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(72) Inventors:
• **Kawakami, Nobuhiro**
Minato-ku, Tokyo 108-8410 (JP)
• **Kido, Yusuke**
Minato-ku, Tokyo 108-8410 (JP)
• **Hori, Sumito**
Minato-ku, Tokyo 108-8410 (JP)

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(74) Representative: **Vossius & Partner**
Patentanwälte Rechtsanwälte mbB
Siebertstrasse 3
81675 München (DE)

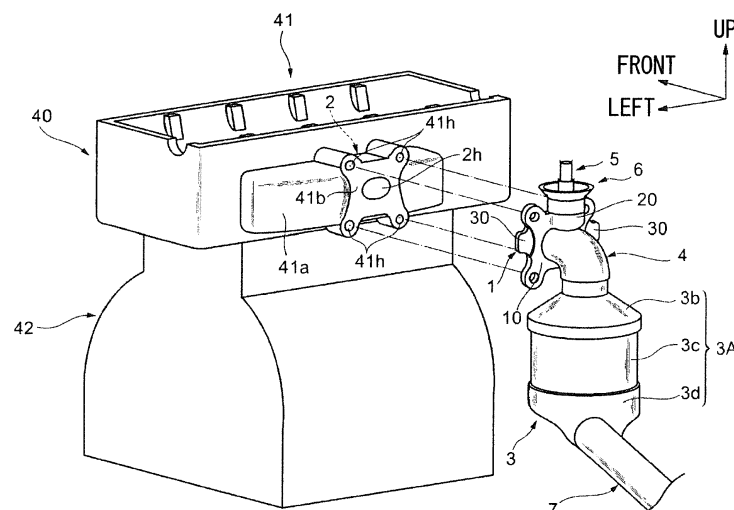
(71) Applicant: **Mitsubishi Jidosha Kogyo K.K.**
Tokyo 108-8410 (JP)

(54) **EXHAUST SYSTEM STRUCTURE OF INTERNAL COMBUSTION ENGINE**

(57) An exhaust system structure of an internal combustion engine (40), includes an exhaust manifold (2) which is configured to be connected to a cylinder of the internal combustion engine (40), an exhaust pipe (4) which is provided on a downstream side of an exhaust flow from the exhaust manifold (2), a connection member (1) including a flange portion (10) which connects the exhaust pipe (4) and the exhaust manifold (2) to each other and a boss portion (20) which is provided integrally

with the flange portion (10) and is fixed to a portion of an outer circumferential surface of the exhaust pipe (4), a sensor (5) which is attached to the boss portion (20) and is configured to detect components of the exhaust, and a purification device (3) which is connected to a downstream end of the exhaust pipe (4) and is disposed on a side opposite to the boss portion (20) with respect to the exhaust pipe (4).

Fig. 1



Description

Technical Field

[0001] The present invention relates to an exhaust system structure for compactly disposing an exhaust purification device of an internal combustion engine, an exhaust pipe provided between the purification device and an exhaust manifold, and a sensor attached to the exhaust pipe.

Background Art

[0002] Generally, an exhaust system structure of an internal combustion engine includes an exhaust manifold which is connected to a cylinder and a purification device which is provided on a downstream side of an exhaust flow from the exhaust manifold. In addition, a sensor which detects, for example, an exhaust air-fuel ratio or NOx concentration (hereinafter, referred to as "exhaust component") is provided in an exhaust pipe which connects the exhaust manifold and the purification device to each other, and information detected by the sensor is used for controlling the internal combustion engine.

[0003] In the exhaust system structure as described above, since exhaust flowing out from a plurality of exhaust ports merges in a process of flowing through the exhaust manifold and mixes with each other in the exhaust pipe to flow into the purification device, as the exhaust gets closer to the purification device, the way of flow is likely to be complicated. Therefore, as the position of the sensor is on the downstream side of the exhaust pipe (that is, closer to purification device), the way the exhaust hits the sensor is likely to vary and the detection accuracy of the sensor is likely to decrease.

[0004] On the other hand, Patent Document 1 discloses a technique in which each branch of an exhaust manifold is connected to a common exhaust gas sensor using a communication passage and air-fuel ratio of the internal combustion engine is controlled based on the air-fuel ratio of the exhaust gas of each cylinder detected by the exhaust gas sensor. According to the technique, since the exhaust gas sensor is provided at one point where the downstream ends of the respective communication passages are gathered, it can be considered that variations in the way the exhaust hits the exhaust gas sensor can be suppressed.

Related art Document

Patent Document

[0005] [Patent Document 1] JP-A-2006-17081

Summary of Invention

Technical Problem

[0006] The invention relates to an exhaust system structure of an internal combustion engine, and an object thereof is to improve a detection accuracy of a sensor and realize space saving. The invention is not limited to the object and another object thereof is also to exhibit operational effects which are derived from each configuration illustrated in the embodiments for carrying out the invention to be described below and which cannot be obtained by the technique of the related art.

Solution to Problem

[0007] According to the invention, there is provided an exhaust system structure of an internal combustion engine, including: an exhaust manifold which is configured to be connected to a cylinder of the internal combustion engine, an exhaust pipe which is provided on a downstream side of an exhaust flow from the exhaust manifold, a connection member including a flange portion which connects the exhaust pipe and the exhaust manifold to each other and a boss portion which is provided integrally with the flange portion and is fixed to a portion of an outer circumferential surface of the exhaust pipe, a sensor which is attached to the boss portion and is configured to detect components of the exhaust, and a purification device which is connected to a downstream end of the exhaust pipe and is disposed on a side opposite to the boss portion with respect to the exhaust pipe.

Brief Description of Drawings

[0008]

Fig. 1 is an exploded perspective view illustrating an exhaust system structure together with an internal combustion engine according to an embodiment.

Fig. 2 is a cross-sectional view of a main portion of the exhaust system structure of Fig. 1.

Fig. 3 is an exploded perspective view for explaining an attachment structure of a protective member with respect to a connection member.

Fig. 4 is a front view of the connection member of Fig. 3 (view seen from side where exhaust pipe is attached).

Fig. 5 is a side view for explaining the disposition of the exhaust system structure of Fig. 1.

Description of Embodiments

[0009] In the technique of Patent Document 1, since the communication passage for guiding the exhaust from each branch of the exhaust manifold to the common exhaust gas sensor is provided separately from the exhaust pipe between the exhaust manifold and the purification

device, space for installation of the communication passage is necessary. Therefore, a new structure which improves the detection accuracy of the sensor and suppresses the exhaust system structure to be compact is required.

[0010] The invention is invented in view of the problems as described above, and relates to an exhaust system structure of an internal combustion engine, and an object thereof is to improve a detection accuracy of a sensor and realize space saving. The invention is not limited to the object and another object thereof is also to exhibit operational effects which are derived from each configuration illustrated in the embodiments for carrying out the invention to be described below and which cannot be obtained by the technique of the related art.

[0011] An exhaust system structure of an internal combustion engine as an embodiment will be described with reference to the drawings. The following embodiments are merely examples and there is no intention to exclude the application of various modifications and technologies which are not explicitly described in the following embodiments.

[1. Configuration]

[1-1. Engine]

[0012] The exhaust system structure according to this embodiment is applied to an engine (internal combustion engine) 40 illustrated in Fig. 1. The engine 40 of this embodiment is a multi-cylinder engine mounted on a vehicle (not illustrated). In the following description, a direction of the engine 40 is defined in a state where the engine 40 is mounted on the vehicle. In other words, a front-rear direction and a left-right direction thereof are determined with reference to the vehicle on which the engine 40 is mounted. In addition, the direction of gravity is defined as downward, and a direction opposite thereto is defined as upward. In Fig. 1, a cylinder head 41 and a cylinder block 42 of the engine 40 are illustrated in a simplified manner.

[0013] The engine 40 has the cylinder head 41 and the cylinder block 42 fixed to each other. In this embodiment, a case where the cylinder head 41 is provided above the cylinder block 42 and a crankshaft extends in the left-right direction will be described. In other words, the engine 40 of this embodiment is a horizontal placement engine in which the direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel is an up-down direction. The direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel and an extending direction of the crankshaft may not be consistent with each of the up-down direction and the left-right direction strictly and may have a slight angle with respect to the up-down direction and the left-right direction, for example.

[0014] A plurality of cylinders are provided in parallel in the left-right direction inside the engine 40. An exhaust

manifold 2 forming an exhaust passage is connected to each of these cylinders. The exhaust manifold 2 has a shape in which an upstream side of the exhaust flow branches into a plurality of branches and the downstream side thereof collects into one. Exhaust discharged from each cylinder is gathered in one place during flowing through the exhaust manifold 2.

[0015] The exhaust manifold 2 of this embodiment is built in the cylinder head 41. Specifically, the exhaust manifold 2 is built in an overhang portion 41 a in which a side surface of the cylinder head 41 on the exhaust side bulges outward. The cylinder head 41 of this embodiment is provided such that the overhang portion 41 a bulges rearward. In other words, the exhaust manifold 2 of this embodiment is positioned behind the cylinder of the engine 40.

[0016] An opening 2h (hereinafter, referred to as exhaust port 2h) at a downstream end of the exhaust manifold 2 is formed on a side surface of the overhang portion 41 a of the cylinder head 41 (outer surface facing rearward in this embodiment). In addition, a planar attachment surface 41 b perpendicular to an exhaust flow direction is formed around the exhaust port 2h. The attachment surface 41 b of this embodiment is provided as a surface that spreads in the up-down direction and the left-right direction. A plurality of fastening holes 41 h to which fasteners (not illustrated) are fastened are formed on the attachment surface 41 b. In this embodiment, four fastening holes 41 h are arranged at substantially regular intervals in a circumferential direction of the exhaust port 2h.

[1-2. Exhaust system structure]

[0017] The exhaust system structure according to this embodiment includes a purification device 3 which purifies exhaust, the exhaust manifold 2 described above, an exhaust pipe 4 which guides exhaust from the exhaust manifold 2 to the purification device 3, and a connection member 1 which is provided at a connection portion between the exhaust manifold 2 and the exhaust pipe 4. In addition, the exhaust system structure according to this embodiment further includes a sensor 5 which is attached to the exhaust pipe 4 via the connection member 1, a sensor cover 6 for surrounding the outer circumference of the sensor 5 to block heat, and a heat protector 8 (protection member, see Fig. 3) which covers the exhaust pipe 4 and the purification device 3.

[0018] The purification device 3 contains a filter (not illustrated) which traps particulate matter in the exhaust and a catalyst (not illustrated) which oxidizes or reduces predetermined components in the exhaust in a case 3A. The case 3A of this embodiment is configured of a main body portion 3c formed in a substantially cylindrical shape and an inlet portion 3b and an outlet portion 3d which are fixed to both ends of the main body portion 3c, respectively. The main body portion 3c is a portion for holding a catalyst or the like. In addition, the inlet portion

3b is a portion forming an inlet of exhaust in the purification device 3. The inlet portion 3b is formed in a hollow shape gradually reduced in diameter toward the upstream side. The upstream end of the inlet portion 3b is connected to the exhaust pipe 4. On the other hand, the outlet portion 3d is a portion forming the outlet of the exhaust in the purification device 3. The outlet portion 3d is formed in a hollow shape gradually reduced in diameter toward the downstream side. The downstream end of the outlet portion 3d is connected to a pipe 7 connected to another purification device (not illustrated).

[0019] The exhaust pipe 4 forms an exhaust passage between the exhaust manifold 2 and the purification device 3. In other words, the exhaust pipe 4 is provided on the downstream side of the exhaust flow from the exhaust manifold 2 and on the upstream side of the exhaust flow relative to the purification device 3. The exhaust pipe 4 is formed in a curved shape so that the directions of the openings at both ends thereof are substantially perpendicular to each other. The exhaust pipe 4 of this embodiment is provided in such a posture that the exhaust pipe extends backward from the exhaust port 2h and then bends downward. In other words, the exhaust pipe 4 has an upstream end opening toward the front and a downstream end opening downward. The diameter of the exhaust pipe 4 is substantially uniform in the exhaust flow direction.

[0020] The upstream end of the exhaust pipe 4 is connected to the exhaust manifold 2 via the connection member 1 so as to communicate with the exhaust port 2h. In this embodiment, the upstream end of the exhaust pipe 4 is connected to the attachment surface 41 b of the cylinder head 41 via the connection member 1. In addition, an inlet portion 3b of the case 3A of the purification device 3 is fixed to the downstream end of the exhaust pipe 4, for example, by welding. As illustrated in Fig. 2, the exhaust pipe 4 has a hole portion 4h for allowing the tip of the sensor 5 to protrude into the exhaust pipe 4. The hole portion 4h is formed in the vicinity of the upstream end of the exhaust pipe 4 and is drilled on the side opposite to the side where the downstream end is positioned with respect to the upstream end thereof. The hole portion 4h of this embodiment is provided on the upper side surface of the outer circumferential surface of the exhaust pipe 4.

[0021] As illustrated in Fig. 3, the connection member 1 also serves as three elements which are a flange for connecting the exhaust pipe 4 to the exhaust manifold 2, a boss for attaching the sensor 5 to the exhaust pipe 4, and an attachment base for attaching the heat protector 8. The connection member 1 has a flange portion 10, a boss portion 20, and an attachment portion 30 which function as the flange, the boss, and the attachment base, respectively. The flange portion 10, the boss portion 20, and the attachment portion 30 are integrally formed by casting, for example, using ductile cast iron as a material.

[0022] The flange portion 10 is a flat plate-shaped portion fixed to the exhaust manifold 2 and the exhaust pipe 4. The flange portion 10 has an opening 11 which is

passed through the flange portion in a thickness direction thereof, a plurality of fastening portions 12 which are fastened and fixed to the exhaust manifold 2 (attachment surface 41 b of cylinder head 41 in this embodiment), and a recessed portion 13 which is provided at the outer edge portion between the fastening portions 12 adjacent to each other. As illustrated in Fig. 2, the edge portion of the flange portion 10 surrounding the opening 11 is fixed to the upstream end of the exhaust pipe 4, for example, by welding. In other words, the flange portion 10 is fixed to the exhaust pipe 4 in a state where the opening 11 communicates with the exhaust pipe 4. In addition, the flange portion 10 is fixed to the exhaust manifold 2 in a state where the opening 11 and the exhaust port 2h communicate with each other. Hereinafter, the surface of the outer surfaces of the flange portion 10, which abuts against the attachment surface 41 b of the cylinder head 41 in a state where the flange portion 10 is fixed to the exhaust manifold 2, is referred to as a fastening surface 10a and a surface opposite thereto is referred to as an end surface 10b.

[0023] As illustrated in Fig. 3 and Fig. 4, the fastening portion 12 is provided on an outside of the opening 11 in the radial direction and two fastening portions 12 are respectively disposed on the upper side and the lower side of the opening 11 (that is, at four corners of opening 11). In this embodiment, the four fastening portions 12 are disposed at substantially regular intervals in the circumferential direction of the opening 11 and the boss portion 20 is positioned between the two upper fastening portions 12. These fastening portions 12 have through holes 12h which are provided at positions corresponding to the fastening holes 41 h of the attachment surface 41 b of the cylinder head 41, respectively. The fastening portion 12 of this embodiment is fixed to the cylinder head 41 by fastening a fastener (not illustrated) inserted through the through hole 12h to the fastening hole 41 h.

[0024] The recessed portion 13 is a portion recessed toward the opening 11 side in the outer edge portion of the flange portion 10. The recessed portion 13 of this embodiment includes two first recessed portions 13A between which the opening 11 is interposed and which are disposed facing each other and a second recessed portion 13B which is disposed on the opposite side to the boss portion 20 with respect to the opening 11. The first recessed portion 13A is disposed between the upper and lower fastening portions 12 positioned on the same side with respect to the opening 11. The second recessed portion 13B is disposed between the two lower fastening portions 12. In other words, the boss portion 20, the fastening portion 12, and the recessed portion 13 are provided at positions deviating from each other in the circumferential direction of the opening 11. In a state where the connection member 1 is fixed to the exhaust pipe 4, the second recessed portion 13B is provided adjacent to a downstream end (a connection position with the inlet portion 3b) of the exhaust pipe 4.

[0025] As illustrated in Fig. 4, the second recessed por-

tion 13B is formed to have recessed amount larger than that of the first recessed portion 13A. In other words, the recessed amount Db of the second recessed portion 13B is set larger than the recessed amount Da of the first recessed portion 13A ($Db > Da$). The recessed amounts Da and Db referred to here are a distance between a portion most recessed in the recessed portion 13 (closest to opening 11) and a straight line L which connects between the edge portions which are positioned on the outermost side of the fastening portion 12 positioned on both sides of the recessed portion 13 (which are farthest from opening 11 in up-down direction or left-right direction).

[0026] As illustrated in Fig. 3 and Fig. 4, the boss portion 20 is a tubular portion to which the sensor 5 is attached. The boss portion 20 is provided integrally with the flange portion 10. The boss portion 20 is provided to bulge from the end surface 10b of the flange portion 10 in the thickness direction on an outside of the opening 11 of the flange portion 10 in the radial direction. The boss portion 20 of this embodiment has an axis C2 orthogonal to the center axis C1 of the opening 11 of the flange portion 10. The center axis C1 is an axis extending in the thickness direction of the flange portion 10. In other words, the axis C2 of the boss portion 20 of this embodiment extends in parallel with the fastening surface 10a and the end surface 10b of the flange portion 10. The boss portion 20 has an inner circumferential surface 23 which surrounds the axis C2, an outer wall surface 24 which is positioned outside the inner circumferential surface 23 in the radial direction, a lower end surface 21 and an upper end surface 22 which are provided at both ends of the inner circumferential surface 23 and the outer wall surface 24.

[0027] A female thread process for fixing the sensor 5 is performed on the inner circumferential surface 23. In addition, the outer wall surface 24 is formed in a curved surface shape overhung rearward (exhaust pipe 4 side) from the end surface 10b of the flange portion 10. The lower end surface 21 is a surface facing downward (opening 11 side) and forms a curved surface continuous with the edge portion of the flange portion 10 in which the opening 11 is formed. In other words, the lower end surface 21 is formed in a curved surface shape along a portion of the outer circumferential surface on the upper side of the exhaust pipe 4. On the other hand, the upper end surface 22 is a surface facing upward (side opposite to opening 11) and is formed in a plane shape perpendicular to the axis C2. As illustrated in Fig. 2, in a state where a columnar space surrounded by the inner circumferential surface 23 communicates with the hole portion 4h of the exhaust pipe 4, the boss portion 20 is fixed to a portion of the outer circumferential surface of the exhaust pipe 4 by welding, for example.

[0028] As illustrated in Fig. 3, the attachment portion 30 is a flat plate-like portion to which the heat protector 8 is attached. The attachment portion 30 protrudes from the flange portion 10. Two attachment portions 30 are disposed so as to face each other in a state where the

opening 11 is interposed therebetween. The attachment portion 30 of this embodiment protrudes outward from the outer edge portion of each first recessed portion 13A of the flange portion 10 in the radial direction. In other words, the attachment portion 30 and the first recessed portion 13A positioned on the same side with respect to the opening 11 are provided in parallel in the radial direction of the flange portion 10. Each attachment portion 30 has a flat welding surface 31 facing the exhaust pipe 4 side. One surface portion of an L-shaped bracket 9 for attaching the heat protector 8 is welded to the welding surface 31. A fastening hole 9h is drilled in the other surface portion of the bracket 9.

[0029] The heat protector 8 is for blocking the heat of the exhaust flowing through in the exhaust pipe 4 and the purification device 3 from the peripheral devices. The heat protector 8 is formed in a shape corresponding to the external shape of the exhaust pipe 4 and the purification device 3. The heat protector 8 has a fastening hole 8h for fixing and an edge portion 8a which is formed in a curved shape along the outer wall surface 24 of the boss portion 20 of the connection member 1. The heat protector 8 is attached to the connection member 1 by a fastener (not illustrated) inserted through the fastening hole 8h and the fastening hole 9h of the bracket 9 in a state where the edge portion 8a is brought close to the outer wall surface 24 of the boss portion 20. The edge portion 8a of the heat protector 8 and the outer wall surface 24 of the boss portion 20 may be used for positioning the heat protector 8.

[0030] The sensor 5 detects components of the exhaust. Specific examples of the sensor 5 include a linear air-fuel ratio sensor (LAFS) which detects the oxygen concentration in the exhaust, a NOx sensor which detects the NOx concentration in the exhaust, and the like. The information detected by the sensor 5 is used for controlling the engine 40, for example. As illustrated in Fig. 2, the sensor 5 includes a substantially columnar detection portion 5a which is provided with a detection element, a screw portion 5b which has an outer circumferential surface subjected to a male thread process, a seat portion 5c which has a larger radial dimension than the detection portion 5a and the screw portion 5b, and an output portion 5d in which an output terminal is built. The detection portion 5a, the screw portion 5b, the seat portion 5c, and the output portion 5d are arranged coaxially in this order.

[0031] The sensor 5 is fixed to the boss portion 20 by screwing the screw portion 5b with the inner circumferential surface 23 of the boss portion 20 of the connection member 1. In a state where the sensor 5 is fixed to the boss portion 20, the detection portion 5a is provided by protruding into the exhaust pipe 4 through the hole portion 4h of the exhaust pipe 4. The seat portion 5c interposes a portion (bottom surface portion 6a to be described below) of the sensor cover 6 between the seat portion 5c and the upper end surface 22 of the boss portion 20.

[0032] The sensor cover 6 is for blocking the heat from the surroundings of the sensor 5. The sensor cover 6 is

formed in a cup shape having such a size so as to surround the sensor 5 with a gap between the sensor cover 6 and the sensor 5. The sensor cover 6 has a circular bottom surface portion 6a which has a hole formed at the center and a side surface portion 6b which stands from the outer edge of the bottom surface portion 6a. The bottom surface portion 6a of the sensor cover 6 abuts against the upper end surface 22 of the boss portion 20. The side surface portion 6b of the sensor cover 6 surrounds the output portion 5d side from the seat portion 5c of the sensor 5. The sensor cover 6 is fixed by inserting the sensor 5 into the hole of the bottom surface portion 6a and interposing the bottom surface portion 6a between the seat portion 5c of the sensor 5 and the upper end surface 22 of the boss portion 20.

[1-3. Disposition]

[0033] As illustrated in Fig. 5, the exhaust system structure according to this embodiment is disposed behind the cylinder of the engine 40. In addition, as described above, the connection member 1 is provided so that the boss portion 20 is positioned above the exhaust pipe 4. In addition, the purification device 3 is provided on the lower side of the exhaust pipe 4. In other words, the purification device 3 is provided on the side opposite to the boss portion 20 with respect to the exhaust pipe 4. In other words, the exhaust pipe 4 is positioned between the boss portion 20 of the connection member 1 and the purification device 3 in the radial direction of the exhaust pipe 4. In this way, the sensor 5, the exhaust pipe 4, and the purification device 3 are provided in parallel in the radial direction of the exhaust pipe 4 in this order. In this embodiment, these sensors 5, the exhaust pipe 4, and the purification device 3 are provided in parallel in the up-down direction.

[0034] The purification device 3 is provided in a state where a portion thereof is entered into a space below (that is, below the exhaust manifold 2) the overhang portion 41a of the cylinder head 41. In other words, the purification device 3 is provided to toward a side of the engine 40 from the connection member 1. In addition, the purification device 3 of this embodiment is provided in such a posture that the axis C3 of the case 3A extends in the up-down direction. In other words, the case 3A according to this embodiment extends in the same direction as the parallel arrangement direction of the cylinder head 41 and the cylinder block 42. Here, the axis C3 of the case 3A is the axis C3 of the main body portion 3c of the case 3A.

[0035] Similarly, the connection member 1 is provided in such a posture that the axis C2 of the boss portion 20 extends in the up-down direction. In other words, the boss portion 20 of the connection member 1 has an axis C2 parallel to the direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel. In addition, the sensor 5 of this embodiment is attached along the axis C2 of the boss portion 20 of the connection member

1. Therefore, the sensor 5 also has an axis parallel to the parallel arrangement direction of the cylinder head 41 and the cylinder block 42. In this way, in this embodiment, both the purification device 3 and the sensor 5 are provided along the direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel.

[2. Action and effect]

10 [2-1. Exhaust system structure]

[0036]

(1) In the exhaust system structure described above, the connection member 1 having the flange portion 10 for connecting the exhaust manifold 2 and the exhaust pipe 4 to each other and the boss portion 20 integrated with the flange portion 10 is provided and the sensor 5 is attached to the boss portion 20 of the connection member 1. In addition, a purification device 3 connected to the downstream end of the exhaust pipe 4 is provided on the side opposite to the boss portion 20 with respect to the exhaust pipe 4. Therefore, the sensor 5, the exhaust pipe 4, and the purification device 3 can be disposed compactly and space saving can be achieved. In other words, in this embodiment, since the sensor 5, the exhaust pipe 4, and the purification device 3 are provided in parallel in the up-down direction, in the direction orthogonal to the up-down direction (for example, the front-rear direction and the left-right direction), the installation space of the sensor 5, the exhaust pipe 4, and the purification device 3 can be suppressed to be kept small.

In addition, since the sensor 5 is attached to the boss portion 20 of the connection member 1 provided immediately downstream of the exhaust manifold 2, variations in the way the exhaust hits the sensor 5 can be suppressed. Therefore, the detection accuracy of the sensor 5 can be improved.

(2) Since the boss portion 20 of the connection member 1 has the axis C2 parallel to the direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel and the sensor 5 is attached along the axis C2, the sensor 5 can be arranged along the direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel. Accordingly, since the installation space of the sensor 5 with respect to the engine 40 can be suppressed to be kept small, it can contribute to space saving. For example, as compared with the configuration in which the sensor 5 is fixed to the outer circumferential surface of the curve of the exhaust pipe 4 and at a position close to the purification device 3, since the installation space of the sensor 5 can be made smaller according to the above configuration, space saving can be likely to be realized.

(3) Since the case 3A of the purification device 3 extends in the same direction as the parallel arrangement direction of the cylinder head 41 and the cylinder block 42, the purification device 3 is disposed along the parallel arrangement direction of the cylinder head 41 and the cylinder block 42. Accordingly, since the installation space of the purification device 3 with respect to the engine 40 can be suppressed to be kept small, it can contribute to space saving.

(4) Since the purification device 3 is provided to be further overhung toward the engine 40 side than the connection member 1, the purification device 3 can be brought closer to the engine 40. Therefore, it can further contribute to space saving.

(5) Since the exhaust manifold 2 is built in the cylinder head 41, the installation space of the exhaust manifold 2 can be suppressed to be kept small. Therefore, it is possible to make the exhaust system structure more compact and further contribute to space saving.

(6) Since the sensor 5 interposes a portion of the sensor cover 6 between the sensor 5 and the boss portion 20 of the connection member 1, the sensor cover 6 can be attached at the same time as attaching the sensor 5 to the boss portion 20 of the connection member 1. Therefore, the attachment work of the sensor cover 6 can be simplified. In addition, since a component (for example, screw, adhesive, or the like) for attaching the sensor cover 6 is not required, it can contribute to reduction in the number of parts.

[2-2. Connection member]

[0037]

(1) The connection member 1 described above includes the flange portion 10 which is fixed to the exhaust pipe 4 in a state where the opening 11 communicates with the exhaust pipe 4, the boss portion 20 to which the sensor 5 is attached, and an attachment portion 30 to which the heat protector 8 is attached. In other words, the connection member 1 also serves as three elements which include a flange for connecting the exhaust pipe 4 to the exhaust manifold 2, a boss for attaching the sensor 5, and an attaching base for attaching the heat protector 8. Therefore, by connecting the exhaust pipe 4 to the exhaust manifold 2 using the connection member 1, the sensor 5 and the heat protector 8 can be attached to the exhaust pipe 4 via the connection member 1. Therefore, compared to a case where the boss portion 20 and the attachment portion 30 are provided separately from the flange portion 10, the number of parts can be reduced and it can be contribute to re-

duction in the manufacturing cost.

In addition, since the boss portion 20 is provided so as to bulge from the flange portion 10 on the outer side of the opening 11 of the flange portion 10 in the radial direction, the sensor 5 attached to the boss portion 20 can be positioned immediately downstream of the exhaust manifold 2. Accordingly, since variations in the way the exhaust hits the sensor 5 can be suppressed, the detection accuracy of the sensor 5 can be improved.

(2) Since the flange portion 10 has the recessed portion 13 recessed toward the opening 11 side at the outer edge portion between the plurality of fastening portions 12, the volume of the flange portion 10 can be reduced by the volume lost by the recessed portion 13. In addition, since the boss portion 20, the fastening portion 12, and the recessed portion 13 are provided so as to deviate from each other in the circumferential direction of the opening 11, the connection member 1 can be formed in a compact shape. Accordingly, it is possible to contribute to space saving and it is possible to reduce the weight of the connection member 1.

(3) Since the attachment portion 30 protrudes outward from the recessed portion 13 in the radial direction, the protrusion amount of the attachment portion 30 in the radial direction can be reduced. Therefore, it is possible to make the connection member 1 more compact and further contribute to space saving.

(4) The connection member 1 described above is provided with a first recessed portion 13A in which the attachment portion 30 protrudes and a second recessed portion 13B on which a larger recessed amount is formed than that of the first recessed portion 13A. In addition, the second recessed portion 13B is provided to be adjacent to the downstream end of the exhaust pipe 4. Therefore, access to the downstream end of the exhaust pipe 4 is facilitated by the second recessed portion 13B. Therefore, the work of welding the other tubular member (inlet portion 3b of case 3A in this embodiment) to the downstream end of the exhaust pipe 4 can be likely to be performed.

(5) Since the attachment portion 30 has the flat welding surface 31 to which the bracket 9 for attaching the heat protector 8 is welded, for example, compared to a case where the heat protector 8 is fastened and fixed directly to the attachment portion 30, the attachment portion 30 can be made thinner and the protrusion amount of the attachment portion 30 can be suppressed. If the attachment portion 30 is provided with a female threaded hole, in a case where the heat protector 8 is attached by screwing

a fastener such as a bolt into the female threaded hole, there is a need to secure the thickness of the attachment portion 30 according to the length of the screw portion of the fastener. In addition, in this case, in order to secure a clearance between the heat protector 8 and the exhaust pipe 4, there is a need to increase the protrusion amount of the attachment portion 30 from the flange portion 10. On the other hand, in a case where the heat protector 8 is attached via the bracket 9 as described above, since it is sufficient to provide the flat welding surface 31 on the attachment portion 30, the attachment portion 30 can be made thin and the protrusion amount of the attachment portion 30 can be suppressed. Therefore, the weight of the connection member 1 can be reduced.

[3. Modification Example]

[0038] Regardless of the embodiment described above, various modifications can be made without departing from the spirit of the invention. The respective configurations of this embodiment can be selected as required or may be combined appropriately.

[0039] In the embodiment described above, although a case where the parallel arrangement direction of the cylinder head 41 and the cylinder block 42 is the up-down direction is exemplified, the parallel arrangement direction thereof is not particularly limited. In addition, the orientation (posture) in which the engine 40 is disposed and the position of the exhaust system structure with respect to the engine 40 are not limited to those described above. For example, the cylinder head 41 may be provided so that the overhang portion 41 a bulges forward or leftward and rightward. In other words, the exhaust manifold 2 may be positioned in front of or on the left and right of the cylinder of the engine 40. In addition, along with this, the connection member 1, the exhaust pipe 4, the purification device 3, or the like may be disposed in front of or on the left and right of the engine 40.

[0040] In the embodiment described above, although a case where the exhaust manifold 2 is built in the cylinder head 41 is exemplified, the exhaust manifold 2 may be provided separately from the cylinder head 41. In a case where the exhaust manifold 2 is separate from the cylinder head 41, the attachment base of the flange portion 10 of the connection member 1 may not be the cylinder head 41 but may be a flange portion provided at the downstream end of the exhaust manifold 2, for example.

[0041] This exhaust system structure is applicable not only to the multi-cylinder engine like the engine 40 but also to a single cylinder engine. In a case where this exhaust system structure is applied to a single cylinder engine, the exhaust manifold is connected to each of a plurality of exhaust ports provided in the cylinder.

[0042] In the embodiment described above, although a case where the boss portion 20 of the connection member 1 has a cylindrical shape and has the axis C2 parallel

to the direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel is exemplified, the shape of the boss portion 20 and the direction of the axis C2 are not limited to the those described above. The boss portion 20 may be any boss portion as long as the boss portion can be attached so that at least the sensor 5 can detect the components of the exhaust in the exhaust pipe 4. Similarly, the shape and the extending direction (the direction of the axis C3) of the case 3A of the purification device 3 are not limited to those described above.

[0043] The sensor 5 may be attached along the direction crossing the axis C2 of the boss portion 20 of the connection member 1, with respect to the direction in which the cylinder head 41 and the cylinder block 42 are arranged in parallel. However, it is preferable that the sensor 5 is provided so as not to be further overhung than the purification device 3 in a direction orthogonal to the axis C3 of the case 3A. In other words, as illustrated in Fig. 5, it is preferable that the sensor 5 is installed so as to be accommodated in an area E where the maximum outer diameter portion of the purification device 3 is extended in the direction of the axis C3. In other words, it is preferable that the entire sensor 5 is provided so as to overlap with the purification device 3 in the direction of the axis C3. By installing the sensor 5 in this manner, since it is possible to suppress the installation space of the sensor 5 with respect to the purification device 3 in a direction orthogonal to the axis C3 of the purification device 3, it can contribute to space saving.

[0044] In addition, in a case where it is unnecessary for the connection member 1 to serve as an element which is an attachment base of the heat protector 8, the attachment portion 30 may be omitted from the connection member 1. Even in a case where the attachment portion 30 is omitted, since the sensor 5, the exhaust pipe 4, and the purification device 3 can be disposed compactly as described above according to the exhaust system structure, space saving can be achieved and the detection accuracy of the sensor 5 can be improved. In addition, if the attachment portion 30 is omitted, the weight of the connection member 1 can be reduced by the amount of the omitted attachment portion 30.

[0045] Similarly, the fastening portion 12 and the recessed portion 13 may be omitted from the connection member 1. For example, the fastening portion 12 may be omitted from the connection member 1 and the fastening surface 10a of the flange portion 10 may be welded and fixed to the exhaust manifold 2. In addition, the recessed portion 13 may be omitted from the connection member 1 and the flange portion 10 may be formed in a simple shape such as a circle or a rectangle.

[0046] The sensor 5 may be any sensor as long as the sensor detects components of exhaust and the specific type thereof is not particularly limited. Similarly, the purification device 3 may contain a filter, a catalyst or the like for purifying exhaust and the specific type thereof is not particularly limited.

[0047] In the exhaust system structure described above, the connection member having the flange portion for connecting the exhaust manifold and the exhaust pipe to each other and the boss portion integrated with the flange portion is provided and the sensor 5 is attached to the boss portion of the connection member. In addition, a purification device connected to the downstream end of the exhaust pipe is provided on the side opposite to the boss portion with respect to the exhaust pipe. Therefore, the sensor, the exhaust pipe, and the purification device can be disposed compactly and space saving can be achieved. In addition, since the sensor is attached to the boss portion of the connection member provided immediately downstream of the exhaust manifold, variations in the way the exhaust hits the sensor can be suppressed. Therefore, the detection accuracy of the sensor can be improved.

Reference Signs

[0048]

1 connection member
 2 exhaust manifold
 3 purification device
 3A case
 4 exhaust pipe
 5 sensor
 6 sensor cover
 10 flange portion
 20 boss portion
 30 attachment portion
 40 engine (internal combustion engine)
 41 cylinder head
 42 cylinder block
 C2 axis of the boss portion 20

Claims

1. An exhaust system structure of an internal combustion engine, comprising:

an exhaust manifold which is configured to be connected to a cylinder of the internal combustion engine;
 an exhaust pipe which is provided on a downstream side of an exhaust flow from the exhaust manifold;
 a connection member including a flange portion which connects the exhaust pipe and the exhaust manifold to each other and a boss portion which is provided integrally with the flange portion and is fixed to a portion of an outer circumferential surface of the exhaust pipe;
 a sensor which is attached to the boss portion and is configured to detect components of the exhaust; and

a purification device which is connected to a downstream end of the exhaust pipe and is disposed on a side opposite to the boss portion with respect to the exhaust pipe.

2. The exhaust system structure of an internal combustion engine according to claim 1, wherein the boss portion has a cylindrical shape which has an axis parallel to a direction in which a cylinder head and a cylinder block of the internal combustion engine are arranged in parallel, and wherein the sensor is attached along the axis of the boss portion.
3. The exhaust system structure of an internal combustion engine according to claim 1 or 2, wherein the purification device has a case which extends in the same direction as the direction in which the cylinder head and the cylinder block of the internal combustion engine are arranged in parallel.
4. The exhaust system structure of an internal combustion engine according to any one of claims 1 to 3, wherein the purification device is provided to be overhung toward a side of the internal combustion engine from the connection member.
5. The exhaust system structure of an internal combustion engine according to any one of claims 1 to 4, wherein the exhaust manifold is built in the cylinder head of the internal combustion engine.
6. The exhaust system structure of an internal combustion engine according to any one of claims 1 to 5, further comprising:

a sensor cover for surrounding the outer circumference of the sensor to block heat, wherein a portion of the sensor cover is interposed between the sensor and the boss portion of the connection member.

Fig. 1

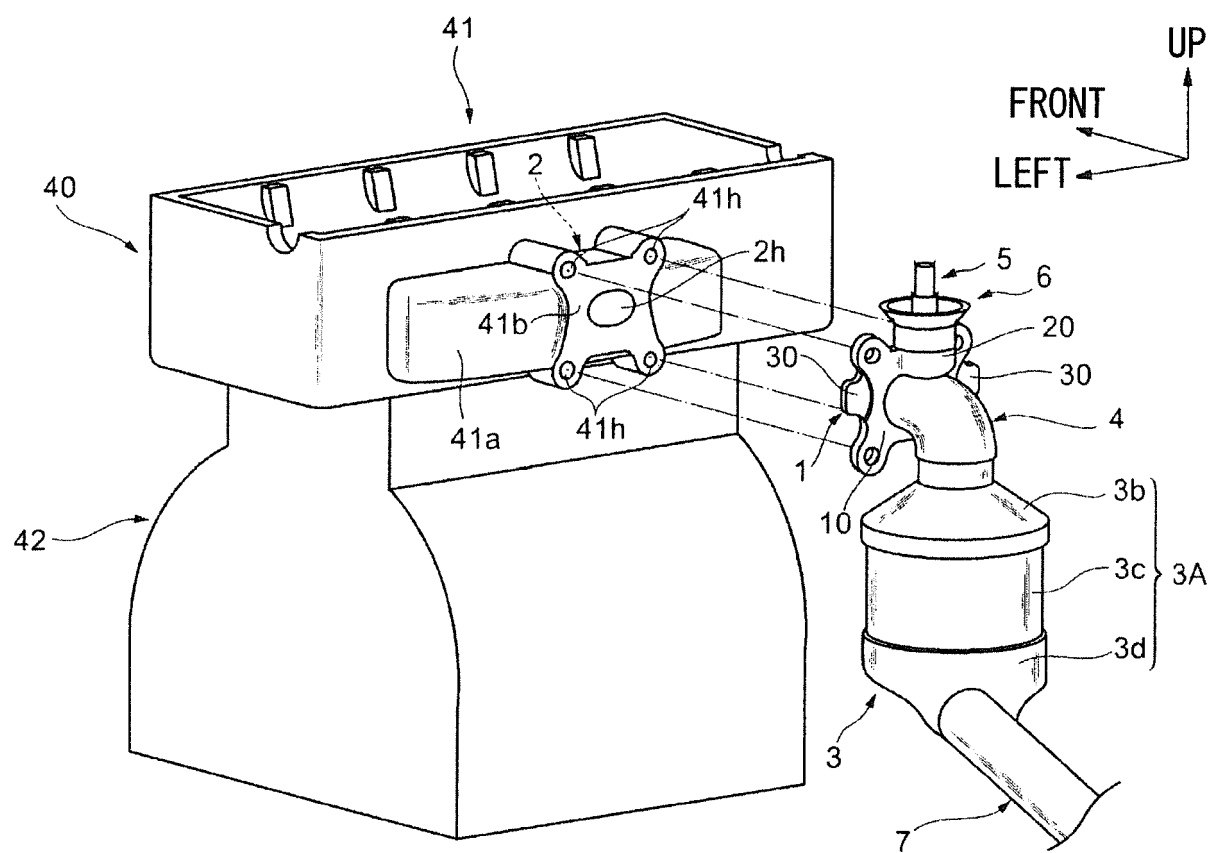


Fig. 2

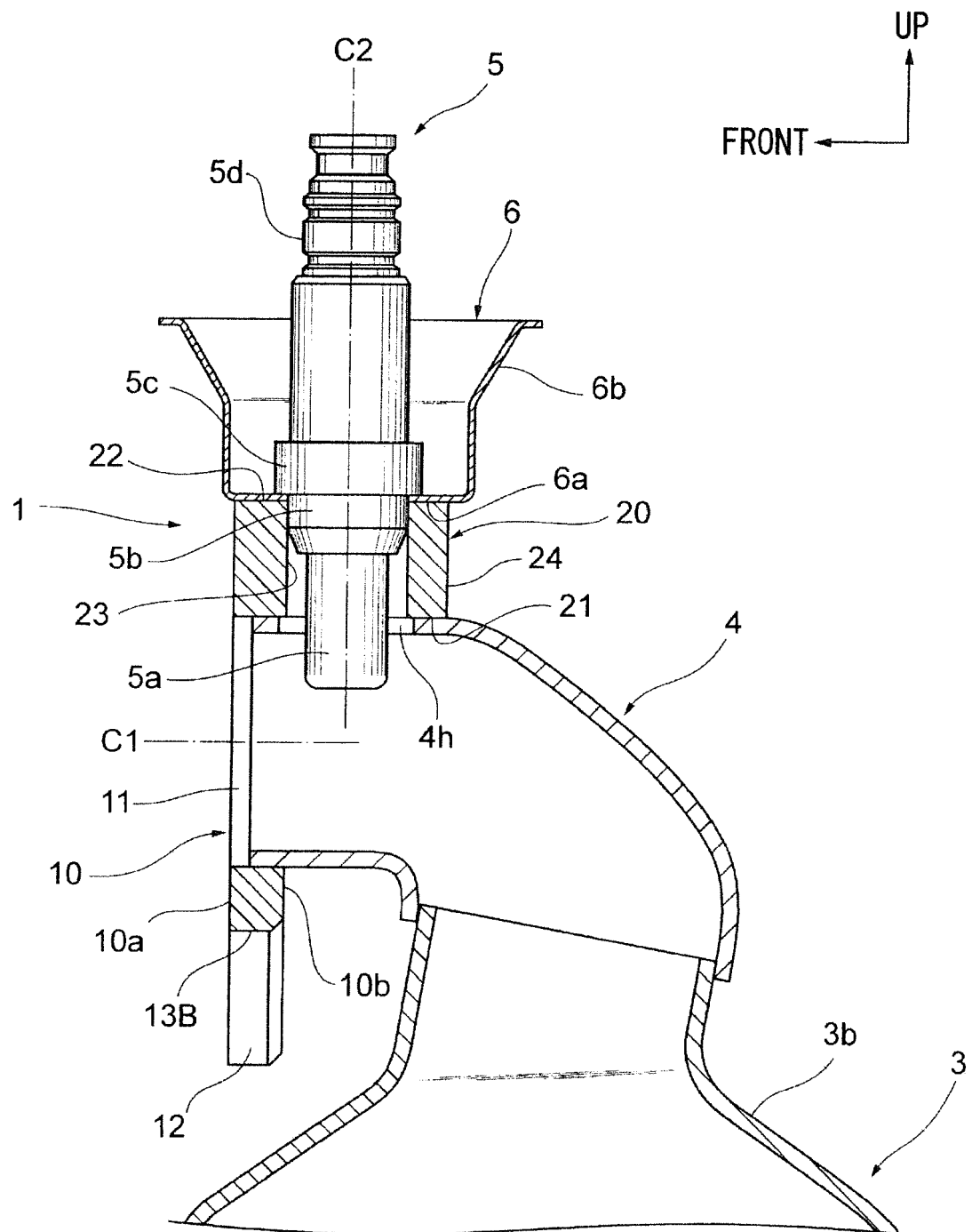


Fig. 3

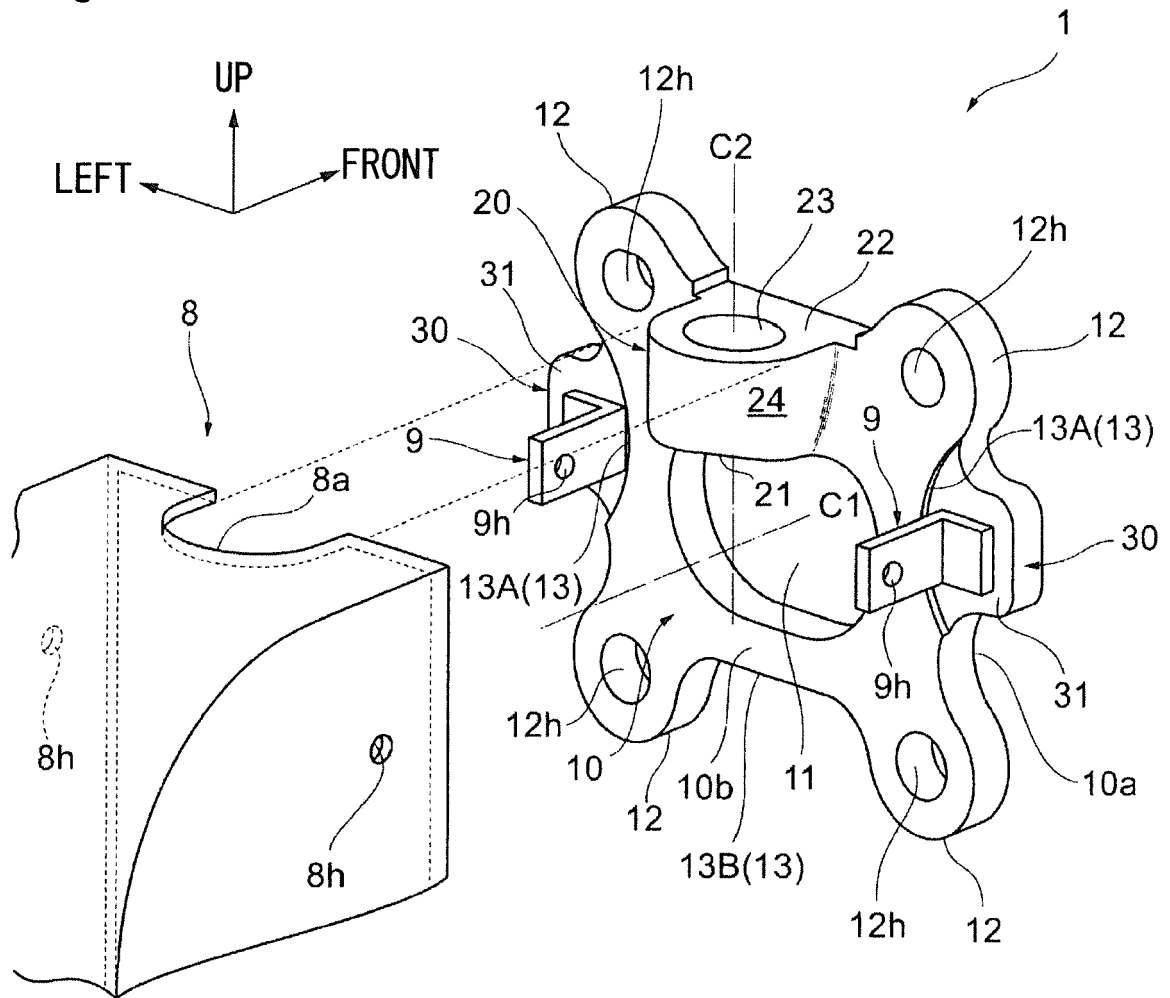


Fig. 4

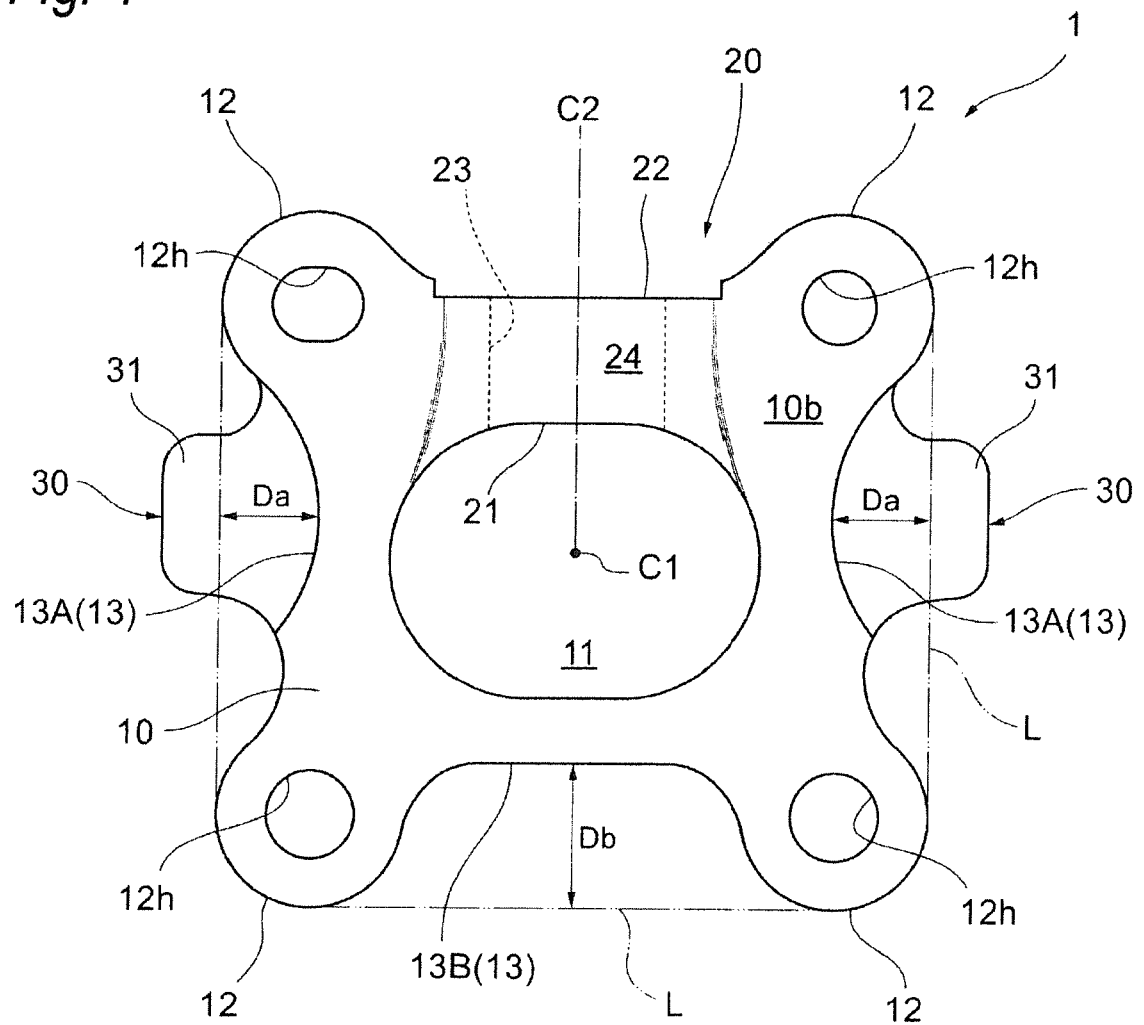
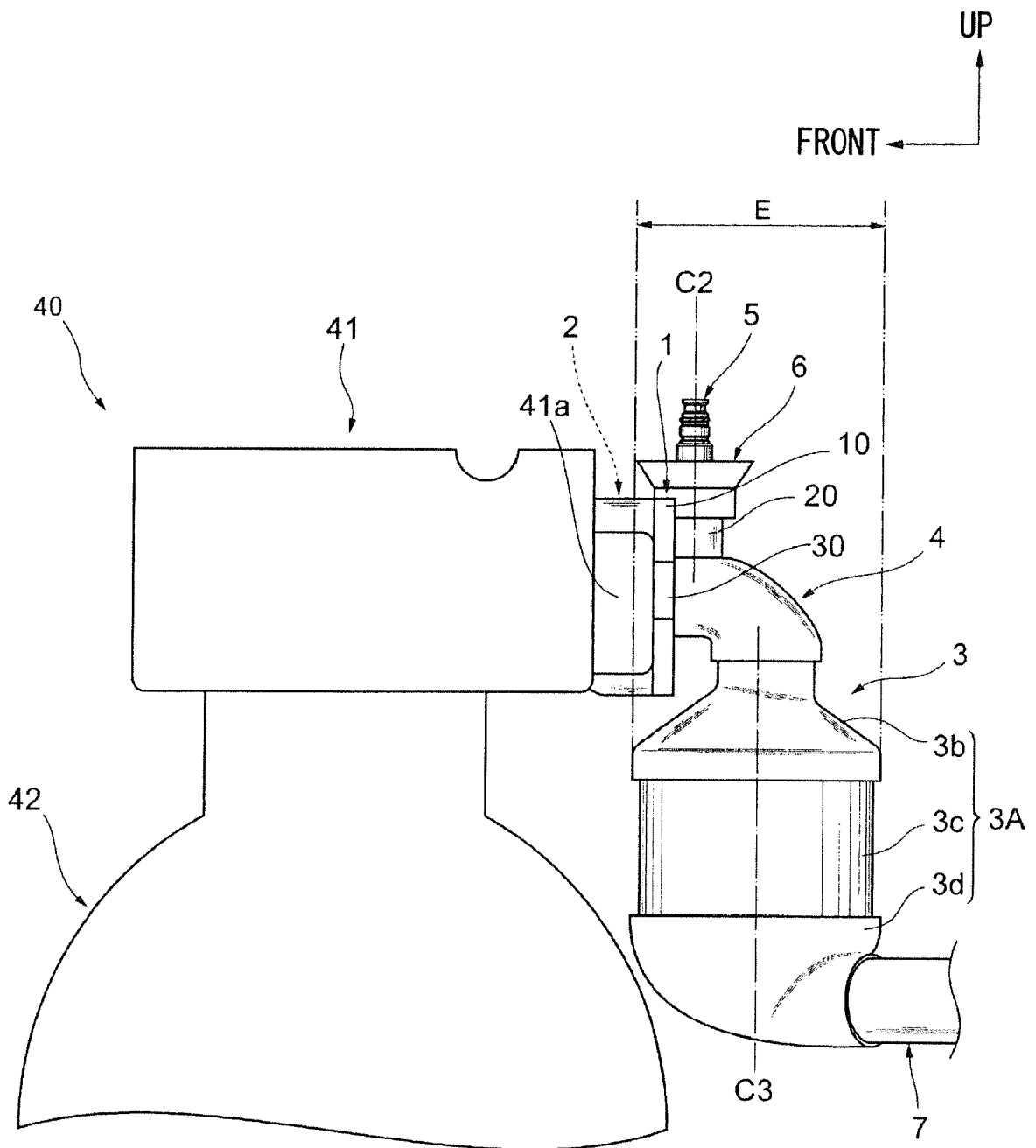


Fig. 5





EUROPEAN SEARCH REPORT

Application Number
EP 17 20 3438

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