

(19)



(11)

EP 2 631 454 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.08.2013 Bulletin 2013/35

(51) Int Cl.:
F02D 9/04 (2006.01)

F02M 25/07 (2006.01)

(21) Application number: **12157157.4**

(22) Date of filing: **27.02.2012**

(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: **Bakindi, Bilal**
24159 Kiel (DE)

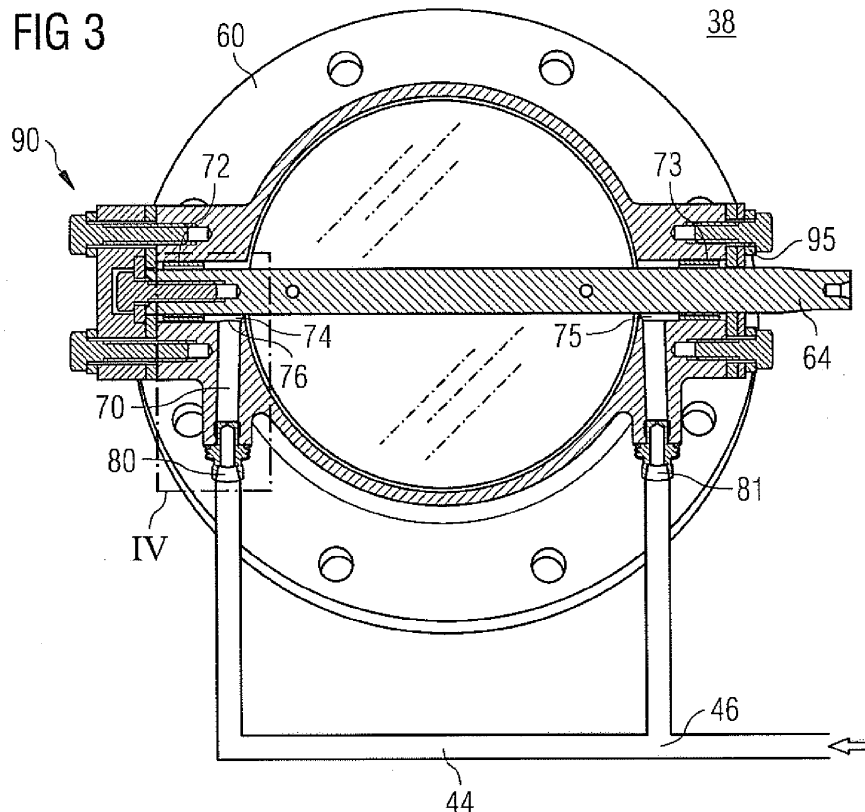
(74) Representative: **Kramer - Barske - Schmidtchen**
Landsberger Strasse 300
80687 München (DE)

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

(54) Throttle valve for internal combustion engines

(57) A throttle valve (38) may comprise a valve body (60) providing a main gas path, a throttle shaft bearing (72) integrated in the valve body (60), a pivotable throttle shaft (64) mounted to the valve body (60) via the throttle shaft bearing (72), a throttle plate (66) mounted to the throttle shaft (64) and being pivotable within the main gas path by pivoting the throttle shaft (64). The throttle valve may further comprise a channel system (70) integrated

into the valve body (60) and configured to guide a high-pressure gas to the throttle shaft (64) for then flowing along the throttle shaft (64) into the main gas path. The throttle valve (38) may be used to control an exhaust gas flow within the exhaust system of an internal combustion engine (10) and allows protecting the throttle shaft bearing (72) from the exhaust gas and its components such as soot.

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Description

Technical Field

[0001] The present disclosure generally refers to throttle valves and methods for operating throttle valves of internal combustion engines and more particularly to rinsing of throttle shaft bearings disposed within the throttle valve with high-pressure gas.

Background

[0002] Throttle valves may be employed as "ON/OFF" valves which means that, for instance, a gas flow through the throttle valve may be controlled. In an "ON" state, the gas flow may pass the throttle valve, whereas in an "OFF" state, the gas flow may be prevented from flowing through the throttle valve. Furthermore, throttle valves may also smoothly adjust the amount of gas flow through the gas flow control valve.

[0003] In the field of machine tools, it is known to provide an air barrier for protecting, for example, a machine spindle from swarfs, as exemplarily disclosed in a summary research report with the title "non-contacting sealing in machine tool application" by the institute of machine components of the University of Stuttgart (http://www.ima.uni-stuttgart.de/dichtungstechnik/abgeschlossene_projekte/staube/abschlussbericht.pdf).

[0004] Exhaust systems of large internal combustion engines may comprise soot that may effect the operation of throttle valves within an exhaust gas system

[0005] The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of prior systems.

Summary of the Disclosure

[0006] According to an aspect of the present disclosure, a throttle valve for controlling an exhaust gas flow within an internal combustion engine is disclosed. The throttle valve may comprise a valve body providing a main gas path. The throttle valve may further include a throttle shaft bearing integrated in the valve body, a pivotable throttle shaft mounted to the valve body via the throttle shaft bearing, and a throttle plate mounted to the throttle shaft and being pivotable within the main gas path by pivoting the throttle shaft. A channel system within the valve body may be configured to provide a high-pressure gas flowing along the throttle shaft into the main gas path.

[0007] According to another aspect of the present disclosure, an exhaust gas system is disclosed. The exhaust gas system may comprise a first exhaust gas flow path and at least one exhaust gas treatment device disposed within the first exhaust gas flow path for treating exhaust gas of an internal combustion engine. The exhaust gas system may further comprise a second exhaust gas flow path fluidly connected to the first exhaust gas flow path,

and at least one throttle valve as described above, wherein the throttle valve being disposed within the first or second exhaust gas flow path.

[0008] According to another aspect of the present disclosure, an internal combustion engine may comprise at least one throttle valve according to the present disclosure.

[0009] According to another aspect of the present disclosure, a method for operating a throttle valve is disclosed. The throttle valve may comprise a throttle body and a throttle shaft bearing configured to support a throttle shaft and disposed within a recessed portion of the valve body. The method for operating the throttle valve may comprise routing a gas flow through the main gas path, and rinsing the recessed portion with high-pressure gas.

[0010] In some embodiments, the throttle valve may further comprise a recessed portion delimited by the throttle shaft bearing and extending around the throttle shaft into which the channel system opens.

[0011] In some embodiments, the channel system may comprise a high-pressure port for connecting to a high-pressure gas source or the charge air system of an internal combustion engine.

[0012] In some embodiments, the channel system may further comprise an opening being in fluid communication with the recessed portion and with the pressure port via the channel system.

[0013] In some embodiments, the opening may be positioned between the throttle shaft bearing and the main gas path.

[0014] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0015]

Fig. 1 shows an exemplary schematic diagram of an internal combustion engine;

Fig. 2 shows an exemplary schematic view of a throttle valve according to the present disclosure;

Fig. 3 shows a schematic cut view of the throttle valve of Fig. 2 along an exhaust gas flow direction; and Fig. 4 shows a detailed view of a portion IV of the throttle valve as indicated in Fig. 3.

Detailed Description

[0016] 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 in-

tended 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.

[0017] The present disclosure may be based in part on the realization that rinsing of throttle shaft bearings of throttle valves may prevent a throttle shaft from being affected, for example, blocked by deposits originating from the exhaust gas.

[0018] In Fig. 1, an exemplary schematic diagram of an internal combustion engine 10 including an engine unit 20 and an exhaust gas system 30 is shown.

[0019] The engine unit 20 may comprise a cylinder block 22 providing multiple cylinders 24, an intake manifold 26 providing a mixture of charge air to the cylinders 24 into which a liquid fuel may be injected. After combustion of the air/fuel mixture, the exhaust gas may be released into an exhaust manifold 28 of the exhaust gas system 30.

[0020] Furthermore, the internal combustion engine 10 may comprise a two-stage turbocharger. For example, the exhaust gas system 30 may comprise a high-pressure turbo stage 29H fluidly connected to and disposed downstream of the exhaust manifold 28. The high-pressure turbo stage may be configured to drive a compressor to compress charge air prior charging the cylinders 24.

[0021] In some embodiments, the engine unit 20 may further comprise a low-pressure turbo stage 29L being disposed downstream of the exhaust gas system 30.

[0022] The exhaust gas system 30 may comprise an exhaust gas treatment device 32, such as a SCR-unit, for treating the exhaust gas prior its release into the environment. The exhaust gas treatment device 32 may be disposed within a first exhaust gas path 34 fluidly connected in between the high-pressure turbo stage 29H and, for instance, the low-pressure turbo stage 29L.

[0023] Furthermore, the exhaust gas system 30 may comprise a second exhaust gas path 36 being arranged in parallel to the first exhaust gas path 34. The second exhaust gas path 36 may be configured to bypass the exhaust gas treatment device 32.

[0024] In order to control the exhaust gas flow, the exhaust gas system 30 may comprise at least one throttle valve 38, 39 for either blocking or unblocking the first or second exhaust gas path 34, 36, respectively. As described above, the throttle valves 38, 39 may prevent or may enable the exhaust gas from passing through.

[0025] As shown in Fig. 1, the throttle valve 38 may be disposed upstream of the SCR-unit 32 within the first exhaust gas path 34, and the throttle valve 39 may be disposed within the second exhaust gas path 36.

[0026] In some embodiments, the exhaust gas system 30 may further comprise an exhaust gas re-circulation (EGR) path 50 for re-circulating exhaust gas from the exhaust manifold 28 into the intake manifold 26. After combustion, the pressurized exhaust gas may be re-circulated and may mix with the compressed charge air within or prior the intake manifold 26. A throttle valve 52

may be disposed within the EGR path 50 for blocking or unblocking the EGR path 50.

[0027] A high-pressure gas pipe 44 may connect the throttle valves 38, 39, and 52 with the air pipe 27 for branching off a desired amount of pressurized gas, for example pressurized charge air.

[0028] In some embodiments, a separate high-pressure gas source 42 may be provided for supplying the throttle valves 38, 39 with a high-pressure gas.

[0029] Referring to Fig. 2, an exemplary schematic view of a throttle valve 38 is shown. The throttle valve 38 may comprise a valve body 60 providing a main gas path 62, a throttle shaft 64 pivotable mounted to the valve body 60, and a throttle plate 66 mounted to the throttle shaft 64 and being pivotable within the main gas path 62 by pivoting the throttle shaft 64. The throttle plate 66 may be mounted to the throttle shaft 64 by techniques known in the art, such as screwing and/or welding.

[0030] The main gas path 62 may have a cylindrical shape having an inner wall 63. In some embodiments, the main gas path 62 may be provided with a rectangular, conical or any other known geometrical shape. The main gas path 62 may extend through the throttle valve 38, thereby enabling, for instance, exhaust gas to flow through the throttle valve 38.

[0031] The throttle valve 38 may further comprise a first flange 68 and a second flange 69 disposed on the opposite ends of a pipe section 67, which delimits the main gas path 62 through the throttle valve 38. The first flange 68 and/or the second flange 69 may be configured to connect, for example, to the exhaust gas system 30.

[0032] As shown in Fig. 2, the exhaust gas may pass through the throttle valve 38 along an exhaust gas flow direction indicated by an arrow E, i.e. from the left to the right in Fig. 2. The throttle plate 66 may be mounted to the throttle shaft 64 at a downstream side of the throttle shaft 64. When flowing through the pipe section 67, the exhaust gas may first pass the throttle shaft 64 and then the throttle plate 66.

[0033] The throttle plate 66 pivoted into a position blocking the main gas path 62 may prevent the exhaust gas to pass through the throttle valve 38.

[0034] The throttle plate 66 may further be pivoted within an angular range of about 75°, in some embodiments even into a position parallel to the exhaust gas flow direction, to enable the exhaust gas to pass through the throttle valve 38.

[0035] Generally, the throttle plate 66 may be pivoted in a controlled manner to throttle the exhaust gas flow through the throttle valve 38. Accordingly, the amount of exhaust gas passing through the throttle valve 38 may be smoothly adjusted.

[0036] A valve control unit (not shown) may be configured to pivot the throttle shaft 64 for controlling the amount of exhaust gas passing through the throttle valve.

[0037] In Fig. 3, an exemplary schematic cut view of the throttle valve 38 in a direction along the exhaust gas flow direction indicated by the arrow E in Fig. 2 is shown.

[0038] Referring to Fig. 3, the throttle valve 38 may comprise a mounting arrangement to pivotably mount the throttle shaft 64 to the valve body 60. In some embodiments, the throttle shaft 64 may be mounted on opposing sides of the valve body 60, whereby at least at one side the throttle shaft 64 may extend through the valve body 60, usually the driving end of the throttle shaft 64.

[0039] The mounting arrangement may include a throttle shaft bearing 72 positioned within a through hole through the valve body 60. A recessed portion 74 may then be formed between the throttle shaft 64 and the wall of the through hole (e.g. surrounding the throttle shaft 64), whereby the recessed portion 74 may be delimited by the throttle shaft bearing 72 and open into the main gas path 62 within the valve body 60. In some embodiments, the recessed portion 74 may extend up to 50 % or more of the thickness of the wall of the valve body 60 and have a radial extension of several millimeters.

[0040] At the driving end of the throttle shaft 64, one or more sealing lips 95 may be configured to circumferentially contact the throttle shaft 64, thereby sealing the through hole from the outside of the valve body 60. At the other end, the through hole may be closed using a sealing arrangement 90 comprising, for example, a cover plate screwed to the valve body 60.

[0041] The throttle valve 38 may further comprise a channel system 70 within the valve body 60, specifically within the wall region of the valve body close to the bearing 72 and recessed portion 74. The channel system 70 may be configured to guide pressurized gas such as air to the recessed portion 74, such that, during operation of the throttle valve 38, a steady stream of pressurized gas may flow along the throttle shaft 64 away from the throttle shaft bearing 72 into the main gas path 62.

[0042] The channel system 70 may extend within the wall of the valve body 60 and fluidly connect one or more openings accessible from the outside of the valve body 60 with one or more openings 76 opening into the recessed portion 74.

[0043] For example, a channel of the channel system 70 may extend perpendicular to the throttle shaft 64 from the outside of the throttle valve 38 through the valve body 60 and open into the recessed portion 74 within a central area of the recessed portion 74 between the throttle shaft bearing 72 and the main inner wall 63 of the pipe section 67.

[0044] During operation of the throttle valve, the channel system 70 may be fluidly connected to the high-pressure gas pipe 44 via a high-pressure port 80 integrated for example into the wall of the valve body 60. The high-pressure port 80 may allow supplying the channel system 70 with high-pressure gas. In some embodiments, the high-pressure port 80 may be a standardized air port known in the art.

[0045] Providing the high-pressure gas with a pressure higher than the pressure of gas flowing through the main gas path 62, the high-pressure gas may flow through the

channel system 70 into the recessed portion 74 of the valve body 60 and along the throttle shaft 64 into the main gas path 62.

[0046] Referring to Fig. 4, the channel system 70 may open into the recessed portion 74 via an opening 76. The opening 76 may, therefore, fluidly connect the channel system 70 to the main gas path 62 via the recessed portion 74. The opening 76 may be disposed between the main gas path 62 and the throttle shaft bearing 72.

[0047] The throttle shaft 64 may be supported by the throttle shaft bearing 72 disposed within the recessed portion 74 of the valve body 60. The throttle shaft bearing 72 may be an anti-friction bearing known in the art, such as a ball-bearing or a roller-bearing.

[0048] In some embodiments, the high-pressure gas may be introduced into the recessed portion 74 through the sealing arrangement 90. In such embodiments, the high-pressure gas may flow through the bearing into the main gas path 62.

[0049] At the drive side, the throttle shaft 64 may be supported in a similar manner by, for example, an anti-friction bearing 73. However, the throttle shaft 64 may extend out of the valve body 60 for connecting to the valve control unit (not shown). The valve control unit may be configured to pivot the throttle shaft 64 with the throttle plate 66 for adjusting and throttling the exhaust gas flow through the main gas path 62.

[0050] Also at the drive side, the bearing 73 may be provided in the through hole such that a recessed portion 75 is formed.

[0051] As shown in Fig 3, a high-pressure port 81 and the high-pressure port 80 may be commonly fluidly connected via the high-pressure gas pipe 44 to a high-pressure gas source 42. The high-pressure gas pipe 44 may comprise a port for connecting to the charge air system and/or the high-pressure gas source 42 such as the high-pressure start up air of a large internal combustion engine. In some embodiments, the high-pressure ports 80, 81 may be respectively connected to the charge air system or the high-pressure gas source 42.

Industrial Applicability

[0052] In the following, the operation of the throttle valve 38 during operation of the internal combustion engine 10 is described with respect to Figs. 1 to 4.

[0053] After combustion of the fuel/air mixture within the cylinders 24, the exhaust gas may be released into the exhaust manifold 28 and the exhaust gas system 30. The exhaust gas treatment device 32 disposed within the first exhaust gas path 34 may be configured to treat the exhaust gas prior to releasing into the environment.

[0054] For controlling the exhaust gas flow, the control unit (not shown) may control the throttle valves 38, 39 to be in a blocking or unblocking state. The unblocking state may be constituted by the throttle plate 66 being in a position parallel to the exhaust gas flow direction E whereas the blocking state may be constituted by the

throttle plate 66 being in a position as shown in Fig. 2, thereby preventing the exhaust gas from passing through the main gas path 62.

[0055] The exhaust gas may contain soot particles which may penetrate into the recessed portion 74 and, thus, affect the throttle shaft bearing 72 of the throttle shaft 64. Soot particles may deposit, for example, at the recessed portion 74 or the throttle shaft bearing 72 and, thus, may block the pivoting movement of the throttle shaft 64.

[0056] In order to prevent or at least slow down blocking of the throttle shaft 64, high-pressure gas may be introduced into the recessed portion 74 for forming a gas cushion within the recessed portion. The high-pressure gas, for example compressed charge air, may originate from the air pipe 27 and the high-pressure turbo stage 29H.

[0057] In some embodiments, the high-pressure gas source 42 may provide high-pressure gas to the throttle valve 38 instead of branching off the compressed charge air from the air pipe 27.

[0058] Referring to the detailed view of the throttle valve portion IV in Fig. 4, the high-pressure gas may be introduced via the high-pressure port 80 into the channel system 70. Subsequently, after passing the channel system 70, the high-pressure gas may flow into the recessed portion 74 via the opening 76, thereby, the high-pressure gas may rinse the recessed portion 74. After rinsing the recessed portion 74, the high-pressure gas may flow along the throttle shaft 64 into the main gas path 62.

[0059] The high-pressure gas may be provided under a pressure higher than the pressure of the exhaust gas to prevent the exhaust gas from penetrating into the recessed portion 74 and, thereby, from polluting the recessed portion 74 and the throttle shaft bearing 72. By having a higher pressure than the exhaust gas, the high-pressure gas may form the gas cushion within the recessed portion 74 and may seal the throttle shaft bearing 72 from the main gas path 62.

[0060] The introduced compressed charge air may be available as soon as the engine is running. The introduced high-pressure charge air may be provided, for example, with a pressure of 2.5 to 3 bar and with a flow rate of about 350 to 410 kg/h, which is about 0.6 percent of the total air flow within the internal combustion engine 10.

[0061] As described above, the throttle plate 66 may be mounted to the throttle shaft 64 at a downstream side of the throttle shaft 64. In some embodiments, the soot of the exhaust gas may also deposit at an interface between the throttle plate 66 and the inner wall 63, when the throttle plate 66 may be in the blocking position. In such embodiments, the high-pressure gas may also flow along this interface for preventing the above mentioned deposition of the soot. The high-pressure gas may further improve closing of the main gas path 62 by the throttle plate 66.

[0062] In addition, the introduced high-pressure gas may cool the components, such as the valve body 60,

the throttle shaft bearing 72, or the throttle shaft 64, and, therefore, may reduce wear of those components.

[0063] The disclosed throttle valve 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.

[0064] 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.

[0065] Medium speed internal combustion engines may be large stand-alone engines that therefore provide reasonable access to the end sides of the engine block.

[0066] 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 (38) for controlling an exhaust gas flow within an internal combustion engine (10), the throttle valve (38) comprising:
 - a valve body (60) providing a main gas path (62);
 - a throttle shaft bearing (72) integrated in the valve body (60);
 - a pivotable throttle shaft (64) mounted to the valve body (60) via the throttle shaft bearing (72);
 - a throttle plate (72) mounted to the throttle shaft (64) and being pivotable within the main gas path (62) by pivoting the throttle shaft (64); and
 - a channel system (70) within the valve body (60) configured to provide a high-pressure gas flowing along the throttle shaft (64) into the main gas path (62).
2. The throttle valve (38) according to claim 1, further comprising a recessed portion (74) delimited by the throttle shaft bearing (72) and extending around the throttle shaft (64) into which the channel system (70) opens.
3. The throttle valve (38) according to any one of the preceding claims, wherein the channel system (70) further comprises a high-pressure port (80) for introducing high-pressure gas.

4. The throttle valve (38) according to claim 3, wherein the high-pressure port (80) is a standardized air port.
5. The throttle valve (38) according to any one of the preceding claims, wherein the channel system (70) comprises an opening (76) into the recessed portion (74), wherein the opening (76) is in fluid communication with the high-pressure port (80). 5
6. The throttle valve (38) according to claim 5, wherein the opening (76) is disposed between the throttle shaft bearing (72) and an inner wall (63) of the main gas path (62). 10
7. The throttle valve (38) according to any one of the preceding claims, wherein the throttle plate (66) is mounted to the throttle shaft (64) from a downstream side with respect to the exhaust gas flow direction. 15
8. An internal combustion engine (10) comprising: 20
 - at least one throttle valve (38) according to any one of claims 1 to 7.
9. The internal combustion engine (10) according to claim 8, wherein the high-pressure gas is provided by the charge air system of the internal combustion engine (10). 25
10. The internal combustion engine (10) according to claim 8, further comprising a separate high-pressure gas source (42) configured to provide the high-pressure gas. 30
11. The internal combustion engine (10) according to claim 8 or claim 9, wherein the pressure of the high-pressure gas is higher than the pressure of the exhaust gas. 35
12. The throttle valve (38) according to any one of claims 8 to 11, wherein the high-pressure gas is compressed charge air. 40
13. An exhaust gas treatment system (30) comprising: 45
 - a first exhaust gas flow path (34);
 - at least one exhaust gas treatment device (32) disposed within the first exhaust gas flow path (34) for treating exhaust gas of an internal combustion engine (10); 50
 - a second exhaust gas flow path (36) being in fluid communication with the first exhaust gas flow path (34); and
 - at least one throttle valve (38) according to any one of claims 1 to 7 is disposed within the first gas flow path (34) and/or the second exhaust gas flow path (36). 55
14. A method for operating a throttle valve (38) configured to control an exhaust gas flow within an internal combustion engine (10), the throttle valve (38) comprising valve body (60) and a throttle shaft bearing (72) configured to support a throttle shaft (64) and disposed within a recessed portion (74) of the valve body (60), the method comprising:
 - routing a gas flow through the main gas path (62); and
 - rinsing the recessed portion (74) with high-pressure gas.
15. The method according to claim 14, wherein the rinsing of the recessed portion (74) is configured to comprise a direction from the throttle shaft bearing (72) to a main gas path (62) through which the exhaust gas flows.

FIG 1

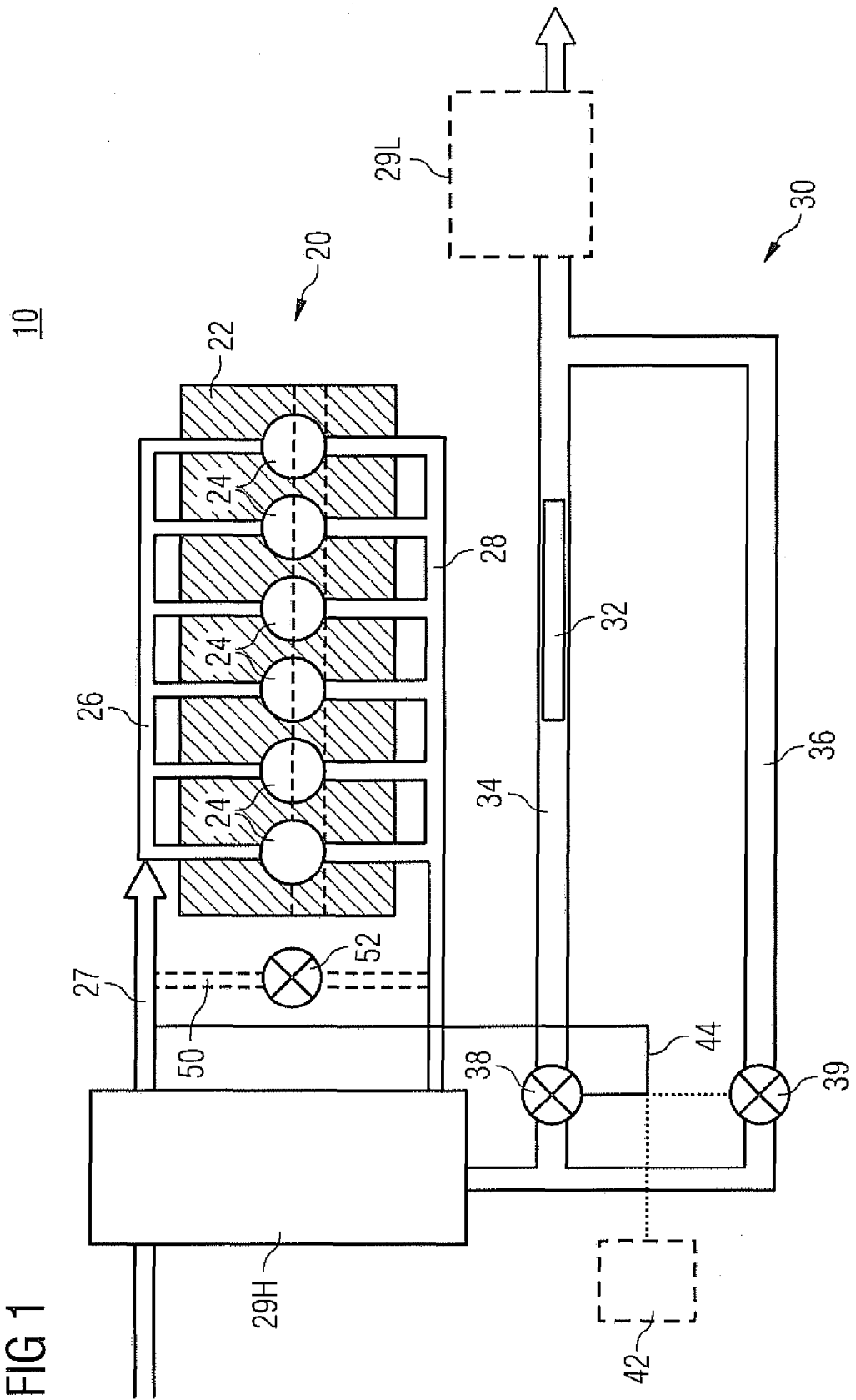


FIG 2

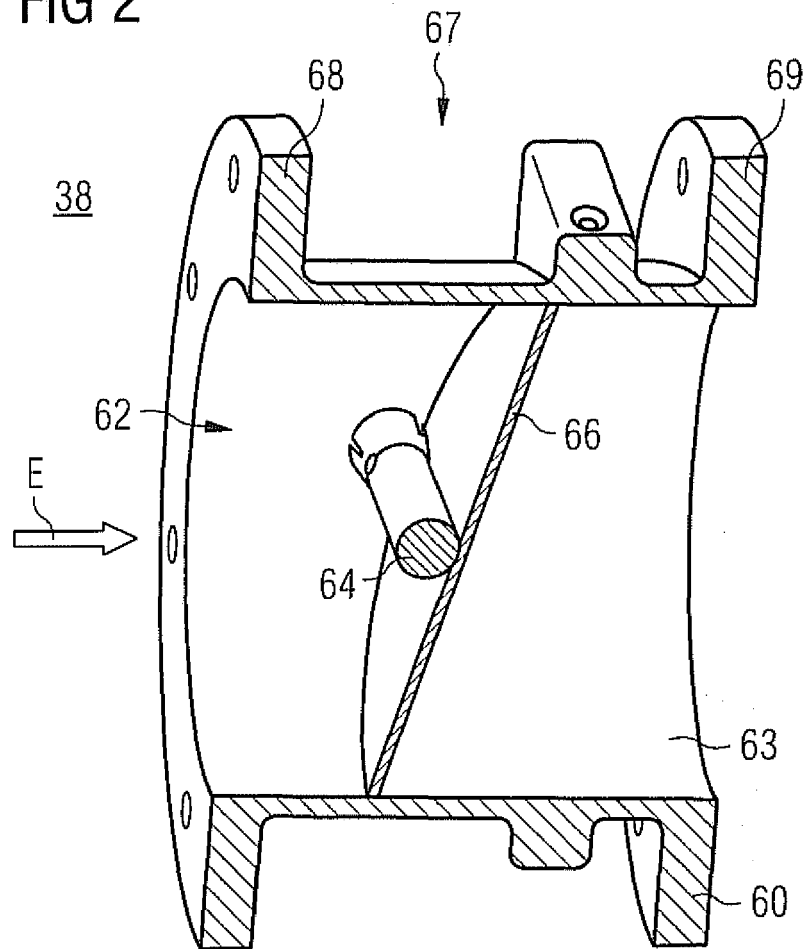


FIG 4

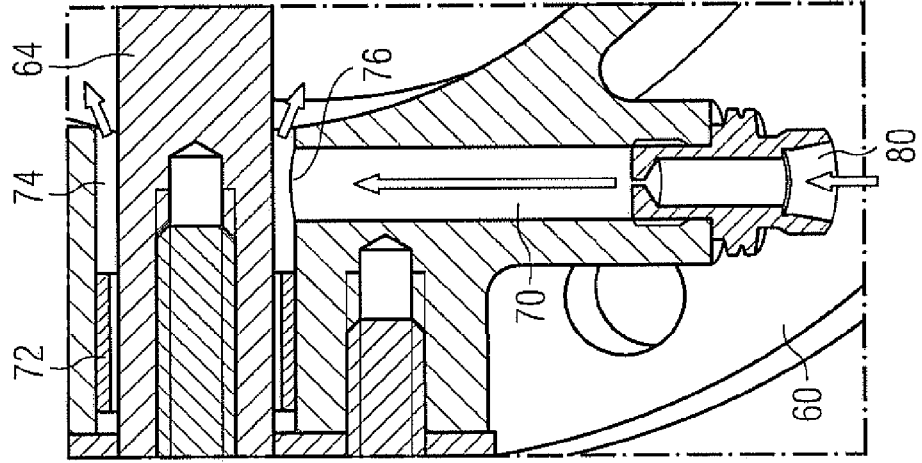
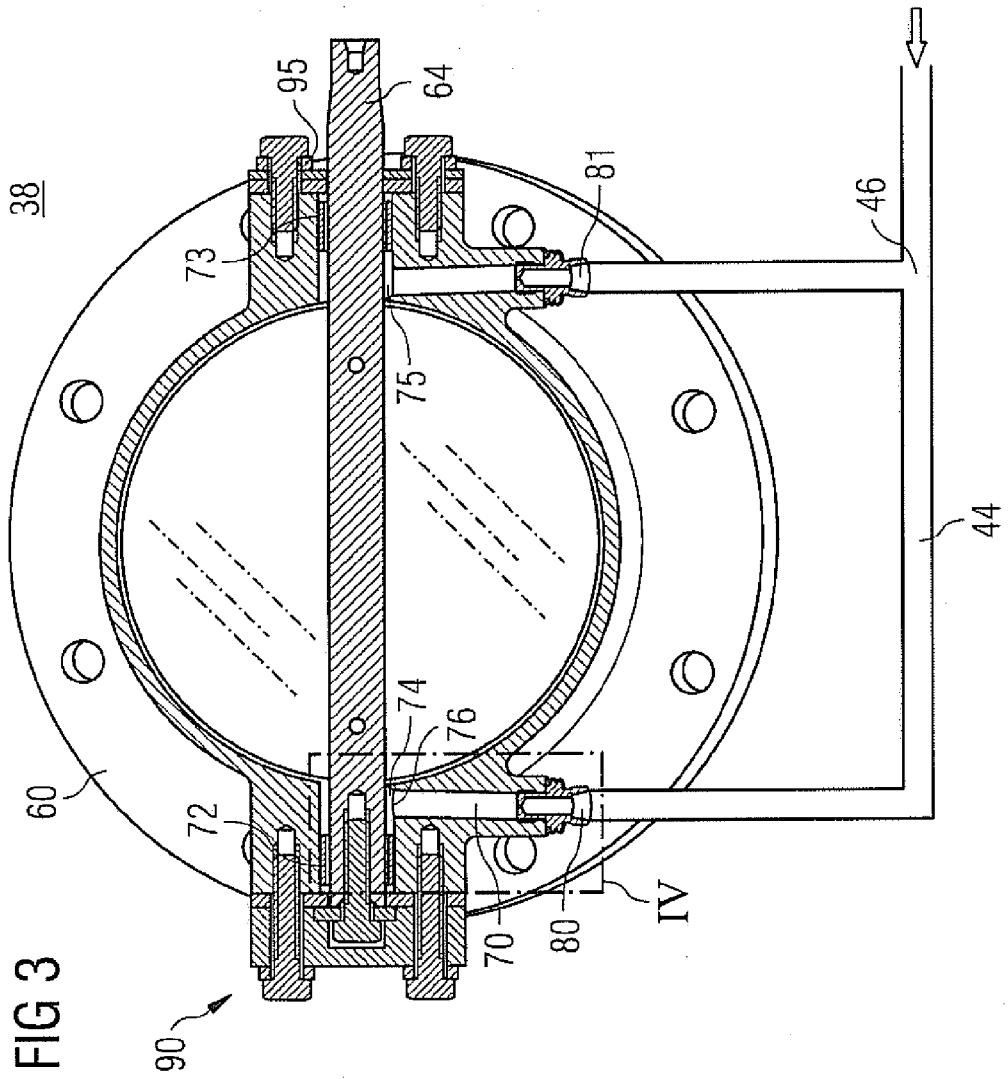


FIG 3





EUROPEAN SEARCH REPORT

Application Number
EP 12 15 7157

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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	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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