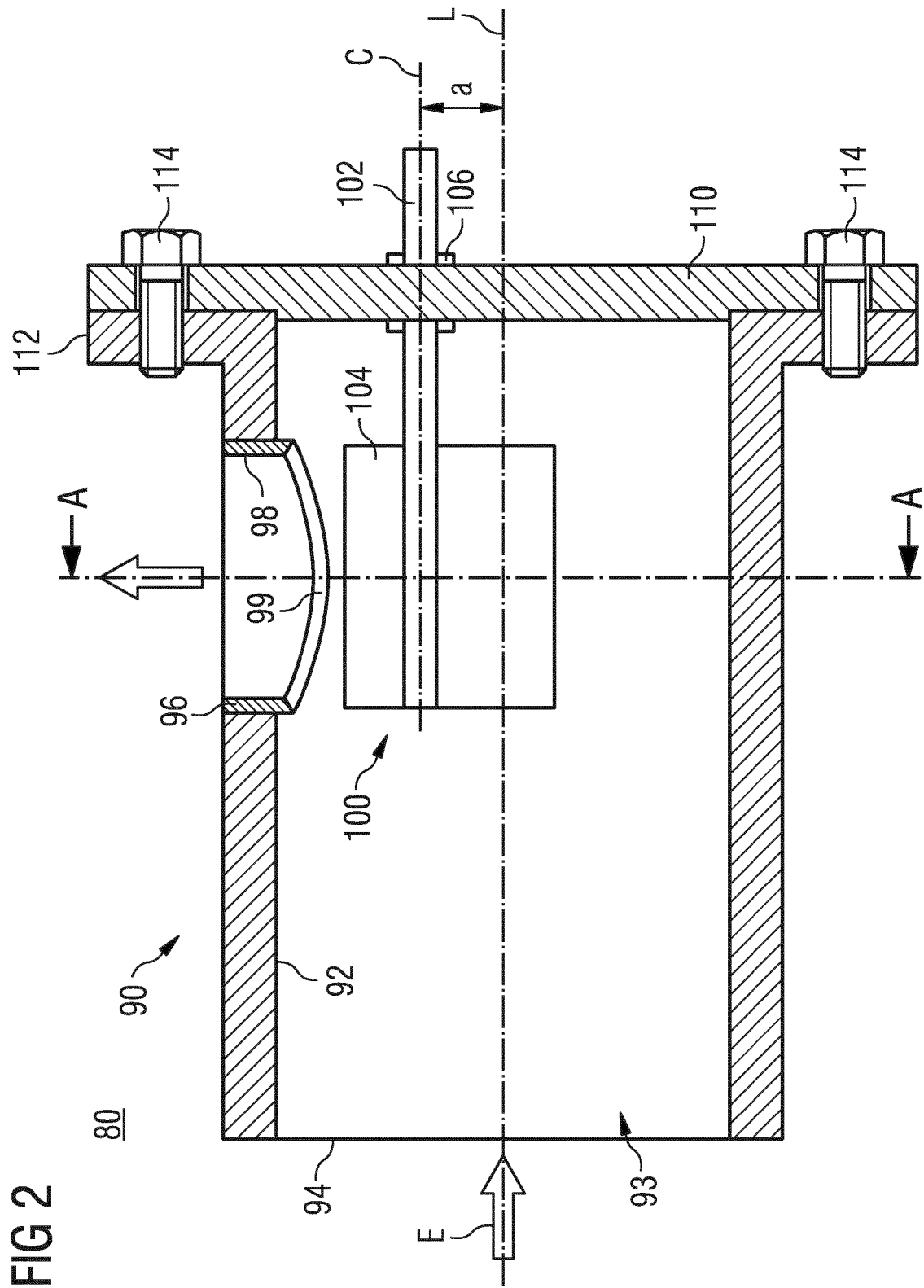


FIG 3

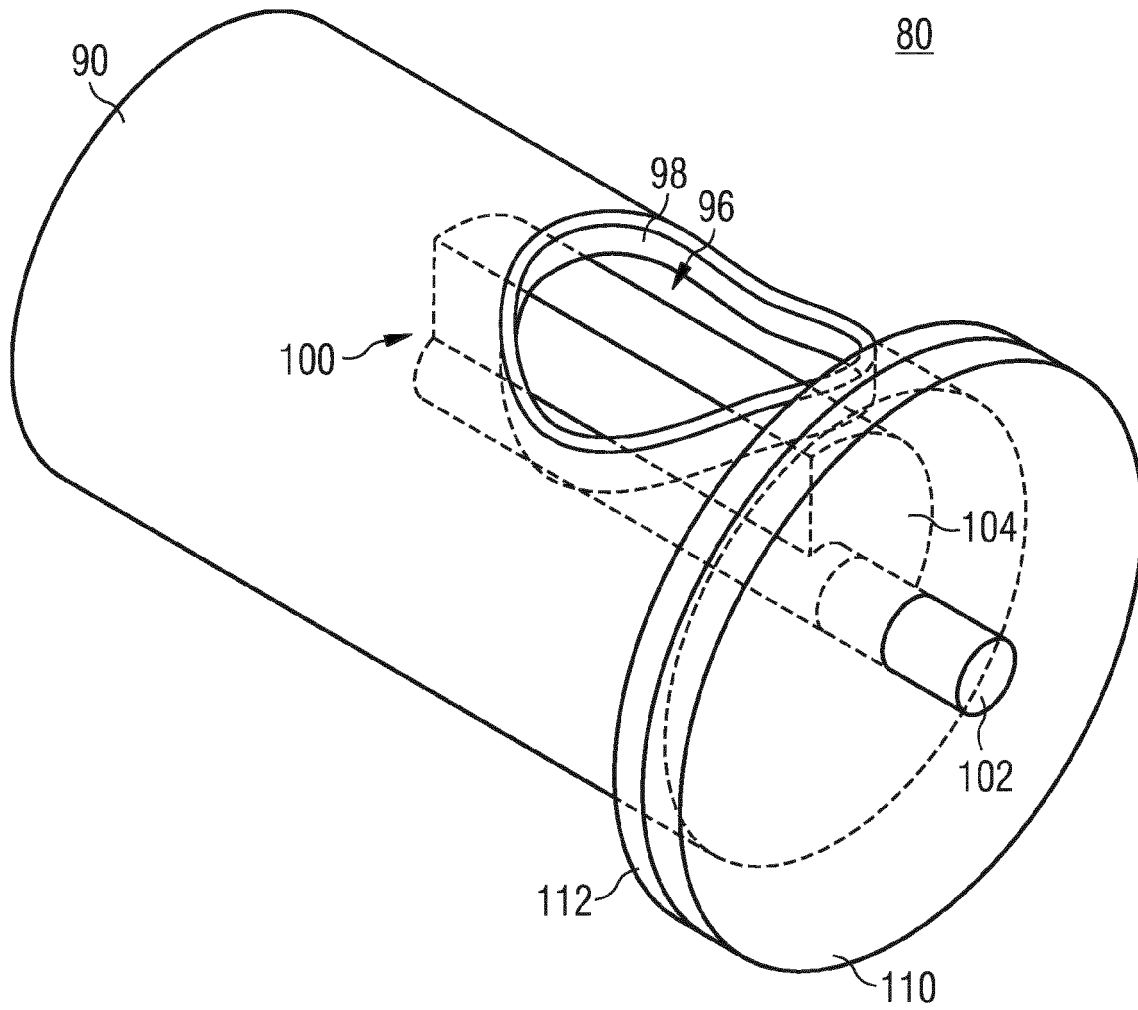
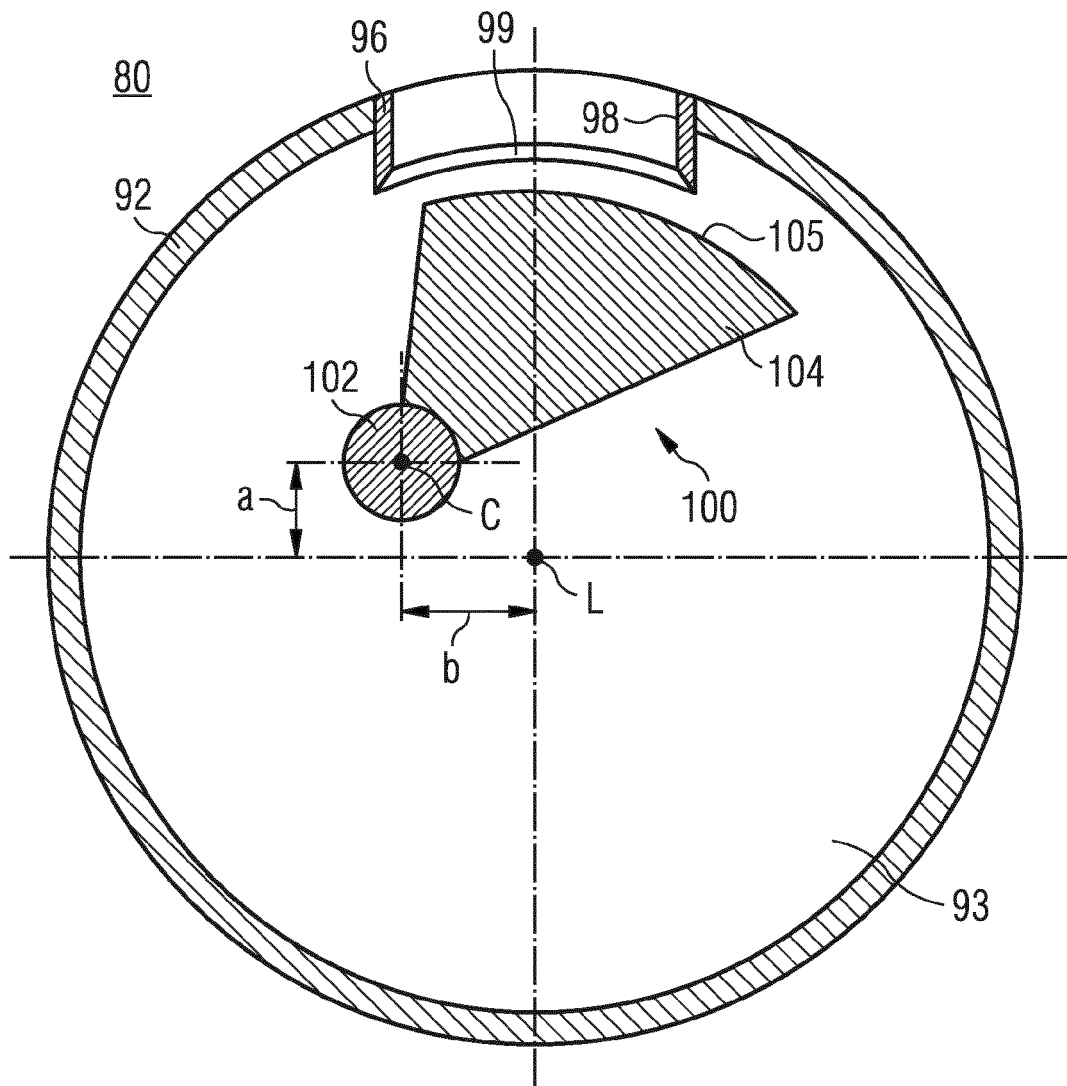


FIG 4





EUROPEAN SEARCH REPORT

 Application Number
EP 13 15 0306

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 236 805 A2 (PIERBURG GMBH [DE]) 6 October 2010 (2010-10-06)	1-4,7-9,11	INV. F02D9/10 F02D9/16 F02D9/04 F02M25/07
Y	* paragraphs [0008] - [0012] *	13	
A	* figure 1 *	5,6	
X	US 4 428 356 A (KEMMNER ULRICH [DE]) 31 January 1984 (1984-01-31)	1-4,7-10,12	
Y	* column 2, line 25 - column 3, line 9 *	13	
A	* figures 2,3 *	5	
X	US 4 222 356 A (UEDA TAKEHITO ET AL) 16 September 1980 (1980-09-16)	1,2,4-7,9,11	
Y	* column 3, lines 14-24 *	13	
	* figures 2,3 *		
X	DE 199 14 213 A1 (BOYSEN FRIEDRICH GMBH CO KG [DE]) 5 October 2000 (2000-10-05)	1,2,4-7,9,11	
Y	* column 3, lines 7-10,24-35 *	13	
	* figure 1 *		
X	US 4 171 689 A (EHEIM FRANZ [DE]) 23 October 1979 (1979-10-23)	1,2,4,5,7,9,11	TECHNICAL FIELDS SEARCHED (IPC) F02D F02M F16K
Y	* column 2, lines 31-54 *	13	
	* figures 1-6 *		
X	US 4 237 837 A (TODA TADAHIDE [JP] ET AL) 9 December 1980 (1980-12-09)	1,2,4-7,9,11	
Y	* column 2, lines 45-64 *	13	
	* column 4, lines 32-46 *		
	* figures 2,6 *		
A	EP 2 236 871 A1 (PIERBURG GMBH [DE]) 6 October 2010 (2010-10-06)	1-9,11,12	
	* column 1, lines 3-20 *		
	* column 2, lines 34-45 *		
	* figures 1,2 *		
----- -/--			

The present search report has been drawn up for all claims			

1

EPO FORM 1503 03 82 (P04C01)

Place of search

Date of completion of the search

Examiner

Munich

23 May 2013

Mallo López, Manuel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
 Y : particularly relevant if combined with another document of the same category
 A : technological background
 O : non-written disclosure
 P : intermediate document

T : theory or principle underlying the invention
 E : earlier patent document, but published on, or after the filing date
 D : document cited in the application
 L : document cited for other reasons

& : member of the same patent family, corresponding document



EUROPEAN SEARCH REPORT

Application Number
EP 13 15 0306

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 1 028 134 A (RAYMAKER JAMES H [US]) 4 June 1912 (1912-06-04) * page 1, lines 10-65 * * pages 1,2 *	1-4, 7-10,12	
Y	DE 10 2006 055818 A1 (FORD GLOBAL TECH LLC [US]) 29 May 2008 (2008-05-29) * abstract * * figures 1,2 *	13	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
Place of search		Date of completion of the search	Examiner
Munich		23 May 2013	Mallo López, Manuel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)



Application Number

EP 13 15 0306

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-13

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

EP 13 15 0306

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-13

A throttle valve for an internal combustion engine, the throttle valve comprising a valve housing and a valve shut-off element rotatably arranged within the valve housing between a first position in which the valve shut-off element is spaced apart from a valve seat and a second position in which the valve shut-off element engages the valve seat, wherein the valve housing includes a side wall, a first port, and a second port extending through the side wall and the valve seat is disposed at the second port and at least partially protruding into the valve housing.

2. claims: 14, 15

A method for removing deposits accumulated at a valve seat of a throttle valve to be used in an internal combustion engine, the throttle valve comprising a valve housing and a valve shut-off element rotatably arranged within the valve housing, the method comprising: rotating the valve shut-off element from a first position in which the valve shut-off element is spaced apart from the valve seat into a second position in which the valve shut-off element engages the valve seat; and simultaneously removing any deposits accumulated on the valve seat by rotating the valve shut-off element from the first position into the second position.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 15 0306

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-05-2013

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2236805 A2	06-10-2010	DE 102009015184 A1 EP 2236805 A2	11-11-2010 06-10-2010
US 4428356 A	31-01-1984	DE 3218210 A1 US 4428356 A	17-11-1983 31-01-1984
US 4222356 A	16-09-1980	DE 2851180 A1 JP S5540209 A JP S6149498 B2 US 4222356 A	27-03-1980 21-03-1980 29-10-1986 16-09-1980
DE 19914213 A1	05-10-2000	NONE	
US 4171689 A	23-10-1979	DE 2703687 A1 GB 1593131 A IT 1092125 B JP S5395430 A US 4171689 A	03-08-1978 15-07-1981 06-07-1985 21-08-1978 23-10-1979
US 4237837 A	09-12-1980	DE 2901703 A1 JP S5540211 A US 4237837 A	27-03-1980 21-03-1980 09-12-1980
EP 2236871 A1	06-10-2010	DE 102009015183 A1 EP 2236871 A1	07-10-2010 06-10-2010
US 1028134 A	04-06-1912	NONE	
DE 102006055818 A1	29-05-2008	NONE	

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- US 20110000209 A1 [0005]
- US 4492519 A [0006]