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(54) Title: TURBO-CHARGED INTERNAL COMBUSTION ENGINE

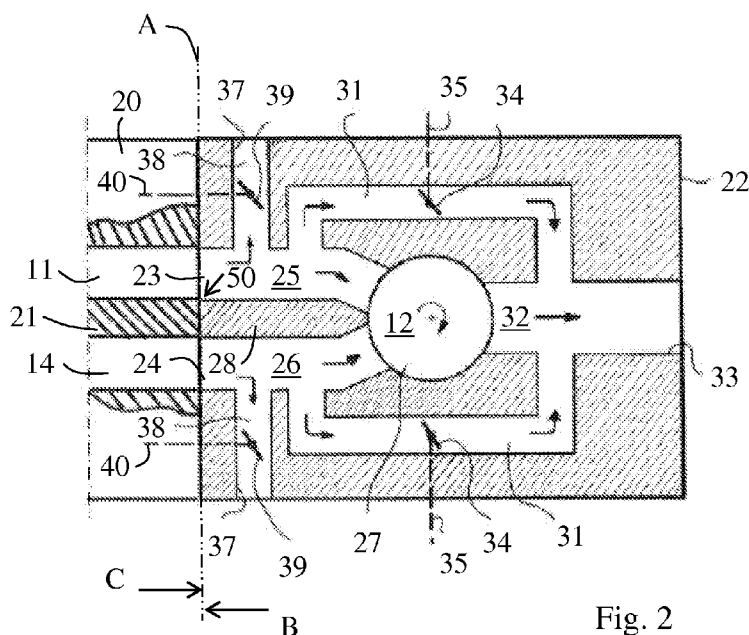


Fig. 2

(57) Abstract: An engine is divided into two cylinder groups. Branch lines from the cylinders of one of the groups gather to a first inlet channel (11) and branch lines from the cylinders of the second group gather to a second inlet channel (14). The respective inlet channel (11, 14) is connected to an inlet opening (23, 24) on a twin entry turbine with a turbine chamber (22) having a separate inlet (23, 24) to each of two separate channels (25, 26) extending into the turbine chamber (22) in which a turbine wheel (12) is stored. A sealing device (50) is arranged between the inlets (23, 24) to prevent cross-talk between the inlet channels (11, 14).

Turbo-Charged Internal Combustion Engine

TECHNICAL FIELD

- 5 The present invention relates to a turbocharged combustion engine and a vehicle comprising a turbocharged combustion engine according to the enclosed claims.

BACKGROUND AND PRIOR ART

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Exhausts from multi-cylinder combustion engines are usually received by a manifold with several branch lines that receive exhausts from the combustion engine's cylinders and a riser that receives the exhausts from the respective branch lines. The exhausts flow through the riser to a turbocharger to increase
15 fuel efficiency and the power in the engine by forcing additional air into the combustion chambers. The turbocharger usually comprises a turbine powered by the exhausts and a compressor that compresses air led to the engine.

20

When the exhaust valves in a cylinder open, exhausts initially flow out into the branch line with a high pressure, which is substantially related to the pressure of the exhausts in the cylinder right after the combustion stroke has ended.

25

The pressure of the exhausts in the branch line during the remaining time, during which the exhaust valves are open, is lower and substantially related to the work of the piston when it presses the exhausts out from the cylinder into the branch line. The exhaust valves in the cylinders are normally open during
the entire exhaust stroke, i.e. during a relatively large part of a four stroke engine's working cycle. In multi-cylinder combustion engines, the opening times of the exhaust valves in different cylinders often overlap. This overlapping varies depending on the number of cylinders and the firing order
30 and as a result one cylinder may be emptied at the same time as another, adjacent cylinder reaches the end of its opening time.

When the exhaust valves in a cylinder open, the exhausts are thus led from the cylinder with a high pressure to the connected branch line and riser. If exhausts are led at the same time out of another cylinder in another branch line with a lower pressure, there is an obvious risk that the exhausts with the higher pressure penetrate down into the branch line with the lower exhaust pressure, which is referred to as cross-talk. Thus, the pressure in this branch line increases and the piston in this cylinder must work harder to eject the exhausts. The increased pumping work results in an increased fuel consumption of the internal combustion engine. Additionally, an increased amount of residue gases is obtained in the cylinder, which adversely affects the temperature and combustion.

It is prior art to counteract cross-talking by dividing the engine on the exhaust side into two cylinder groups, wherein the branch lines from the cylinders of one group are joined into one first riser and the branch lines from the second group of cylinders are joined into a second riser. The respective riser is connected to an inlet of a turbine of so-called twin scroll or twin entry type with a turbine chamber with a separate inlet to each of two separate channels extending into the turbine chamber in which a turbine wheel is stored.

By separating the exhaust streams from each other, the risk of cross-talk is reduced and a more evenly distributed gas exchange is achieved. The result of this division is that compression waves on the exhaust side cannot be transferred to other cylinders and impact the gas exchange.

One problem associated with prior art solutions is that cross-talking of pressure pulses may arise between the first riser and the second riser at the inlet to the turbine and the second riser at the inlet to the turbine where both risers are separated from each other by only a partition wall and connected to corresponding channels in the turbine chamber, which channels are also separated from each other by only a partition wall. Both partition walls extend toward each other, but in order to facilitate for these two to grow as a result of

thermal expansion underload, a gap or clearance is adapted between the end sections of the partition walls. The gap allows for thermal expansion but also creates cross-talk problems since pressure pulses may pass through the gap.

- 5 Another problem is that the partition walls expand over time due to oxidation and other impacts which means that the gap decreases. Although the cross-talk may decrease as a result, instead there is a risk that the partition walls may collide with each other when they expand due to thermal expansion, which may lead to cracking and strength problems.

10

Another problem is that it may be difficult to fit the risers against the turbine chamber so that the partition wall between the respective risers is positioned facing the corresponding partition wall in the turbine chamber. As a result, cross-talk may increase.

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SUMMARY OF THE INVENTION

- One objective of the present invention is to counteract cross-talk between the risers at the inlet of a turbine. Another objective is to prevent the partition walls
20 from colliding with each other when they expand due to thermal expansion in order thus to reduce the risk of cracking and other strength problems.

These objectives are achieved by way of a sealing device defined in the independent claims.

25

- The use of the innovative sealing device prevents cross-talk of pressure pulses between conduits and as a result short-circuit pressure pulses may not disturb the gas exchange operations in the engine during the emptying phase of the respective cylinder, which in turn results in less residual gases in the cylinder
30 and an improvement of the air supply to the engine.

Since cross-talk of pressure pulses is prevented, more pulse energy passes through the turbine, leading to an improved efficiency of the turbine, higher available turbine power and thus also higher charge air pressure and higher engine torque at low engine speeds.

5

The use of the sealing device also reduces the stress that may occur when the respective partition wall expands lengthwise as a result of thermal expansion entailing that the risk of e.g. cracking is reduced.

10 In one advantageous embodiment, the first sealing section consists of a recess in the end section of one partition wall and the second sealing section consists of a protruding section in the end section of the second partition wall, which protruding section is adapted to fit into the recess. Since one of the sealing sections fits into the second sealing section and delimits a gap, which may
15 advantageously be U-shaped, a labyrinth seal is obtained, which efficiently prevents cross-talk at the same time as the gap facilitates thermal expansion of the partition walls.

In another advantageous embodiment, the first sealing section is arranged at
20 the partition wall that separates the groups from each other and the second sealing section is arranged at the partition wall that separates the channels from each other. The sealing effect is achieved by way of pressure pulses entering the labyrinth and is suppressed when they are redirected a number of times in the labyrinth before exiting from the labyrinth significantly weaker than
25 they were at entry. By arranging the sealing sections in this advantageous manner, several redirections are obtained and accordingly also a more efficient sealing.

In another advantageous embodiment, a flange joint is arranged around the
30 end sections of both partition walls, which flange joint is adapted with a centring arrangement to ensure, when fitted, that the first sealing section and the second sealing section are positioned facing each other. As a result, an

improved localisation of both sealing sections in relation to each other is achieved, which ensues a simplified assembly and an efficient function of the sealing arrangement.

- 5 In another advantageous embodiment, the centring arrangement comprises a protruding part adapted in a first flange which is adapted to fit into a corresponding recess adapted in a second flange. Accordingly, an efficient and reliable location of both sealing sections in relation to each other is obtained.
- 10 Other features and advantages of the invention are set out in the claim, the description of the example embodiment and the enclosed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

- 15 Below is a description, as an example, of preferred embodiments of the invention with reference to the enclosed drawings, in which:
- Fig. 1 is a diagram of a vehicle powered by an overloaded combustion engine.
- 20 Fig. 2 shows a cross-section through a turbocharger displayed at Fig. 1.
- Fig. 3a shows a cross-section along a line A at Fig. 2 seen in a direction B.
- Fig. 3b shows a cross-section along a line A at Fig. 2 seen in a direction C.
- Fig. 4 is a diagram of a first embodiment of the innovative sealing device.
- Fig. 5 shows a perspective view with cutaway pieces of a second
- 25 embodiment of the innovative sealing device.

DETAILED DESCRIPTION OF EMBODIMENTS ACCORDING TO THE INVENTION

- 30 Fig. 1 is a diagram of a vehicle 1 powered by an overloaded combustion engine 2. The vehicle 1 is advantageously a heavy goods vehicle and the combustion engine 2 may be a diesel engine or an Otto engine. In case of

alternative embodiments, the combustion engine may be intended for industrial or marine use. In this case, the combustion engine 2 is exemplified as a straight six cylinder engine with a first branch line 3 that receives exhausts from three cylinders 4, 5, 6 via a branch line 4a, 5a, 6a from each cylinder 4, 5, 6 and a second branch line 7 that receives exhausts from three cylinders 8, 9, 10 via a branch line 8a, 9a, 10a from each cylinder 8, 9, 10. Exhausts from the combustion engine's 2 first manifold 3 is led via a first riser which is referred to below as the first inlet channel 11 to a turbine 12 in a turbocharger 13. Exhausts from the combustion engine's 2 second manifold 7 are led via a second riser which is referred to below as the second inlet channel 14 to the turbine 12. The branch lines 4a,5a,6a 8a,9a,10a are thus grouped into two groups. In the description below, the first inlet channel 11 represents one group and the second inlet channel 14 represents the second group.

15 The exhausts leaving the combustion engine 2 have an overpressure and as a result they expand through the turbine 12. The turbine 12 thus obtains a power that is transferred via a connection to a compressor 15 in the turbocharger 13. The compressor 15 compresses air which is sucked into an inlet conduit 17 via an air filter 16. The compressed air in the inlet conduit 17 is cooled in an intercooler 18 before it is led to the combustion engine 2.

By leading exhausts from the combustion engine's 2 respective manifolds 3, 7 via two separate inlet channels 11, 14 to the turbine 12, an essentially even exhaust pressure may be maintained which acts on the turbine 12. Thus, a high volumetric efficiency may be maintained when the exhausts expand through the turbine 12.

Fig. 2 shows that the inlet channels 11, 14 extend through a joint transitional section 20 arranged between the respective manifolds 3, 7 displayed at Fig. 1 and the turbine 12 displayed at Fig. 2 and are separated from each other by a first partition wall 21. The transitional section 20 is connected to a turbine chamber 22. The connection may, as displayed at Fig. 4, be adapted as a

conventional flange joint 42 where two flanges 43, 47 are pressed against each other with screw joints which are not displayed. The flanges 43, 47 may be circular or have any other appearance, e.g. rectangular, depending on the application in which they are arranged. Alternatively, the flanges 43, 47 are
5 pressed against each other in another suitable manner e.g. with a screw-actuated clamp or a band, e.g. a V-shaped band, that encloses the flanges 43, 47 and push these against each other.

Fig. 2 shows that the turbine chamber 22 is adapted with two inlet openings
10 23, 24, one facing each inlet channel 11, 14. Each inlet opening 23, 24 is connected to a channel 25, 26 which is connected with a turbine chamber 27, in which the turbine 12 is arranged. The channels 25, 26 are thus separated from each other by a second partition wall 28 which is positioned facing and in line with the transitional section's 20 partition wall 21.

15 The manifolds 3, 7 which may also be referred to as exhaust manifolds, the transitional section 20, the turbine chamber 22 and the partition walls 21, 28 may be made of any material whatsoever with adequate properties in terms of material strength and resistance to the environment where they are placed, but
20 preferably they are made of steel, cast iron or a composite material. The manifolds 3, 7 may also be made of plate, preferably steel.

At least one of the channels 25, 26 but in this example embodiment both channels 25, 26 are connected via a by-passage 31 through which exhausts
25 may be led to an exhaust pipe 32 located downstream of the turbine 12 and further out through an exhaust outlet opening 33 without passing through the turbine 12 as there is a risk this may be overloaded. The channels 25, 26 may be opened and closed conventionally with the help of a waste gate valve 34 controlled via control lines 35 from a control device which is not displayed.

30 At least one of the channels 25, 26 but in this example embodiment both channels 25, 26 are also connected via a passage 38 which houses an EGR

valve 39 and which, via an outlet opening 37, connects to the combustion engine's 2 non-displayed exhaust recirculation system. The EGR valves 39 are controlled conventionally via control lines 40 from a non-displayed control device to recirculate a part of the exhausts to the inlet pipe 17 downstream of the intercooler 18 displayed at Fig. 1.

Fig. 3a and 3b show a cross-section between the transitional section 20 and the turbine chamber 22 along a line A at Fig. 2. Fig. 3a shows the cross-section seen in a direction B and Fig. 3b shows the cross-section seen in a direction C.

Fig. 3a and 3b show that the transitional section 20 comprises a circular flange 43 with a number of through holes 44 for non-displayed screw joints intended to connect the flange 43 with a corresponding flange 47 with through holes 48 on the turbine chamber 22. The first inlet channel 11 and the second inlet channel 14 have a D-shaped cross-sectional shape and are separated from each other by the partition wall 21. The channels 25, 26 in the turbine chamber also have a D-shaped cross-sectional shape and are separated from each other by partition wall 28. The through holes 44, 48, the channels 11, 14 and 25, 26 respectively, and the partition walls 21, 28 are positioned facing each other following assembly.

The channels 11, 14, 25, 26 need not have a D-shaped cross-sectional shape, but may be adapted in a variety of ways. The channels 11, 14, 25, 26 displayed at Fig. 5 have e.g. an essentially rectangular cross-sectional shape but the cross-sectional shape may also be square, circular, oval or any other shape that fits the relevant application.

A sealing element preferably in the shape of a gasket 45 may, as displayed at Fig. 3a and 3b, be arranged between the flanges 43, 47 is necessary to prevent exhausts from leaking. The gasket is suitably made of metal, preferably steel, and advantageously consists of one or several plate layers

punched in one cohesive piece. If several plate layers are used, they are stacked on each other and compressed into one gasket.

To prevent cross-talk between the inlet channels 11, 14 displayed at Fig. 2 at the inlet openings 23, 24 to the turbine chamber 22, a sealing device 50 is arranged at the partition walls 21, 28. Fig. 2 shows the placement of the sealing device 50 and Fig. 3a and 3b shows that the sealing device 50 comprises a first sealing section 51 arranged at an end section 52 of the transitional section's 20 partition wall 21 and a second sealing section 53 arranged at an end section 54 of the turbine chamber's 22 partition wall 28. Both end sections 52, 53 are thus adapted to be directed against each other. Both sealing sections 51, 54 may, in an alternative embodiment, change places with each other so that the first sealing section 51 is arranged at an end section 54 of the turbine chamber's 22 partition wall 28 and the second sealing section 53 is arranged at an end section 52 of the transitional section's 20 partition wall 21.

The first sealing section 51 consists of an elongated recess extending along essentially the entire length of the end section 52. The second sealing section 53 consists of an elongated protruding section extending along essentially the entire length of the end section 54. The first sealing section 51 and the second sealing section 53 are adapted to sealing interaction with each other and thus form a seal, preferably a labyrinth seal, as displayed at Fig. 4 and 5.

Fig. 4 and 5 display the area between the transitional section 20 and the turbine chamber 22. The second sealing section 53 which consists of the protruding section is arranged to fit into the first sealing section 51 which consists of the recess. Both sealing sections are thus adjacent to a U-shaped gap 55. Since one of the sealing sections fits into the second sealing section and is adjacent to a gap 55, a labyrinth seal is achieved which effectively prevents cross-talk of pressure pulses between the pipes 11, 14 resulting in short-circuit compression waves may not disrupt the gas exchange operations

in the engine during the emptying phase of the respective cylinders which in turn results in less residual gases in the cylinder and an improvement of the air supply to the engine. Since cross-talk of pressure pulses is prevented, essentially all pressure pulses through the turbine are controlled via the channels 25, 26, leading to an improved efficiency of the turbine, higher available turbine power and thus also higher charge air pressure and higher engine torque at low engine speeds. The gap 55 also creates a clearance which facilitates thermal expansion of the partition walls 21, 28 without any risk of said walls colliding with each other, as a result of which the risk of e.g. cracking in the partition walls 21, 28 decreases.

The height of the second sealing section 53, i.e. that of the protruding section, is less than 10 mm, but preferably 3-5 mm, and its width is less than 10 mm, but preferably 3-5 mm. The width of the gap, i.e. the distance between the protruding section and the walls of the recess is less than 3 mm, but preferably 1-1.5 mm. The depth of the first sealing section 51, i.e. that of the recess, is less than 13 mm, but preferably 4-6.5 mm. In one advantageous embodiment the height of the protruding section is 5 mm, its width 3 mm and the width of the gap 1.5 mm.

In order to ensure, at assembly, that the first sealing section 51 and the second sealing section 53 are positioned facing each other, the flange joint 42 comprises a centring arrangement 46. One of the flanges 43, 47 is thus adapted with a protruding part 57 adapted to fit into a corresponding recess 58 in the second flange 43, 47.

At operation of the vehicle, exhausts flow through both inlet conduits 11, 14 through the inlet openings 23, 24 and the channels 25, 26 to the turbine chamber. The sealing device 50 is arranged between the partition walls 21, 28 to prevent that pressure pulses are transferred from one inlet conduit 11, 14 to the other inlet conduit 11, 14. The sealing action is achieved by way of pressure pulses entering the gap 55, which are dampened by being throttled or

redirected a number of times in the gap 55 before exiting the gap 55, significantly weaker than at entry.

The invention is not limited to the embodiments described above, but
5 numerous possible modifications thereof are obvious to a person skilled in the area, without such person departing from the spirit of the invention as defined by the claims.

The number of cylinders which connect, via manifolds, to a riser, may vary,
10 and in its simplest form the engine has only two cylinders that connect to a joint riser, but the invention may obviously be applied to engines with a different number of cylinders, e.g. four, five, six or eight, without the invention idea being lost.

15

CLAIMS

1. Turbocharged combustion engine (2) with at least two cylinders (4,5,6,8,9,10) and one manifold (3,7) having a branch line (4a,5a,6a,8a,9a,10a) from each cylinder (4,5,6,8,9,10), wherein the branch lines (4a,5a,6a,8a,9a,10a) are gathered in at least two groups (11,14) each debouching in an inlet (23,24) to channels separate from each other (25,26) each of which debouches in a turbine chamber (22), wherein the groups (11,14) are separated from each other by a first partition wall (21) and wherein the channels (25,26) are separated from each other by a second partition wall (28) which partition walls (21,28) have end sections facing each other (51,54), *characterised in that* a sealing device (50) extends between the partition walls' (21,28) end sections (51,54) which sealing device (50) comprises a first sealing section (51) and a second sealing section (53) adapted to work together to achieve a sealing action and delimit a gap (55).
2. Turbocharged combustion engine according to claim 1, *characterised in that* the first sealing section (51) is arranged at the end section (52, 54) of one of the partition walls (21, 28) and the second sealing section (53) is arranged at the end section (52, 54) of the second partition wall (21, 28).
3. Turbocharged combustion engine according to claim 2 *characterised in that* the first sealing section (51) consists of a recess in the end section (52, 54) of one of the partition walls (21, 28), and the second sealing section (53) consists of a protruding section in the end section (52, 54) of the second partition wall (21, 28), which protruding section is adapted to fit into the recess.
4. Turbocharged combustion engine according to any of the previous claims, *characterised in that* the first sealing section (51) and the second sealing section (53) delimit a U-shaped gap (55).

5. Turbocharged combustion engine according to any of the previous claims,
characterised in that the first sealing section (51) is arranged at the
partition wall (21) separating the groups (11, 14) from each other and the
second sealing section (53) is arranged at the partition wall (28) separating
5 the channels (25, 26) from each other.
6. Turbocharged combustion engine according to any of the previous claims,
characterised in that a flange joint (52) is arranged around the end section
(52, 54) of both partition walls (21, 28), which flange joint (52) is adapted
10 with a centring arrangement (46) to ensure, at assembly, that the first
sealing section (51) and the second sealing section (53) are positioned
facing each other.
7. Turbocharged combustion engine according to claim 6, *characterised in*
15 *that* the centring arrangement (46) comprises a protruding part (57)
adapted in a first flange (43, 47) designed to fit into a corresponding recess
(58) adapted in a second flange (43, 47).
8. Turbocharged combustion engine according to any of claims 1-6,
20 *characterised in that* the height of the second sealing section (53) is less
than 10 mm but preferably 3-5 mm.
9. Turbocharged combustion engine according to any of claims 1-6,
characterised in that the width of the second sealing section (53) is less
25 than 10 mm, but preferably 3-5 mm.
- 10 Turbocharged combustion engine according to any of claims 1-6,
characterised in that the depth of the first sealing section (51) is less than
13 mm, but preferably 4-6.5 mm
30
11. Turbocharged combustion engine according to claim 1 or 4, *characterised*
in that the width of the gap (55) is less than 3 mm but preferably 1-1.5 mm.

12. Vehicle (1) comprising a turbocharged combustion engine according to any of claims 1-11.

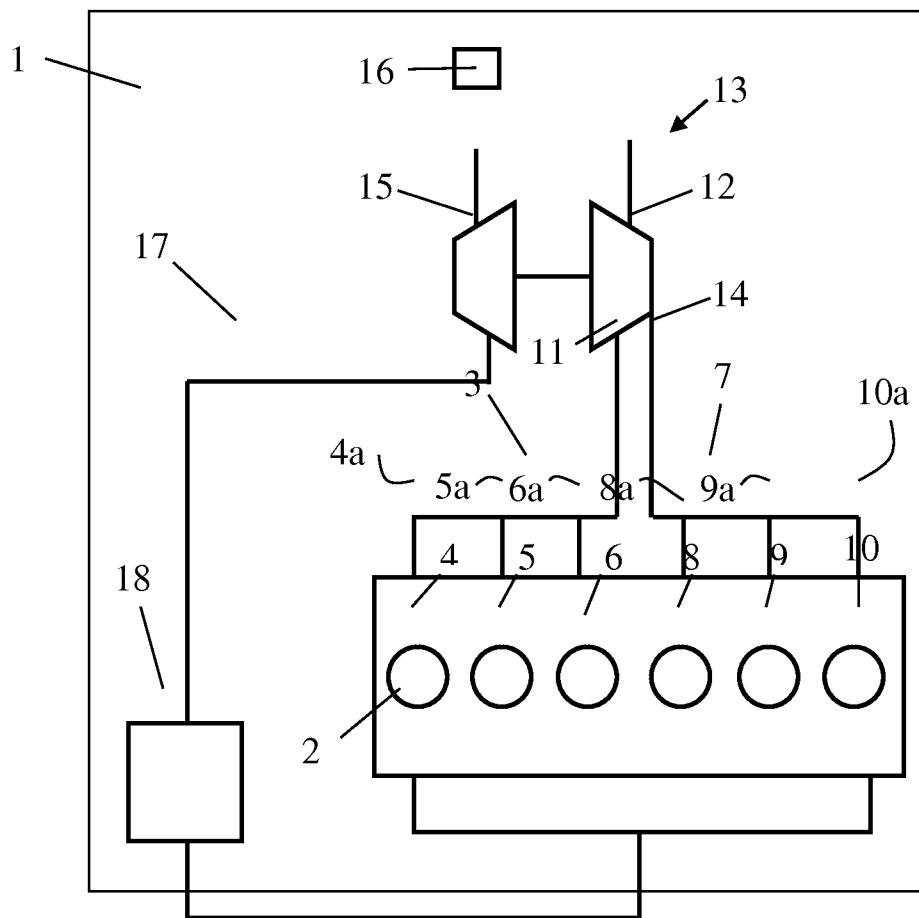


Fig. 1

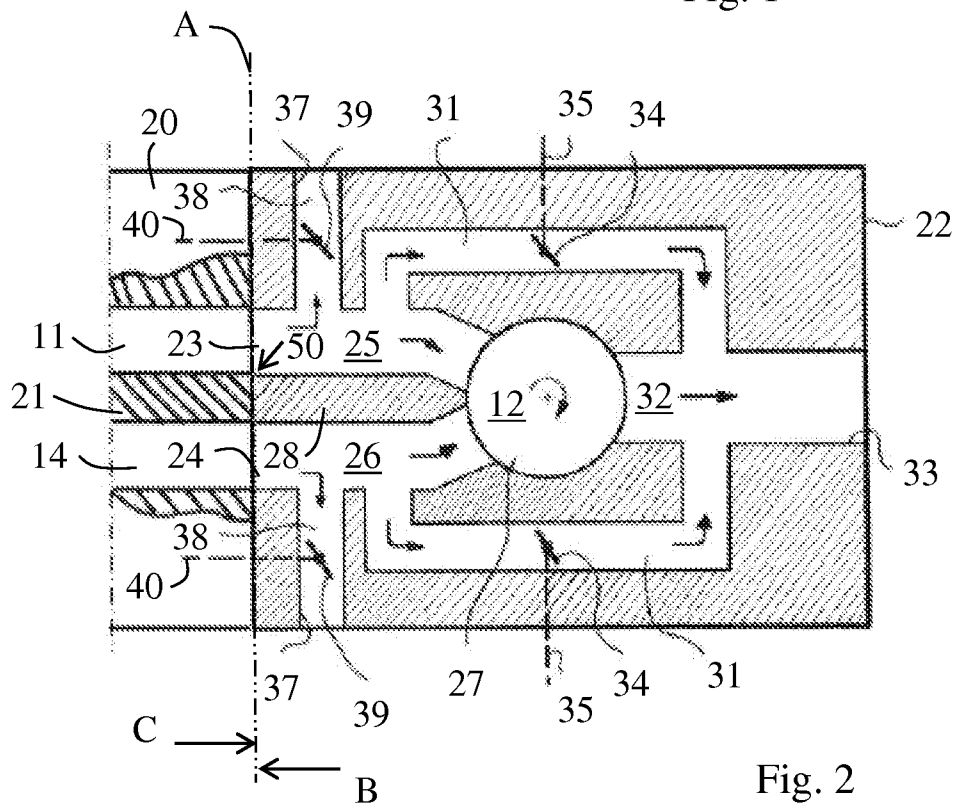


Fig. 2

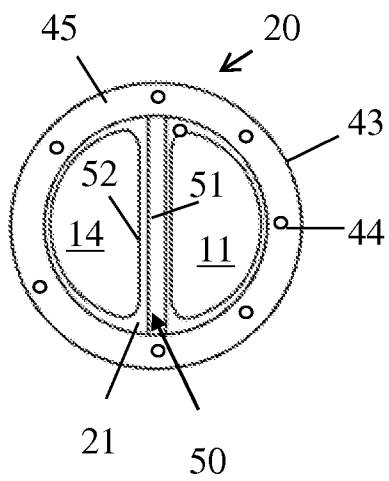


Fig. 3a

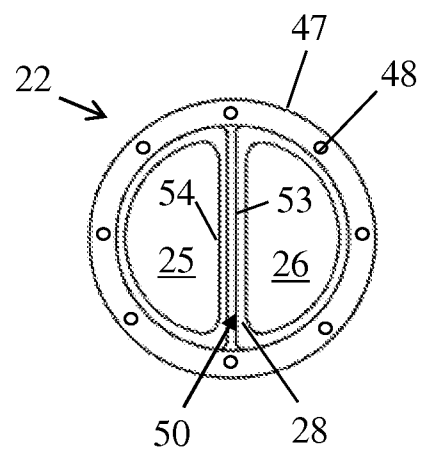


Fig. 3b

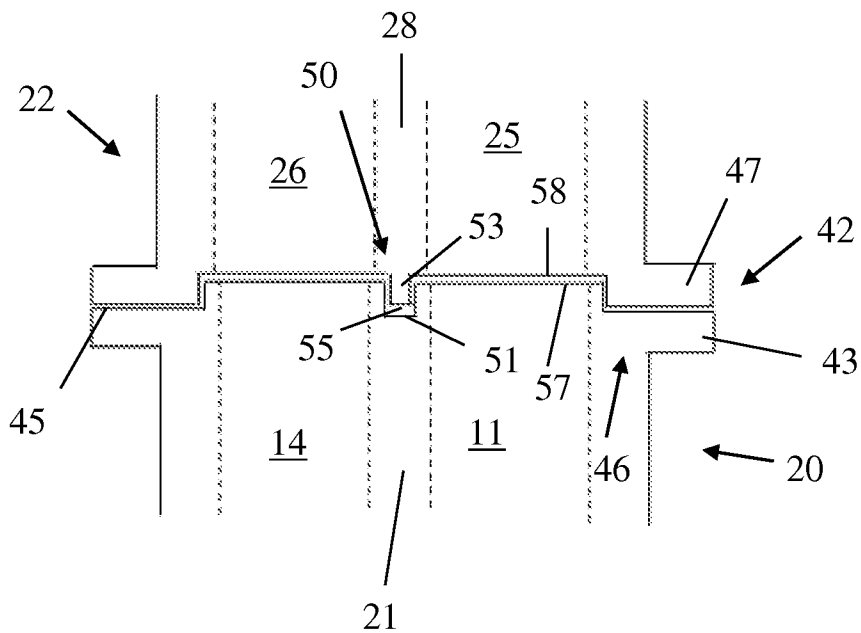


Fig. 4

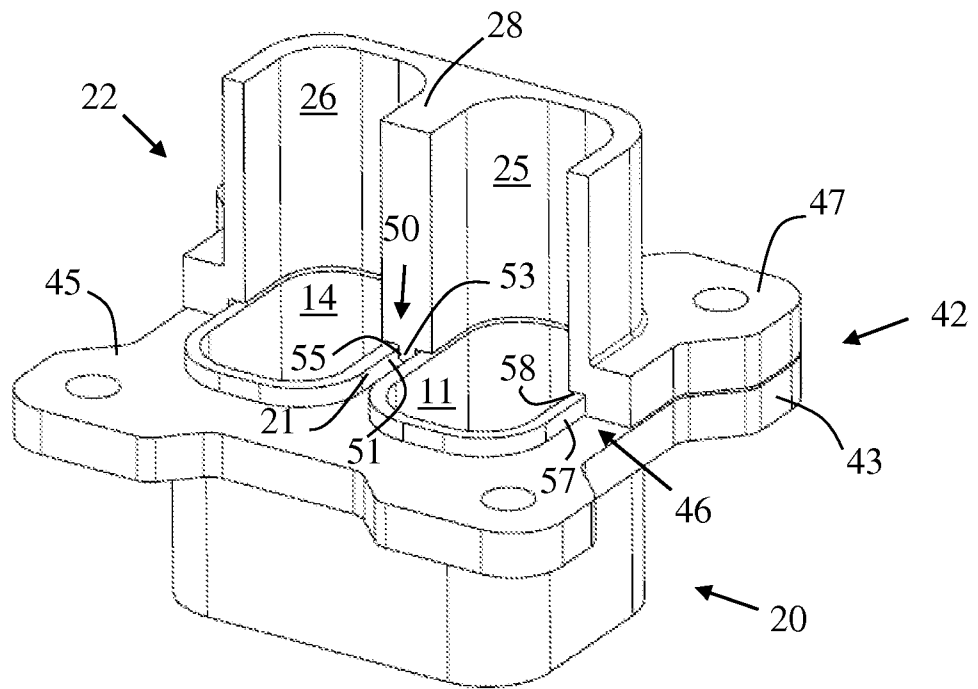


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050508

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F01N, F02B, F02C, F16J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 102009043117 A1 (DAIMLER AG), 31 March 2011 (2011-03-31); abstract; paragraphs [0022]-[0024]; figures --	1-12
X	DE 102008013767 A1 (BAYERISCHE MOTOREN WERKE AG ET AL), 24 September 2009 (2009-09-24); abstract; paragraphs [0023]-[0024]; figures --	1, 12
X	DE 102008018668 A1 (GILLET HEINRICH GMBH - (B4) TENNECO GMBH [DE]), 12 November 2009 (2009-11-12); abstract; paragraphs [0033]-[0035]; figures 3c,4 --	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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04-08-2016

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050508

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20140366525 A1 (WAGNER ANDREAS ET AL), 18 December 2014 (2014-12-18); abstract; paragraphs [0003], [0007], [0010], [0045]-[0046]; figures --	1-12
A	US 20090158724 A1 (MULLER FRANK - (B2) MUELLER FRANK [DE]), 25 June 2009 (2009-06-25); abstract; paragraph [0029]; figure 4 --	1-12
A	JP 2004301012 A (HITACHI METALS LTD), 28 October 2004 (2004-10-28); abstract; figures 1-5 -- -----	1-12

Continuation of: second sheet

International Patent Classification (IPC)

F02B 37/02 (2006.01)

F01N 13/10 (2010.01)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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