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Kaasunsyöttöjärjestelmä mäntämoottorille ja asennusmenetelmä
Gasmatningssystem för en kolvmotor och installationsförfarande

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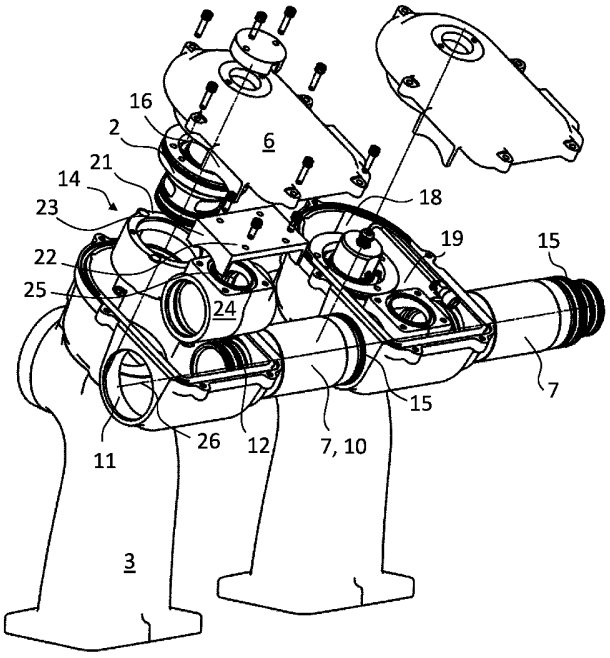
The gas feed system (1) for a reciprocating engine comprises intake ports (3) for conducting combustion air and gaseous fuel into cylinders (4) of the engine, gas feed valves (2) for feeding gaseous fuel into the intake ports (3), and valve housings (5) surrounding the gas feed valves (2). The gas feed system (1) further comprises separate gas line portions (7) for conducting gaseous fuel to the gas feed valves (2). Each gas line portion (7) is arranged between two adjacent valve housings (5) so that one end of the gas line portion (7) is in one of the valve housings (5) and the other end is in the other valve housing (5).

Kaasunsyöttöjärjestelmä (1) mäntämoottoria varten käsittää imukanavat (3) palamisilman ja kaasumaisen polttoaineen johtamiseksi moottorin sylintereihin (4), kaasunsyöttöventtiilit (2) kaasumaisen polttoaineen syöttämiseksi imukanaviin (3) ja venttiilikotelot (5) kaasunsyöttöventtiilien (2) ympärillä. Kaasunsyöttöjärjestelmä (1) käsittää lisäksi erilliset kaasulinjaosiot (7) kaasumaisen polttoaineen johtamiseksi kaasunsyöttöventtiileille (2). Kukin kaasulinjaosio (7) on järjestetty kahden vierekkäisen venttiilikotelon (5) väliin niin, että kaasulinjaosion (7) toinen pää on toisessa venttiilikoteloista (5), ja toinen pää on toisessa venttiilikotelossa (5).



Gas feed system for reciprocating engine and installation method

The invention relates to a gas feed system for a reciprocating engine. The invention also relates to a method of installing a gas feed system.

Gas operated reciprocating engines use gas feed valves to feed gaseous fuel into the intake ports of the cylinders. In the intake ports the gaseous fuel is mixed with combustion air of the engine and thereafter conducted into the cylinders. Each intake port is provided with its own gas feed valve. Gaseous fuel can be fed to the gas feed valves via a gas manifold, which is connected to all gas feed valves of the cylinders of the cylinder bank. For example, US 2008/0184964 A1 discloses such a gas feed system.

The object of the present invention is to provide an improved gas feed system for a reciprocating engine and method for installing such a system.

The object of the present invention can be achieved by a gas feed system and an installation method according to respective independent claims.

The gas feed system according to the invention comprises intake ports for conducting combustion air and gaseous fuel into cylinders of the engine, gas feed valves for feeding gaseous fuel into the intake ports, wherein each intake port is provided with its own gas feed valve, and valve housings surrounding the gas feed valves. The gas feed system further comprises separate gas line portions for conducting gaseous fuel to the gas feed valves, each gas line portion being arranged between two adjacent valve housings so that one end of the gas line portion is in one of the valve housings and the other end is in the other valve housing.

The gas feed system according to the invention has a modular design, which enables the use of the system in different engine configurations, for example in engines having a different number of cylinders. Since the ends of the gas line portions are inserted into adjacent valve housings, the valve housings support the gas line portions, and no separate bracket or other support structure is needed. This shortens the installation time of the gas feed system. The gas

feed valves can be easily serviced, since only the cover of the valve housing of the gas feed valve to be serviced must be removed. Further, the gas feed system according to the invention can be implemented without welded structures, which lowers the manufacturing costs of the system and is an advantage especially in corrosive and vibrating environments.

According to an embodiment of the invention, each valve housing is provided with a securing mechanism for securing the end of the gas line portion in the desired position within the valve housing.

According to another embodiment of the invention, the gas line portions comprise an inner gas line portion for gaseous fuel and an outer gas line portion for collecting possibly leaking gaseous fuel, the inner gas line portion being arranged inside the outer gas line portion. A leak space can be provided between the outer surface of the inner gas line portion and the inner surface of the outer gas line portion, the leak space being in flow connection with the interior of the valve housing. The valve housing can be provided with a sensor for measuring content of the gaseous fuel in the interior of the valve housing.

According to an embodiment of the invention, each valve housing is mounted to the respective intake port.

According to another embodiment of the invention, a connecting piece is arranged inside each valve housing for forming a flow connection between a gas line portion and the inlet of the gas feed valve. With the connecting piece the whole gas feed system can be made double-walled.

In the method of installing the gas feed system, a first valve housing is mounted to a first intake port, an end of a first gas line portion is inserted into the first valve housing, a second valve housing is mounted to a second intake port, which second valve housing is adjacent to the first valve housing, and the first gas line portion is moved outward from the first valve housing and the other end of the first gas line portion is inserted into the second valve housing so that one end of the first gas line portion is in the first valve housing and the other end in the second valve housing.

After installing the second valve housing, an end of a second gas line portion can be introduced into the second valve housing, a third valve housing is mounted to a third intake port, which third valve housing is adjacent to the second valve housing, and the second gas line portion is moved outward from the second valve housing and the other end of the second gas line portion is inserted into the third valve housing so that one end of the second gas line portion is in the second valve housing and the other end in the third valve housing.

If the gas line portion comprises an inner gas line portion and an outer gas line portion, an end of the inner gas line portion and an end of the outer gas line portion of the first gas line portion are inserted into the first valve housing, the second valve housing is mounted to the second intake port, the inner gas line portion is moved outward from the first valve housing and the other end of the inner gas line is inserted into the second valve housing, and the outer gas line portion is moved outward from the first valve housing and the other end of the outer gas line portion is inserted into the second valve housing.

In the following the invention will be described by way of examples with reference to the accompanying drawings, in which:

Fig. 1 shows schematically a gas feed system according to an embodiment of the invention,

Fig. 2 shows two adjacent valve housings of the gas feed system of fig. 1 and a gas line portion arranged between the valve housings,

Fig. 3 is a cross sectional view of the valve housings and the gas line portion of fig. 2, and

Fig. 4 is a cross sectional view of an inlet port and a valve housing of fig. 2.

The drawings show a gas feed system 1 of a reciprocating engine. The reciprocating engine is operated with a gaseous fuel, such as methane. The engine can be a gas engine, which is solely operated by gaseous fuel. Gaseous fuel is mixed with combustion air in intake ports 3 of the cylinders 4. Some gaseous

fuel is also fed into a prechamber, where it is ignited by a spark plug. Flames from the prechamber ignite the gas/air mixture in the cylinder 4. Alternatively, the engine can be a so-called duel fuel engine, which can be operated in two modes. In a liquid fuel mode liquid fuel, such as diesel or heavy fuel oil, is directly injected into the cylinders 4 of the engine as a sole source of energy during combustion. In a gas mode (or a dual fuel mode) a gaseous fuel is mixed with combustion air in intake ports 3 of the cylinders 4 and a small amount of liquid pilot fuel is injected into the cylinders 4 in order to ignite the mixture of air and gaseous fuel. Typically, the pilot fuel consumption in the gas mode is less than 5% of the total fuel consumption.

The engine is a large reciprocating engine, which can be used as a main and/or an auxiliary engine in ships and/or in power plants for generation of electricity and/or heat. The engine is a medium speed, four-stroke engine. However, the invention can also be applied to high-speed engines. The rotational speed of the engine is typically 300-1500 rpm. Cylinders 4 of the engine can be arranged in a single bank or in two banks in a V-configuration. In the embodiment of fig. 1 the cylinders 4 are arranged in a single bank. The engine can be provided with a turbocharger.

The engine comprises an air receiver 17 for storing combustion air. The engine further comprises a gas feed system 1 for conducting gaseous fuel from a gas source 20, such as a gas tank, into the cylinders 4. The gas feed system 1 comprises intake ports 3 for conducting combustion air from the air receiver 17 and gaseous fuel into the cylinders 4. Each cylinder 4 is provided with its own intake port 3. If each of the cylinders 4 of the engine is provided with more than one intake valve, each intake port 3 can be divided into two or more branches, which lead to the intake valves. Part of the intake port 3 is arranged inside the cylinder head. The gas feed system 1 further comprises gas feed valves 2 for feeding gaseous fuel into intake ports 3. Each intake port 3 is provided with its own gas feed valve 2. The gas feed valve 2 is mounted to the intake port 3. Further, each gas feed valve 2 is surrounded by a separate valve housing 5. The valve housing 5 is also mounted to the intake port 3. The gas feed valve 2

and the surrounding valve housing 5 are thus in close proximity to the intake port 3. The valve housing 5 is provided with a releasable cover 6.

The gas feed system 1 comprises separate gas line portions 7 for conducting gaseous fuel to the gas feed valves 2. Each gas line portion 7 is arranged between two adjacent valve housings 5. The gas line portions 7 can be arranged between adjacent valve housings 5 of the cylinders 4 that are in the same cylinder bank. One end of the gas line portion 7 is inserted into a valve housing 5 and the other end is inserted into an adjacent valve housing 5. The valve housing 5 comprises two openings 11, through which the gas line portions 7 can be inserted into the valve housing 5. The openings 11 are located on the opposite sides of the valve housing 5. The openings 11 may have a common central axis 26. The openings 11 of the adjacent valve housings 5 face each other. The central axes 27 of the gas line portions 7 are straight.

A connecting piece 14 is placed in the valve housing 5. The connecting piece 14 forms a flow connection between the two gas line portions 7 that are inserted into said valve housing 5. Naturally, in those valve housings 5 that are at the ends of a cylinder bank, there is only one gas line portion 7 inserted into the valve housing 5. However, a similar part can be used for supplying gas from the gas source 20 to the gas feed valve 2 of the first cylinder 4 of the cylinder bank. The connecting piece 14 also forms a flow connection between said gas line portions 7 and the inlet of the gas feed valve 2. Because of the connecting pieces 14 that are arranged inside the valve housings 5, the whole gas supplying system is double walled. The connecting piece 14 comprises an annular flange 21, through which the gas feed valve 2 is installed to the intake port 3. At the end of the gas line, one end of the connecting piece 14 can be connected to a bleed line, through which gas can removed from the system when the engine is not operated. The bleed line can be designed so that the valve housing 5 and the connecting piece 14 of the last cylinder 4 of the cylinder bank can be identical to the parts 5, 14 of the other cylinders 4.

The gas line portion 7 comprises an inner gas line portion 9 for gaseous fuel and an outer gas line portion 10 for collecting possibly leaking gaseous fuel.

The inner gas line portion 9 is arranged inside the outer gas line portion 10. A leak space 13 is provided between the outer surface of the inner gas line portion 9 and the inner surface of the outer gas line portion 10. The leak space 13 is in flow connection with an interior 18 of the valve housing 5. The valve housing 5 can be provided with a sensor 19 for measuring content of gaseous fuel in the interior 18 of the valve housing 5. Thus, possible fuel leaks from the inner gas line portion 9 can be detected.

The valve housing 5 is provided with a securing mechanism for securing the end of the gas line portion 7 in the desired position within the valve housing 5. The gas line portion 7 is capable of moving deeper into the valve housing 5 when the end of said gas line portion 7 is released from the securing mechanism. The securing mechanism can be mounted to the cover 6 of the valve housing 5.

In the embodiment shown in the drawings, the securing mechanism comprises a first mechanism for securing the end of the inner gas line portion 9 in the desired position within the valve housing 5. The first mechanism is formed of a securing element 22 that can be attached to the connecting piece 14. The outer surface of the inner gas line portion 9 is provided with a groove 12 and the securing element 22 with a projection 23 that engages the groove 12 and thus secures the end of the inner gas line portion 9 in its place. The securing mechanism also comprises a second mechanism for securing the end of the outer gas line portion 10 in the desired position within the valve housing 5. The outer gas line portion 10 is provided with a second groove 15 and the cover 6 of the valve housing with a second projection 16 that engages the second groove 15 and thus secures the end of the outer gas line portion 10 in its place.

In the embodiment shown in the drawings the connecting piece 14 forms a flow connection between the two inner gas line portions 9, which are inserted into the valve housing 5, and the inlet of the gas feed valve 2. The connecting piece 14 comprises a cylindrical part 24, in which the ends of inner gas flow portions 9 are inserted. The connecting piece 14 comprises an opening 25

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through which the inner gas line portions 9 can be moved when the securing element 22 is detached from the connecting piece 14.

The inner gas line portion 9 is capable of moving deeper into the valve housing 5 when the inner gas line portion 9 is released from the first securing mechanism i.e. the securing element 22 is detached from the connecting piece 14. Also the outer gas line portion 10 is capable of moving deeper into the valve housing 5, when the outer gas line portion 10 is released from the second securing mechanism i.e. the cover 6 is removed from the valve housing 5.

The gas feed system 1 can be installed in connection with the engine as follows. Reference is made to fig. 1, which shows a gas feed system having adjacent valve housings 5, 5.1-5.N that are mounted to the adjacent intake ports 3, 3.1-3.N. The first valve housing 5.1 is mounted to the first intake port 3.1. Thereafter, the connecting piece 14 (not shown in fig. 1) is placed in the first valve housing 5.1. The gas feed valve 2 is mounted to the first intake port 3.1. The ends of the inner and outer gas line portions of the first gas line portion 7.1 are inserted into the first valve housing 5.1 through the opening 11. The end of the inner gas line portion 9 is inserted into the connecting piece 14. The ends of the inner and outer gas line portions are inserted to such a depth that the other ends of said gas line portions do not hamper the installation of the second valve housing 5.2 to the second intake port 3.2.

Thereafter, the second valve housing 5.2 is mounted to the second intake port 3.2. The first intake port 3.1 is adjacent to the second intake port 3.2. The first valve housing 5.1 is adjacent to the second valve housing 5.2. The connecting piece 14 is placed in second the valve housing 5.2. The gas feed valve 2 is mounted to the second intake port 3.2. Thereafter, the inner gas line portion 9 is moved outward from the first valve housing 5.1 and the other end of the inner gas line portion 9 is inserted into the second valve housing 5.2 through the opening 11, which faces the opening 11 of the first valve housing 5.1. The other end of the inner gas line portion 9 is inserted into the connecting piece 14. Thereafter, the outer gas line portion 10 is moved outward from the first valve housing 5.1 and the other end of outer gas line portion 10 is inserted into the

second valve housing 5.2. Thus, one end of the first gas line portion 7.1 is in the first valve housing 5.1 and the other end in the second valve housing 5.2. The end of the inner gas line portion is secured in its place by attaching the securing element 22 to the connecting piece 14 of the first valve housing 5.1. The end of the outer gas line portion 10 is secured in its place by attaching the cover 6 to first the valve housing 5.1.

Thereafter, the ends of the inner and outer gas line portions of the a second gas line portion 7.2 are inserted into the second valve housing 5.2 to such a depth that the other ends of said gas line portions do not hamper the installation of the third valve housing 5.3 to the third intake port 3.3. The third valve housing 5.3 is mounted to the third intake port 3.3. The second intake port 3.2 is adjacent to the third intake port 3.3. The second valve housing 5.2 is adjacent to the third valve housing 5.3. The connecting piece 14 is placed in the third valve housing 5.3. The gas feed valve 2 is mounted to the third intake port 3.3. The inner gas line portion 9 is moved outward from the second valve housing 5.2 and the other end of the inner gas line portion 9 is inserted into the third valve housing 5.3. Thereafter, the outer gas line portion 10 is moved outward from the second valve housing 5.2 and the other end of the outer gas line portion 10 is inserted into the third valve housing 5.3. Thus, one end of the second gas line portion 7.2 is in the second valve housing 5.2 and the other end in the third valve housing 5.3. The ends of the inner gas line portions 9 that are in the second valve housing 5.2 are secured by attaching the securing element 22 to the connecting piece 14 of the second valve housing 5.2. The ends of the outer gas line portions 10 that are in the second valve housing 5.2 are secured by attaching the cover 6 to the second valve housing 5.2.

The other valve housings 5, gas feed valves 2 and the gas line portions 7 of the gas feed system 1 can be installed in a similar manner. One valve housing 5, typically the valve housing of the cylinder 4 at the end of the cylinder bank, is connected to the gas source 20.

Claims:

1. A gas feed system (1) for a reciprocating engine, the gas feed system (1) comprising:

- intake ports (3) for conducting combustion air and gaseous fuel into cylinders (4) of the engine,

- gas feed valves (2) for feeding gaseous fuel into the intake ports (3), wherein each intake port (3) is provided with its own gas feed valve (2), and

- valve housings (5) surrounding the gas feed valves (2),

which gas feed system (1) comprises separate gas line portions (7) for conducting gaseous fuel to the gas feed valves (2), each gas line portion (7) being arranged between two adjacent valve housings (5) so that one end of the gas line portion (7) is in one of the valve housings (5) and the other end is in the other valve housing (5), **characterized** in that the gas line portions (7) comprise an inner gas line portion (9) for gaseous fuel and an outer gas line portion (10) for collecting possibly leaking gaseous fuel, the inner gas line portion (9) being arranged inside the outer gas line portion (10), that a leak space (13) is provided between the outer surface of the inner gas line portion (9) and the inner surface of the outer gas line portion (10), and said leak space (13) is in flow connection with the interior (18) of the valve housing (5) and that a connecting piece (14) is arranged inside each valve housing (5) for forming a flow connection between a gas line portion (7) and the inlet of the gas feed valve (2).

2. The gas feed system according to claim 1, **characterized** in that each valve housing (5) is provided with a securing mechanism (16, 22) for securing the end of the gas line portion (7) in the desired position within the valve housing (5).

3. The gas feed system (1) according to claim 2, **characterized** in that the gas line portion (7) is capable of moving deeper into the valve housing (5), when said gas line portion (7) is released from the securing mechanism (16, 22).

4. The gas feed system (1) according to claim 1, **characterized** in that the valve housing (5) is provided with a sensor (19) for measuring content of the gaseous fuel in the interior (18) of the valve housing (5).

5. The gas feed system (1) according to claim 1 , **characterized** in the central axes (27) of the gas line portions (7) are straight.

6. The gas feed system (1) according to claim 1or 5, **characterized** in that the valve housings (5) are provided with openings (11), through which the gas line portions (7) are inserted into the valve housings (5), and that the openings of the adjacent valve housings (5) face each other.

7. The gas feed system (1) according to any of the preceding claims, **characterized** in that each valve housing (5) is mounted to the respective intake port (3).

8. A method of installing the gas feed system (1) according to any of claims 1-10 in connection with the reciprocating engine, in which method a first valve housing (5.1) is mounted to a first intake port (3.1), **characterized** in that

- an end of a first gas line portion (7.1) is inserted into the first valve housing (5.1),

- a second valve housing (5.2) is mounted to a second intake port (3.2), which second valve housing (5.2) is adjacent to the first valve housing (5.1), and

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- the first gas line portion (7.1) is moved outward from the first valve housing (5.1) and the other end of the first gas line portion (7.1) is inserted into the second valve housing (5.2) so that one end of the first gas line portion (7.1) is in the first valve housing (5.1) and the other end in the second valve housing (5.2).

9. The method according to claim 8, **characterized** in that

- an end of a second gas line portion (7.2) is introduced into the second valve housing (5.2),

- a third valve housing (5.3) is mounted to a third intake port (3.3), which third valve housing (5.3) is adjacent to the second valve housing (5.2), and

- the second gas line portion (7.2) is moved outward from the second valve housing (5.2) and the other end of the second gas line portion (7.2) is inserted into the third valve housing (5.3) so that one end of the second gas line portion (7.2) is in the second valve housing (5.2) and the other end in the third valve housing (5.3).

10. The method according to claim 8 or 9, **characterized** in that the gas line portion (7.1, 7.2) comprises an inner gas line portion (9) and an outer gas line portion (10), and that

- an end of the inner gas line portion (9) and an end of the outer gas line portion (10) of the first gas line portion (7.1) are inserted into the first valve housing (5.1),

- the second valve housing (5.2) is mounted to the second intake port (3.2),

- the inner gas line portion (9) is moved outward from the first valve housing (5.1) and the other end of the inner gas line portion (9) is inserted into the second valve housing (5.2), and

- the outer gas line portion (10) is moved outward from the first valve housing (5.1) and the other end of the outer gas line portion (10) is inserted into the second valve housing (5.2).

Patenttivaatimukset

1. Kaasunsyöttöjärjestelmä (1) mäntämoottoria varten, jolloin kaasunsyöttöjärjestelmä (1) käsittää

- imukanavat (3) palamisilman ja kaasumaisen polttoaineen johtamiseksi moottorin sylintereihin (4),

- kaasunsyöttöventtiilit (2) kaasumaisen polttoaineen syöttämiseksi imukanaviin (3), jolloin kukin imukanava (3) on varustettu omalla kaasunsyöttöventtiilillään (2), ja

- venttiilikotelot (5) kaasunsyöttöventtiilien (2) ympärillä,

joka kaasunsyöttöjärjestelmä (1) käsittää erilliset kaasulinjaosiot (7) kaasumaisen polttoaineen johtamiseksi kaasunsyöttöventtiileille (2), jolloin kukin kaasulinjaosio (7) on järjestetty kahden vierekkäisen venttiilikotelon (5) väliin niin, että kaasulinjaosion (7) toinen pää on toisessa venttiilikoteloista (5), ja toinen pää on toisessa venttiilikotelossa (5), **tunnettu** siitä, että kaasulinjaosiot (7) käsittävät sisemmän kaasulinjaosion (9) kaasumaista polttoainetta varten ja ulomman kaasulinjaosion (10) mahdollisesti vuotavan kaasumaisen polttoaineen keräämiseksi, jolloin sisempi kaasulinjaosio (9) on järjestetty ulomman kaasulinjaosion (10) sisäpuolelle, että sisemmän kaasulinjaosion (9) ulkopinnan ja ulomman kaasulinjaosion (10) sisäpinnan väliin on järjestetty vuotetila (13), ja mainittu vuotetila (13) on virtausyhteydessä venttiilikotelon (5) sisustan (18) kanssa, ja että kunkin venttiilikotelon (5) sisään on järjestetty yhdyskappale (14) virtausyhteyden muodostamiseksi kaasulinjaosion (7) ja kaasunsyöttöventtiilin (2) tulon välille.

2. Patenttivaatimuksen 1 mukainen kaasunsyöttöjärjestelmä, **tunnettu** siitä, että kukin venttiilikotelo (5) on varustettu kiinnitysmekanismilla (16, 22) kaasulinjaosion (7) pään kiinnittämiseksi haluttuun asemaan venttiilikotelossa (5).

3. Patenttivaatimuksen 2 mukainen kaasunsyöttöjärjestelmä (1), **tunnettu** siitä, että kaasulinjaosio (7) pystyy menemään syvemmälle venttiilikoteloon (5), kun mainittu kaasulinjaosio (7) vapautetaan kiinnitysmekanismista (16, 22).

4. Patenttivaatimuksen 1 mukainen kaasunsyöttöjärjestelmä (1), **tunnettu** siitä, että venttiilikotelo (5) on varustettu anturilla (19) kaasumaisen polttoaineen pitoisuuden mittaamiseksi venttiilikotelon (5) sisustassa (18).

5. Patenttivaatimuksen 1 mukainen kaasunsyöttöjärjestelmä (1), **tunnettu** siitä, että kaasulinjaosioiden (7) keskiakselit (27) ovat suorat.

6. Patenttivaatimuksen 1 tai 5 mukainen kaasunsyöttöjärjestelmä (1), **tunnettu** siitä, että venttiilikotelot (5) on varustettu aukoilla (11), joiden kautta kaasulinjaosiot (7) on viety venttiilikoteloihin (5), ja että vierekkäisten venttiilikoteloiden (5) aukot osoittavat toisiaan kohti.

7. Jonkin edeltävistä patenttivaatimuksista mukainen kaasunsyöttöjärjestelmä (1), **tunnettu** siitä, että kukin venttiilikotelo (5) on asennettu vastaavaan imukanavaan (3).

8. Menetelmä jonkin patenttivaatimuksista 1 - 10 mukaisen kaasunsyöttöjärjestelmän (1) asentamiseksi mäntämoottorin yhteyteen, jossa menetelmässä asennetaan ensimmäinen venttiilikotelo (5.1) ensimmäiseen imukanavaan (3.1), **tunnettu** siitä, että

- ensimmäisen kaasulinjaosion (7.1) pää viedään ensimmäisen venttiilikotelon (5.1) sisään,

- toinen venttiilikotelo (5.2) asennetaan toiseen imukanavaan (3.2), joka toinen venttiilikotelo (5.2) on ensimmäisen venttiilikotelon (5.1) vieressä, ja

- ensimmäistä kaasulinjaosiota (7.1) liikutetaan ulospäin ensimmäisestä venttiilikotelosta (5.1), ja ensimmäisen kaasulinjaosion (7.1) toinen pää viedään toisen venttiilikotelon (5.2) sisään niin, että ensimmäisen kaasulinjaosion (7.1) toinen pää on ensimmäisessä venttiilikotelossa (5.1) ja toinen pää toisessa venttiilikotelossa (5.2).

9. Patenttivaatimuksen 8 mukainen menetelmä, **tunnettu** siitä, että

- toisen kaasulinjaosion (7.2) pää viedään toisen venttiilikotelon (5.2) sisään,

- kolmas venttiilikotelo (5.3) asennetaan kolmanteen imukanavaan (3.3), joka kolmas venttiilikotelo (5.3) on toisen venttiilikotelon (5.2) vieressä, ja

- toista kaasulinjaosiota (7.2) liikutetaan ulospäin toisesta venttiilikotelosta (5.2), ja toisen kaasulinjaosion (7.2) toinen pää viedään kolmannen venttiilikotelon (5.3) sisään niin, että toisen kaasulinjaosion (7.2) toinen pää on toisessa venttiilikotelossa (5.2) ja toinen pää kolmannessa venttiilikotelossa (5.3).

10. Patenttivaatimuksen 8 tai 9 mukainen menetelmä, **tunnettu** siitä, että kaasulinjaosio (7.1, 7.2) käsittää sisemmän kaasulinjaosion (9) ja ulomman kaasulinjaosion (10), ja siitä, että

- ensimmäisen kaasulinjaosion (7.1) sisemmän kaasulinjaosion (9) pää ja ulomman kaasulinjaosion (10) pää viedään ensimmäisen venttiilikotelon (5.1) sisään,

- toinen venttiilikotelo (5.2) asennetaan toiseen imukanavaan (3.2),

- sisempää kaasulinjaosiota (9) liikutetaan ulospäin ensimmäisestä venttiilikotelosta (5.1), ja sisemmän kaasulinjaosion (9) toinen pää viedään toisen venttiilikotelon (5.2) sisään, ja

- ulompaa kaasulinjaosiota (10) liikutetaan ulospäin ensimmäisestä venttiilikotelosta (5.1), ja ulomman kaasulinjaosion (10) toinen pää viedään toisen venttiilikotelon (5.2) sisään.

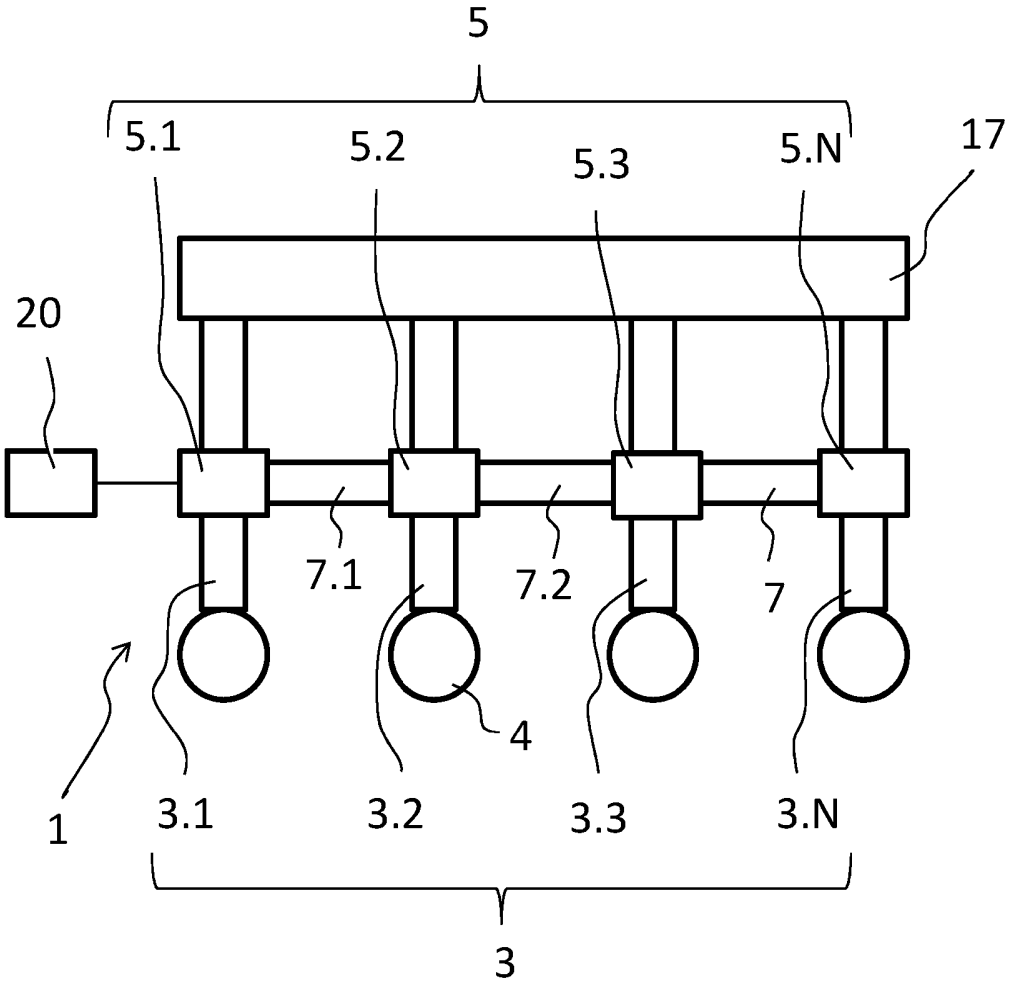

Fig. 1

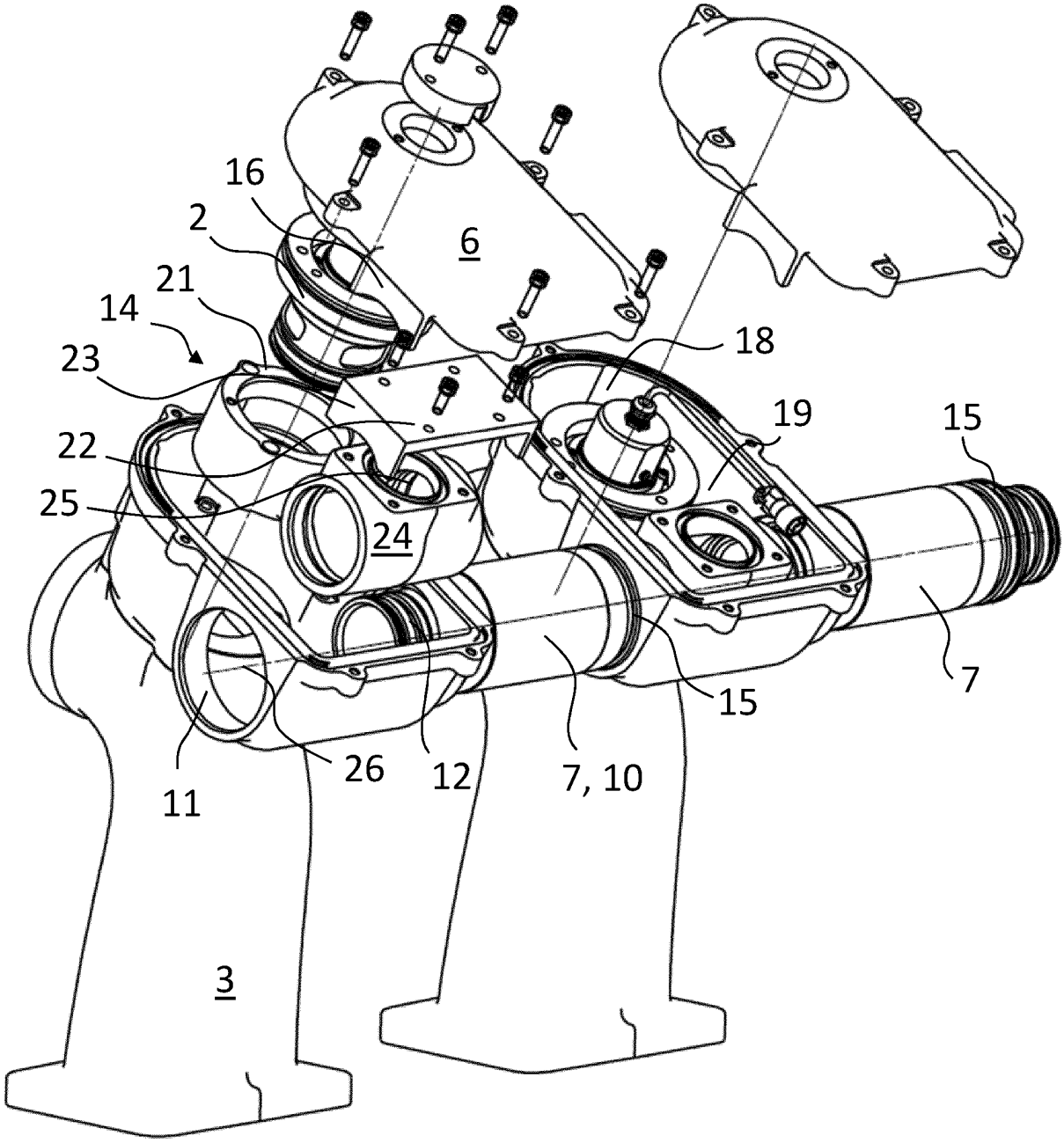

Fig. 2

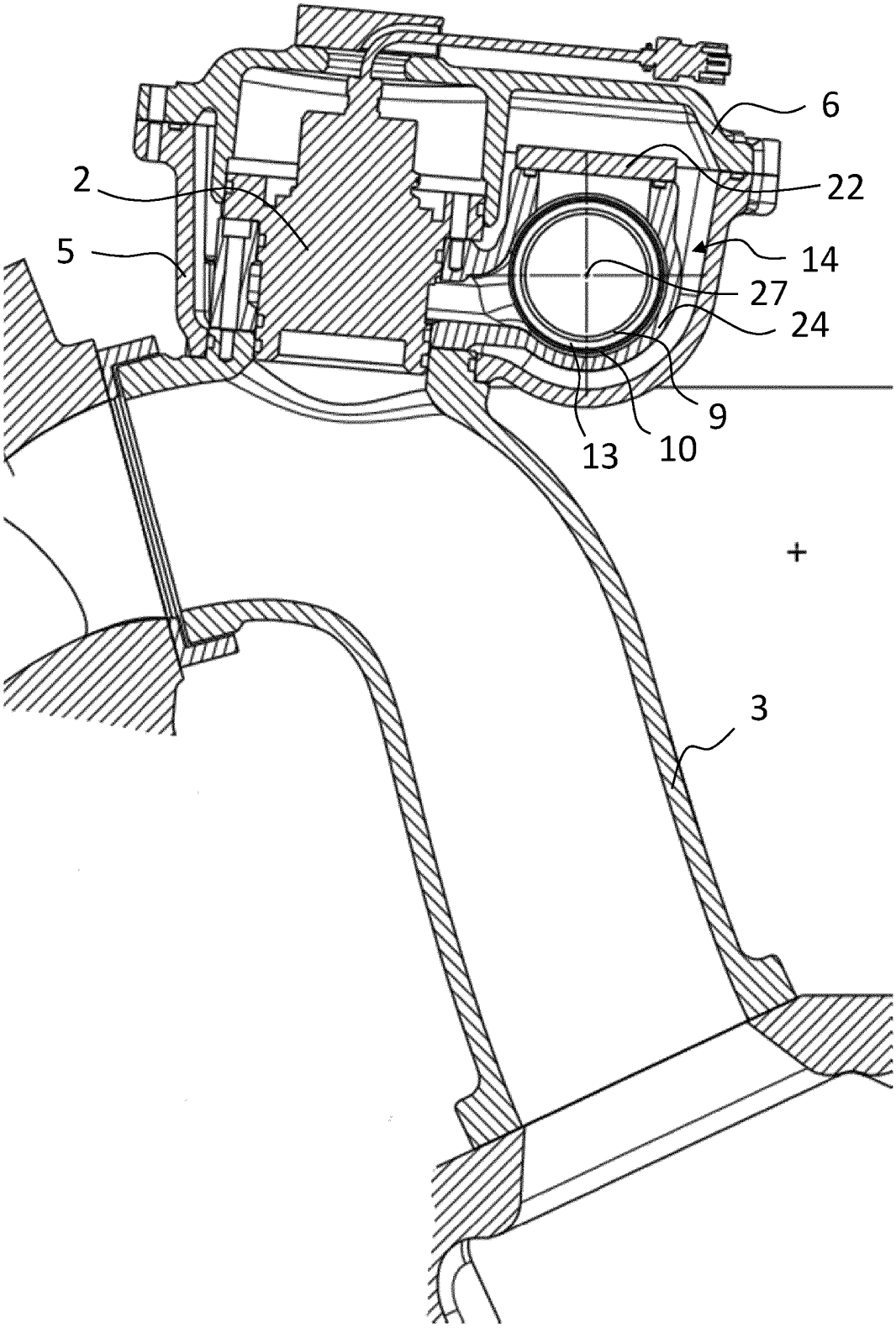

Fig. 3

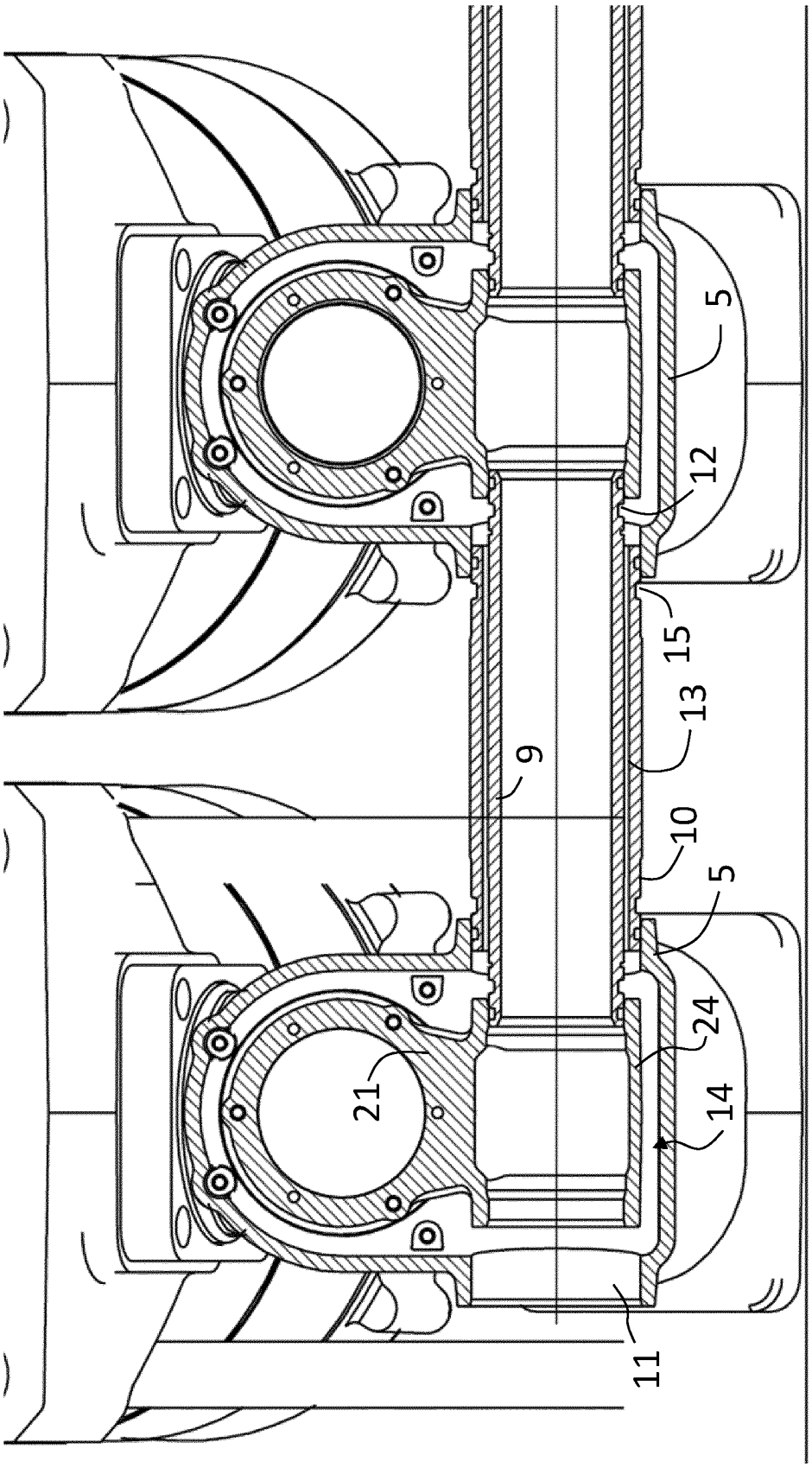

Fig. 4

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