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OUTBOARD MOTOR AND MARINE VESSEL

Abstract

An outboard motor includes a first pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to a first fuel injector, a second pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to a second fuel injector, and a flexible pipe made of bendable metal to connect the first pipe to the second pipe so as to allow the high-pressure hydrogen to flow therethrough to both the first pipe and the second pipe.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to Japanese Patent Application No. 2024-019854 filed on Feb. 13, 2024. The entire contents of this application are hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to outboard motors and marine vessels.

2. Description of the Related Art

[0003] An outboard motor including a power unit is known in general. Such an outboard motor is disclosed in Japanese Patent Laid-Open No. 2020-101095, for example.

[0004] Japanese Patent Laid-Open No. 2020-101095 discloses an outboard motor including a power unit including a first cylinder head and a second cylinder head aligned in a right-left direction of an outboard motor main body, and a first fuel injector and a second fuel injector attached to the first cylinder head and the second cylinder head, respectively, to inject fuel inside the first cylinder head and the second cylinder head.

[0005] Although not described in Japanese Patent Laid-Open No. 2020-101095, an outboard motor as described in Japanese Patent Laid-Open No. 2020-101095 conceivably includes a power unit to be driven by hydrogen as fuel. In such a case, the outboard motor needs to include a first high-pressure metal pipe to supply high-pressure hydrogen to a first fuel injector, a second high-pressure metal pipe to supply high-pressure hydrogen to the second fuel injector, and a high-pressure metal connecting pipe to connect the first pipe to the second pipe such that high-pressure hydrogen flows through both the first pipe and the second pipe. In such a case, the first high-pressure pipe, the second high-pressure pipe, and the high-pressure connecting pipe are made of a highly rigid metal, and thus when connection positions of the connecting pipe to the first pipe and the second pipe are misaligned due to assembly errors of the first pipe and the second pipe to the outboard motor when the connecting pipe is connected to the first pipe and the second pipe, it is difficult to absorb the misalignments of the connection positions of the connecting pipe to the first pipe and the second pipe, unlike a rubber pipe used to supply gasoline to a power unit to be driven by the gasoline as fuel. That is, it becomes difficult to connect the metal connecting pipe to the first metal pipe and the second metal pipe. Therefore, a configuration is desired in which even when the connection positions between the high-pressure metal pipes to allow high-pressure hydrogen to be supplied therethrough to the first fuel injector and the second fuel injector are misaligned, the misalignments of the connection positions are absorbed, and the connections are easily made.

SUMMARY OF THE INVENTION

[0006] Example embodiments of the present invention provide outboard motors and marine vessels that each absorb, even when connection positions between high-pressure metal pipes to allow high-pressure hydrogen to be supplied therethrough to fuel injectors of power units to be driven by hydrogen as fuel are misaligned, misalignments of the connection positions, and enable easy connections.

[0007] An outboard motor according to an example embodiment of the present invention includes an outboard motor main body, a power unit configured to be driven by hydrogen as a fuel and including a first cylinder head and a second cylinder head aligned along a right-left direction of the outboard motor main body, and a first fuel injector and a second fuel injector attached to the first cylinder head and the second cylinder head to inject the hydrogen into combustion chambers inside the first cylinder head and the second cylinder head, respectively, a propeller to be driven via a drive shaft and a propeller shaft both below the power unit, a first pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to the first fuel injector, a second pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the second fuel injector, and a flexible pipe made of bendable metal, having a corrugated or braided structure, to connect the

first pipe to the second pipe so as to allow the high-pressure hydrogen to flow therethrough to both the first pipe and the second pipe.

[0008] An outboard motor according to an example embodiment of the present invention includes the first pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the first fuel injector, the second pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the second fuel injector, and the flexible pipe made of bendable metal, having a corrugated or braided structure, to connect the first pipe to the second pipe so as to allow the high-pressure hydrogen to flow therethrough to both the first pipe and the second pipe. Accordingly, even when connection positions of the flexible pipe to the first pipe and the second pipe are misaligned due to assembly errors of the first pipe and the second pipe to the outboard motor when the flexible pipe is connected to the first pipe and the second pipe, the misalignments of the connection positions of the flexible pipe to the first pipe and the second pipe are absorbed by the bendable flexible pipe. That is, the flexible pipe made of metal is easily connected to the first pipe and the second pipe, both of which are made of metal. Consequently, even when the connection positions between the high-pressure metal pipes to allow high-pressure hydrogen to be supplied therethrough to the fuel injectors of the power unit to be driven by hydrogen as fuel are misaligned, the misalignments of the connection positions are absorbed, and the connections are easily made. When a pressure from high-pressure hydrogen is not acting on the flexible pipe, the flexible pipe is bendable, and thus the flexible pipe is easily connected to the first pipe and the second pipe. When a pressure from the high-pressure hydrogen is acting on the flexible pipe, the rigidity of the flexible pipe is increased, and thus the strength against vibrations generated in the flexible pipe due to vibrations of the power unit, external disturbances (such as waves) acting on the outboard motor main body, etc. is increased.

[0009] An outboard motor according to an example embodiment of the present invention preferably further includes a first joint airtight against the high-pressure hydrogen to connect the first pipe to a first end of the flexible pipe, and a second joint airtight against the high-pressure hydrogen to connect the second pipe to a second end of the flexible pipe. Accordingly, the first joint and the second joint enable the high-pressure flexible pipe to be connected to the first high-pressure pipe and the second high-pressure pipe while airtightness against high-pressure hydrogen is achieved.

[0010] In an outboard motor according to an example embodiment of the present invention, the flexible pipe preferably extends along the right-left direction of the outboard motor main body. Accordingly, the first pipe and the second pipe, which are provided on one side and the other side in the right-left direction of the outboard motor main body, respectively, are connected to each other at the shortest distance.

[0011] In an outboard motor according to an example embodiment of the present invention, the power unit preferably includes a first exhaust manifold rearward of the first cylinder head in a forward-rearward direction of the outboard motor main body and connected to the first cylinder head to allow exhaust gas to pass therethrough from the first cylinder head, and a second exhaust manifold rearward of the second cylinder head in the forward-rearward direction of the outboard motor main body and connected to the second cylinder head to allow exhaust gas to pass therethrough from the second cylinder head, and at least a portion of the flexible pipe preferably overlaps the first exhaust manifold and the second exhaust manifold as viewed in an upward-downward direction of the outboard motor main body. Accordingly, in the forward-rearward direction perpendicular to the upward-downward direction of the outboard motor main body, the power unit and the flexible pipe are compactly configured.

[0012] In an outboard motor in which at least a portion of the flexible pipe overlaps the first exhaust manifold and the second exhaust manifold as viewed in the upward-downward direction of the outboard motor main body, the power unit preferably includes an exhaust pipe below the first exhaust manifold and the second exhaust manifold in the upward-downward direction of the outboard motor main body and connected to the first exhaust manifold and the second exhaust

manifold to allow the exhaust gas that has passed through the first exhaust manifold and the exhaust gas that has passed through the second exhaust manifold to pass therethrough, and at least a portion of the flexible pipe preferably overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body. Accordingly, in the upward-downward direction perpendicular to the forward-rearward direction of the outboard motor main body, the power unit and the flexible pipe are compactly configured.

[0013] In an outboard motor in which at least a portion of the flexible pipe overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body, at least a portion of the flexible pipe is preferably forward of at least a portion of the exhaust pipe in the forward-rearward direction of the outboard motor main body. Accordingly, at least a portion of the flexible pipe easily overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body.

[0014] In an outboard motor in which at least a portion of the flexible pipe is forward of at least a portion of the exhaust pipe in the forward-rearward direction of the outboard motor main body, the power unit preferably includes a first cylinder head cover and a second cylinder head cover attached to rear sides of the first cylinder head and the second cylinder head, respectively, in the forward-rearward direction of the outboard motor main body, and at least a portion of the flexible pipe is preferably between the exhaust pipe and both the first cylinder head cover and the second cylinder head cover in the forward-rearward direction of the outboard motor main body. Accordingly, a space between the exhaust pipe and both the first cylinder head cover and the second cylinder head cover in the forward-rearward direction of the outboard motor main body is effectively used to locate the flexible pipe.

[0015] An outboard motor including the first joint and the second joint preferably further includes a third pipe made of metal and connected to the first pipe and the flexible pipe via the first joint to allow the high-pressure hydrogen to be supplied therethrough to the first pipe and the flexible pipe. Accordingly, the third pipe allows high-pressure hydrogen to be easily supplied to the first pipe and the flexible pipe.

[0016] In an outboard motor according to an example embodiment of the present invention, the outboard motor main body preferably includes a cowling to house the power unit, and the outboard motor preferably further includes a hydrogen detection sensor inside the cowling to detect the hydrogen. Accordingly, when hydrogen leaks from the pipes, the hydrogen detection sensor detects the hydrogen, and thus leakage of the hydrogen from the pipes is dealt with promptly.

[0017] In an outboard motor including the hydrogen detection sensor inside the cowling, the hydrogen detection sensor is preferably at least either at an upper end of the cowling or in a vicinity of a ventilation opening on a surface of the cowling that connects an inside of the cowling to an outside of the cowling. Accordingly, the hydrogen detection sensor is at a location inside the cowling at which hydrogen is relatively easy to detect, and thus when hydrogen leaks from the pipes, the hydrogen detection sensor easily detects the hydrogen. In this description, the term “vicinity of a ventilation opening” indicates a broader concept including the position of the ventilation opening itself, a position contacting the ventilation opening, and a position spaced apart from the ventilation opening but relatively close to the ventilation opening.

[0018] A marine vessel according to an example embodiment of the present invention includes a hull including a hydrogen tank filled with hydrogen, and an outboard motor attached to the hull. The outboard motor includes an outboard motor main body, a power unit configured to be driven by hydrogen as fuel and including a first cylinder head and a second cylinder head aligned along a right-left direction of the outboard motor main body, and a first fuel injector and a second fuel injector attached to the first cylinder head and the second cylinder head to inject the hydrogen into combustion chambers inside the first cylinder head and the second cylinder head, respectively, a propeller to be driven via a drive shaft and a propeller shaft both below the power unit, a first pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to the first fuel injector,

a second pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the second fuel injector, and a flexible pipe made of bendable metal, having a corrugated or braided structure, to connect the first pipe to the second pipe so as to allow the high-pressure hydrogen to flow therethrough to both the first pipe and the second pipe.

[0019] A marine vessel according to an example embodiment of the present invention includes the first pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the first fuel injector, the second pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the second fuel injector, and the flexible pipe made of bendable metal, having a corrugated or braided structure, to connect the first pipe to the second pipe so as to allow the high-pressure hydrogen to flow therethrough to both the first pipe and the second pipe. Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, even when connection positions of the flexible pipe to the first pipe and the second pipe are misaligned due to assembly errors of the first pipe and the second pipe to the outboard motor when the flexible pipe is connected to the first pipe and the second pipe, the misalignments of the connection positions of the flexible pipe to the first pipe and the second pipe are absorbed by the bendable flexible pipe. Consequently, similarly to the outboard motors according to example embodiments of the present invention described above, even when the connection positions between the high-pressure metal pipes to allow high-pressure hydrogen to be supplied therethrough to the fuel injectors of the power unit are misaligned, the misalignments of the connection positions are absorbed, and the connections are easily made. Furthermore, similarly to the outboard motors according to example embodiments of the present invention described above, when a pressure from high-pressure hydrogen is not acting on the flexible pipe, the flexible pipe is bendable, and thus the flexible pipe is easily connected to the first pipe and the second pipe. When a pressure from high-pressure hydrogen is acting on the flexible pipe, the rigidity of the flexible pipe is increased, and thus the strength against vibrations generated in the flexible pipe due to vibrations of the power unit, external disturbances (such as waves) acting on the outboard motor main body, etc. is increased.

[0020] A marine vessel according to an example embodiment of the present invention preferably further includes a first joint airtight against the high-pressure hydrogen to connect the first pipe to a first end of the flexible pipe, and a second joint airtight against the high-pressure hydrogen to connect the second pipe to a second end of the flexible pipe. Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, the first joint and the second joint enable the high-pressure flexible pipe to be connected to the first high-pressure pipe and the second high-pressure pipe while airtightness against high-pressure hydrogen is achieved.

[0021] In a marine vessel according to an example embodiment of the present invention, the flexible pipe preferably extends along the right-left direction of the outboard motor main body. Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, the first pipe and the second pipe, which are provided on one side and the other side in the right-left direction of the outboard motor main body, respectively, are connected to each other at the shortest distance.

[0022] In a marine vessel according to an example embodiment of the present invention, the power unit preferably includes a first exhaust manifold rearward of the first cylinder head in a forward-rearward direction of the outboard motor main body and connected to the first cylinder head to allow exhaust gas to pass therethrough from the first cylinder head, and a second exhaust manifold rearward of the second cylinder head in the forward-rearward direction of the outboard motor main body and connected to the second cylinder head to allow exhaust gas to pass therethrough from the second cylinder head, and at least a portion of the flexible pipe preferably overlaps the first exhaust manifold and the second exhaust manifold as viewed in an upward-downward direction of the outboard motor main body. Accordingly, similarly to the outboard motors according to example

embodiments of the present invention described above, in the forward-rearward direction perpendicular to the upward-downward direction of the outboard motor main body, the power unit and the flexible pipe are compactly configured.

[0023] In a marine vessel in which the flexible pipe overlaps the first exhaust manifold and the second exhaust manifold as viewed in the upward-downward direction of the outboard motor main body, the power unit preferably includes an exhaust pipe below the first exhaust manifold and the second exhaust manifold in the upward-downward direction of the outboard motor main body and connected to the first exhaust manifold and the second exhaust manifold to allow the exhaust gas that has passed through the first exhaust manifold and the exhaust gas that has passed through the second exhaust manifold to pass therethrough, and at least a portion of the flexible pipe preferably overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body. Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, in the upward-downward direction perpendicular to the forward-rearward direction of the outboard motor main body, the power unit and the flexible pipe are compactly configured.

[0024] In a marine vessel in which the flexible pipe overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard engine main body, at least a portion of the flexible pipe is preferably forward of at least a portion of the exhaust pipe in the forward-rearward direction of the outboard motor main body. Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, at least a portion of the flexible pipe easily overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body.

[0025] In a marine vessel in which at least a portion of the flexible pipe is forward of at least a portion of the exhaust pipe in the forward-rearward direction of the outboard motor main body, the power unit preferably includes a first cylinder head cover and a second cylinder head cover attached to rear sides of the first cylinder head and the second cylinder head, respectively, in the forward-rearward direction of the outboard motor main body, and at least a portion of the flexible pipe is preferably between the exhaust pipe and both the first cylinder head cover and the second cylinder head cover in the forward-rearward direction of the outboard motor main body.

[0026] Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, a space between the exhaust pipe and both the first cylinder head cover and the second cylinder head cover in the forward-rearward direction of the outboard motor main body is effectively used to locate the flexible pipe.

[0027] A marine vessel in which the outboard motor includes the first joint and the second joint preferably further includes a third pipe made of metal and connected to the first pipe and the flexible pipe via the first joint to allow the high-pressure hydrogen supplied from the hydrogen tank of the hull to be supplied therethrough to the first pipe and the flexible pipe. Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, the third pipe allows high-pressure hydrogen to be easily supplied to the first pipe and the flexible pipe.

[0028] In a marine vessel according to an example embodiment of the present invention, the outboard motor main body preferably includes a cowling to house the power unit, and the marine vessel preferably further includes a hydrogen detection sensor inside the cowling to detect the hydrogen. Accordingly, similarly to the outboard motors according to example embodiments of the present invention described above, when hydrogen leaks from the pipes, the hydrogen detection sensor detects the hydrogen, and thus leakage of the hydrogen from the pipes is dealt with promptly.

[0029] An outboard motor according to an example embodiment of the present invention includes a power unit including at least one cylinder bank including a plurality of cylinder rows, and a fuel injector to inject hydrogen into combustion chambers inside the plurality of cylinder rows of the

cylinder bank, a propeller to be driven via a drive shaft and a propeller shaft both below the power unit, a fuel pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to the fuel injector, a flexible pipe made of bendable metal, having a corrugated or braided structure, connected to the fuel pipe so as to allow the high-pressure hydrogen to flow therethrough to the fuel pipe, and a joint to connect the fuel pipe to the flexible pipe such that a central axis extending in a longitudinal direction of the fuel pipe and a central axis extending in a longitudinal direction of the flexible pipe intersect with each other. The flexible pipe is a rigid structural body when the high-pressure hydrogen is supplied therethrough.

[0030] An outboard motor according to an example embodiment of the present invention includes the flexible pipe made of bendable metal, having a corrugated or braided structure, and connected to the fuel pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the fuel injector so as to allow the high-pressure hydrogen to flow therethrough to the fuel pipe. Accordingly, when the flexible pipe is connected to the fuel pipe, the bendable flexible pipe absorbs a misalignment of the connection position of the flexible pipe to the fuel pipe even when the connection position of the flexible pipe to the fuel pipe is misaligned due to an assembly error of the fuel pipe to the outboard motor. That is, the flexible pipe made of metal is easily connected to the fuel pipe made of metal. Consequently, similarly to the outboard motors and the marine vessels according to example embodiments of the present invention described above, even when the connection position between the high-pressure metal pipes to allow the high-pressure hydrogen to be supplied therethrough to the fuel injector of the power unit is misaligned, the misalignment of the connection position is absorbed, and the connection is easily made. Furthermore, when a pressure from the high-pressure hydrogen is not acting on the flexible pipe, the flexible pipe is bendable, and thus the flexible pipe is easily connected to the fuel pipe. In addition, the fuel injector includes the joint to connect the fuel pipe to the flexible pipe such that the central axis extending in the longitudinal direction of the fuel pipe and the central axis extending in the longitudinal direction of the flexible pipe intersect with each other, and the flexible pipe acts as a rigid structural body when high-pressure hydrogen is supplied therethrough. Thus, the strength against vibrations generated in the flexible pipe due to vibrations of the power unit, external disturbances (such as waves) acting on an outboard motor main body, etc., is increased.

[0031] The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the example embodiments with reference to the attached drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] FIG. **1** is a plan view of a marine vessel according to an example embodiment of the present invention.

[0033] FIG. **2** is a side view of a marine vessel according to an example embodiment of the present invention.

[0034] FIG. **3** is a perspective view of a power unit according to an example embodiment of the present invention.

[0035] FIG. **4** is a diagram of a power unit according to an example embodiment of the present invention as viewed from the rear side in a forward-rearward direction of an outboard motor main body.

[0036] FIG. **5** is a diagram showing bending of a flexible pipe according to an example embodiment of the present invention.

[0037] FIG. **6** is a partial enlarged view of an exhaust manifold and a flexible pipe of a power unit according to an example embodiment of the present invention as viewed from above in an upward-

downward direction of an outboard motor main body.
[0038] FIG. **7** is a diagram showing a state in which an exhaust pipe is removed from FIG. **4**.
DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS
[0039] Example embodiments of the present invention are hereinafter described with reference to the drawings.
[0040] An outboard motor **100** and a marine vessel **120** according to example embodiments of the present invention are now described with reference to FIGS. **1** to **7**. The marine vessel **120** may be a relatively small marine vessel used for sightseeing or fishing, for example.
[0041] As shown in FIG. **1**, the marine vessel **120** includes a hull **110** and the outboard motor **100**. The hull **110** includes a plurality of hydrogen tanks **112** filled with hydrogen. The plurality of hydrogen tanks **112** are housed inside the hull **110**. The outboard motor **100** is attached to the hull **110**. The outboard motor **100** includes a power unit **10** to be driven by hydrogen as fuel.
[0042] As shown in FIG. **2**, the outboard motor **100** includes an outboard motor main body **101** and a bracket **102**. The outboard motor main body **101** is attached to a stern **111** of the hull **110** via the bracket **102**. The outboard motor main body **101** is tiltable relative to the hull **110** about a tilt shaft **102***a* provided on the bracket **102** and extending along a right-left direction of the outboard motor main body **101**. In the figures, FWD, BWD, L, R, Z**1**, and Z**2** indicate the front side in a forward-rearward direction of the outboard motor main body **101**, the rear side in the forward-rearward direction of the outboard motor main body **101**, the left side (port side) in the right-left direction of the outboard motor main body **101**, the right side (starboard side) in the right-left direction of the outboard motor main body **101**, the upper side in an upward-downward direction of the outboard motor main body **101**, and the lower side in the upward-downward direction of the outboard motor main body **101**, respectively, when the outboard motor main body **101** is not tilted relative to the hull **110**.
[0043] The outboard motor main body **101** includes the power unit **10**, a drive shaft **21**, a gearing **22**, a propeller shaft **23**, and a propeller **24**. The power unit **10** includes an internal combustion engine to generate a driving force. The drive shaft **21** extends along the upward-downward direction of the outboard motor main body **101**. An upper end of the drive shaft **21** is connected to a crankshaft (not shown) of the power unit **10**. That is, the drive shaft **21** is provided below the power unit **10**. A lower end of the drive shaft **21** is connected to the gearing **22**. The propeller shaft **23** extends along the forward-rearward direction of the outboard motor main body **101**. That is, the propeller shaft **23** is provided below the power unit **10**. A front end of the propeller shaft **23** is connected to the gearing **22**. A rear end of the propeller shaft **23** is connected to the propeller **24**. A driving force is transmitted from the power unit **10** to the propeller **24** via the drive shaft **21**, the gearing **22**, and the propeller shaft **23**. The propeller **24** generates a propulsive force to propel the marine vessel **120** by rotating in the water by the driving force transmitted from the power unit **10**. The power unit **10** is described in detail below.
[0044] The outboard motor main body **101** includes a cowling **31**, an upper case **32**, and a lower case **33**. The cowling **31**, the upper case **32**, and the lower case **33** define a housing of the outboard motor main body **101**. The cowling **31** is made of resin, for example. The upper case **32** and the lower case **33** are preferably made of metal (aluminum, for example). The cowling **31** houses the power unit **10**. The upper case **32** is located below the cowling **31**. The upper case **32** houses an upper portion of the drive shaft **21**. The lower case **33** is located below the upper case **32**. The lower case **33** houses a lower portion of the drive shaft **21**, the gearing **22**, and the propeller shaft **23**. The propeller **24** is located behind the lower case **33**.
[0045] As shown in FIG. **3**, the power unit **10** includes a cylinder block including a first cylinder block **11** and a second cylinder block **12**, a first cylinder head **13**, a second cylinder head **14**, a first fuel injector **15**, and a second fuel injector **16** (see FIG. **4**).
[0046] Each of the first cylinder block **11** and the second cylinder block **12** includes a plurality of cylinders (not shown) aligned in the upward-downward direction of the outboard motor main body

101 (see FIG. **2**). The first cylinder block **11** and the second cylinder block **12** are aligned in the right-left direction of the outboard motor main body **101**. Each of the first cylinder block **11** and the second cylinder block **12** includes a plurality of (four, for example) cylinders. The plurality of cylinders of the first cylinder block **11** and the plurality of cylinders of the second cylinder block **12** are alternately provided in the upward-downward direction of the outboard motor main body **101**. The plurality of cylinders of the first cylinder block **11** and the plurality of cylinders of the second cylinder block **12** are provided in a V-shape, as viewed in the upward-downward direction of the outboard motor main body **101**. That is, the power unit **10** is a V-type or V-shaped engine.

[0047] The first cylinder head **13** and the second cylinder head **14** are connected to the rear sides of the first cylinder block **11** and the second cylinder block **12**, respectively, in the forward-rearward direction of the outboard motor main body **101** (see FIG. **2**). The first cylinder head **13** and the second cylinder head **14** are aligned along the right-left direction of the outboard motor main body **101**. The first cylinder block **11** and the first cylinder head **13** define a cylinder bank in which a plurality of cylinder rows are provided. The second cylinder block **12** and the second cylinder head **14** define a cylinder bank in which a plurality of cylinder rows are provided. That is, in the power unit **10**, the cylinder banks in which the plurality of cylinder rows are provided are aligned along the right-left direction of the outboard motor main body **101**.

[0048] As shown in FIG. **4**, the first fuel injector **15** and the second fuel injector **16** are attached to the first cylinder head **13** and the second cylinder head **14**, respectively. The first fuel injector **15** and the second fuel injector **16** inject hydrogen inside the first cylinder head **13** and the second cylinder head **14**, respectively. Each of the first fuel injector **15** and the second fuel injector **16** includes an injector to inject fuel and a delivery pipe to supply fuel to the injector.

[0049] The power unit **10** is driven by hydrogen as fuel. Specifically, hydrogen is supplied to each of the first fuel injector **15** and the second fuel injector **16** from the plurality of hydrogen tanks **112** (see FIG. **1**) in the hull **110** (see FIG. **1**). The first fuel injector **15** and the second fuel injector **16** inject hydrogen as fuel into combustion chambers inside the first cylinder head **13** and the second cylinder head **14**, respectively. In the combustion chambers inside the first cylinder head **13** and the second cylinder head **14**, a mixture of hydrogen as fuel and air supplied from an intake system IS (described below) is combusted to cause pistons (not shown) in the cylinders of the first cylinder block **11** (see FIG. **3**) and the second cylinder block **12** (see FIG. **3**) to reciprocate. The reciprocating motion of the pistons is transmitted to the crankshaft.

[0050] As shown in FIG. **3**, the power unit **10** includes the intake system IS and an exhaust system ES. The intake system IS supplies air taken in from outside the outboard motor **100** (see FIG. **2**) to the first cylinder head **13** and the second cylinder head **14**. The exhaust system ES exhausts (discharges) exhaust gas generated by burning the air-fuel mixture in the first cylinder head **13** and the second cylinder head **14** to the outside of the outboard motor **100**.

[0051] The exhaust system ES includes a first exhaust manifold **17**, a second exhaust manifold **18**, and an exhaust pipe **19**. The first exhaust manifold **17** is connected to the first cylinder head **13**, and exhaust gas from the first cylinder head **13** passes through the first exhaust manifold **17**. The first exhaust manifold **17** is located rearward of the first cylinder head **13** in the forward-rearward direction (see FIG. **2**) of the outboard motor main body **101**. The second exhaust manifold **18** is connected to the second cylinder head **14**, and exhaust gas from the second cylinder head **14** passes through the second exhaust manifold **18**. The second exhaust manifold **18** is located rearward of the second cylinder head **14** in the forward-rearward direction of the outboard motor main body **101**. Exhaust gas that has passed through the first exhaust manifold **17** and exhaust gas that has passed through the second exhaust manifold **18** pass through the exhaust pipe **19**. That is, the exhaust pipe **19** is provided downstream of the first exhaust manifold **17** and the second exhaust manifold **18** in the exhaust system ES. The exhaust pipe **19** is located below the first exhaust manifold **17** and the second exhaust manifold **18** in the upward-downward direction of the outboard motor main body **101**. The exhaust pipe **19** is connected to ends (lower ends in the upward-downward direction of

the outboard motor main body **101**) of the first exhaust manifold **17** and the second exhaust manifold **18**.

[0052] The power unit **10** includes a first cylinder head cover **13***a* and a second cylinder head cover **14***a*. The first cylinder head cover **13***a* is attached to the rear side of the first cylinder head **13** in the forward-rearward direction of the outboard motor main body **101** (see FIG. **2**). The second cylinder head cover **14***a* is attached to the rear side of the second cylinder head **14** in the forward-rearward direction of the outboard motor main body **101**.

[0053] As shown in FIG. **4**, the outboard motor **100** includes a first pipe **41**, a second pipe **42**, a flexible pipe **43**, a first joint **44**, a second joint **45**, and a third pipe **46**. The first pipe **41**, the second pipe **42**, the third pipe **46**, and the flexible pipe **43** have a strength that allows high-pressure hydrogen to pass therethrough. The first joint **44** and the second joint **45** are airtight against high-pressure hydrogen. The first pipe **41**, the second pipe **42**, the third pipe **46**, and the flexible pipe **43** are made of metal (stainless steel, for example).

[0054] The first pipe **41** is a pipe through which high-pressure hydrogen is supplied to the first fuel injector **15**. Specifically, the first pipe **41** extends along the upward-downward direction of the outboard motor main body **101** (see FIG. **2**). An end **41***a* of the first pipe **41** on a first side (the upper side in the upward-downward direction of the outboard motor main body **101**) is connected to the first fuel injector **15**.

[0055] The second pipe **42** is a pipe through which high-pressure hydrogen is supplied to the second fuel injector **16**. Specifically, the second pipe **42** extends along the upward-downward direction of the outboard motor main body **101** (see FIG. **2**). An end **42***a* of the second pipe **42** on the first side (the upper side in the upward-downward direction of the outboard motor main body **101**) is connected to the second fuel injector **16**. The second pipe **42** is located to the right of the first pipe **41** in the right-left direction of the outboard motor main body **101**.

[0056] The flexible pipe **43** connects the first pipe **41** to the second pipe **42** so as to allow high-pressure hydrogen to flow therethrough to both the first pipe **41** and the second pipe **42**. Specifically, the flexible pipe **43** extends along the right-left direction of the outboard motor main body **101** (see FIG. **2**). An end **43***a* of the flexible pipe **43** on a third side (the left side in the right-left direction of the outboard motor main body **101**) is connected to an end **41***b* of the first pipe **41** on a second side (the lower side in the upward-downward direction of the outboard motor main body **101**) via the first joint **44**. That is, the first joint **44** connects the first pipe **41** to the end **43***a* of the flexible pipe **43** on the third side. An end **43***b* of the flexible pipe **43** on a fourth side (the right side in the right-left direction of the outboard motor main body **101**) is connected to an end **42***b* of the second pipe **42** on the second side (the lower side in the upward-downward direction of the outboard motor main body **101**) via the second joint **45**. That is, the second joint **45** connects the second pipe **42** to the end **43***b* of the flexible pipe **43** on the fourth side. As shown in FIG. **5**, the flexible pipe **43** is a bendable pipe that has a corrugated or braided structure. The flexible pipe **43** acts as a rigid structural body when high-pressure hydrogen is supplied thereto. The end **43***a* of the flexible pipe **43** on the third side is an example of a “first end of the flexible pipe”, and the end **43***b* of the flexible pipe **43** on the fourth side is an example of a “second end of the flexible pipe”.

[0057] As shown in FIG. **4**, the first joint **44** has a T-shape as viewed in the forward-rearward direction of the outboard motor main body **101** so as to connect the end **41***b* on the second side (the lower side in the upward-downward direction of the outboard motor main body **101**) of the first pipe **41** extending along the upward-downward direction of the outboard motor main body **101** (see FIG. **2**), the end **43***a* on the third side (the left side in the right-left direction of the outboard motor main body **101**) of the flexible pipe **43** extending along the right-left direction of the outboard motor main body **101**, and a first end **46***a* of the third pipe **46** to each other. In other words, the first joint **44** connects the first pipe **41** to the flexible pipe **43** such that a central axis extending in the longitudinal direction (the upward-downward direction of the outboard motor main body **101**) of the first pipe **41** and a central axis extending in the longitudinal direction (the right-left direction of

the outboard motor main body **101**) of the flexible pipe **43** intersect with each other.
[0058] The second joint **45** has an L-shape as viewed in the forward-rearward direction of the outboard motor main body **101** so as to connect the end **43***b* on the second side (the lower side in the upward-downward direction of the outboard motor main body **101**) of the second pipe **42** extending along the upward-downward direction of the outboard motor main body **101** (see FIG. **2**) to the end **43***b* on the fourth side (the right side in the right-left direction of the outboard motor main body **101**) of the flexible pipe **43** extending along the right-left direction of the outboard motor main body **101**. In other words, the second joint **45** connects the second pipe **42** to the flexible pipe **43** such that a central axis extending in the longitudinal direction (the upward-downward direction of the outboard motor main body **101**) of the second pipe **42** and a central axis extending in the longitudinal direction (the right-left direction of the outboard motor main body **101**) of the flexible pipe **43** intersect with each other.
[0059] The first end **46***a* of the third pipe **46** is connected to the first pipe **41** and the flexible pipe **43** via the first joint **44**. As shown in FIG. **3**, a second end **46***b* of the third pipe **46** is connected to a hull-outboard motor pipe (not shown) that connects the third pipe **46** to a pipe (not shown) on the hull **110** (see FIG. **1**) side that is connected to the plurality of hydrogen tanks **112** (see FIG. **1**). In other words, the third pipe **46** is a pipe through which high-pressure hydrogen is supplied from the hydrogen tanks **112** of the hull **110** to the first pipe **41** and the flexible pipe **43**.
[0060] As shown in FIG. **6**, at least a portion of the flexible pipe **43** overlaps the first exhaust manifold **17** and the second exhaust manifold **18** as viewed in the upward-downward direction of the outboard motor main body **101** (see FIG. **2**). Specifically, as shown in FIG. **7**, the flexible pipe **43** is located below the first exhaust manifold **17** and the second exhaust manifold **18** in the upward-downward direction of the outboard motor main body **101**. As shown in FIG. **6**, a portion of the flexible pipe **43** other than the vicinity of the end **43***a* on the third side (the left side in the right-left direction of the outboard motor main body **101**) and the vicinity of the end **43***b* on the fourth side (the right side in the right-left direction of the outboard motor main body **101**) overlaps the first exhaust manifold **17** and the second exhaust manifold **18** as viewed in the upward-downward direction of the outboard motor main body **101**.
[0061] As shown in FIG. **4**, at least a portion of the flexible pipe **43** overlaps the exhaust pipe **19** as viewed in the forward-rearward direction of the outboard motor main body **101** (see FIG. **2**). Specifically, a central portion of the flexible pipe **43** in the right-left direction of the outboard motor main body **101** overlaps the exhaust pipe **19** as viewed in the forward-rearward direction of the outboard motor main body **101**. As shown in FIG. **6**, at least a portion (the central portion in the right-left direction of the outboard motor main body **101**) of the flexible pipe **43** is located forward of at least a portion (a portion on the first exhaust manifold **17** and second exhaust manifold **18** side) of the exhaust pipe **19** in the forward-rearward direction of the outboard motor main body **101**. That is, the flexible pipe **43** is located between the exhaust pipe **19** and both the first cylinder head cover **13***a* and the second cylinder head cover **14***a* in the forward-rearward direction of the outboard motor main body **101**.
[0062] As shown in FIG. **2**, the outboard motor **100** includes a hydrogen detection sensor **51** inside the cowling **31** to detect hydrogen. The hydrogen detection sensor **51** is located at an upper end **31***a* of the cowling **31** and in the vicinity of a ventilation opening **31***b* on a surface of the cowling **31** that connects the inside of the cowling **31** to the outside of the cowling **31**. In other words, the ventilation opening **31***b* is located at the upper end **31***a* of the cowling **31**.
[0063] According to the various example embodiments of the present invention described above, the following advantageous effects are achieved.
[0064] According to an example embodiment of the present invention, the outboard motor **100** includes the first pipe **41** made of metal to allow high-pressure hydrogen to be supplied therethrough to the first fuel injector **15**, the second pipe **42** made of metal to allow high-pressure hydrogen to be supplied therethrough to the second fuel injector **16**, and the flexible pipe **43** made

of bendable metal to connect the first pipe **41** to the second pipe **42** so as to allow high-pressure hydrogen to flow therethrough to both the first pipe **41** and the second pipe **42**. Accordingly, even when connection positions of the flexible pipe **43** to the first pipe **41** and the second pipe **42** are misaligned due to assembly errors of the first pipe **41** and the second pipe **42** to the outboard motor **100** when the flexible pipe **43** is connected to the first pipe **41** and the second pipe **42**, the misalignments of the connection positions of the flexible pipe **43** to the first pipe **41** and the second pipe **42** are absorbed by the bendable flexible pipe **43**. Consequently, even when the connection positions between the high-pressure metal pipes to allow high-pressure hydrogen to be supplied therethrough to the first fuel injector **15** and the second fuel injector **16** of the power unit **10** are misaligned, the misalignments of the connection positions are absorbed, and the connections are easily made. When a pressure from high-pressure hydrogen is not acting on the flexible pipe **43**, the flexible pipe **43** is bendable, and thus the flexible pipe **43** is easily connected to the first pipe **41** and the second pipe **42**. When a pressure from high-pressure hydrogen is acting on the flexible pipe **43**, the rigidity of the flexible pipe **43** is increased, and thus the strength against vibrations generated in the flexible pipe **43** due to vibrations of the power unit **10**, external disturbances (such as waves) acting on the outboard motor main body **101**, etc. is increased.

[0065] According to an example embodiment of the present invention, the outboard motor **100** includes the first joint **44** airtight against high-pressure hydrogen to connect the first pipe **41** to the end **43***a* of the flexible pipe **43** on the third side, and the second joint **45** airtight against high-pressure hydrogen to connect the second pipe **42** to the end **43***b* of the flexible pipe **43** on the fourth side. Accordingly, the first joint **44** and the second joint **45** enable the high-pressure flexible pipe **43** to be connected to the first high-pressure pipe **41** and the second high-pressure pipe **42** while airtightness against high-pressure hydrogen is achieved.

[0066] According to an example embodiment of the present invention, the flexible pipe **43** extends along the right-left direction of the outboard motor main body **101**. Accordingly, the first pipe **41** and the second pipe **42**, which are provided on one side and the other side in the right-left direction of the outboard motor main body **101**, respectively, are connected to each other at the shortest distance.

[0067] According to an example embodiment of the present invention, the power unit **10** includes the first exhaust manifold **17** rearward of the first cylinder head **13** in the forward-rearward direction of the outboard motor main body **101** and connected to the first cylinder head **13** to allow exhaust gas to pass therethrough from the first cylinder head **13**, and the second exhaust manifold **18** rearward of the second cylinder head **14** in the forward-rearward direction of the outboard motor main body **101** and connected to the second cylinder head **14** to allow exhaust gas to pass therethrough from the second cylinder head **14**. Furthermore, at least a portion of the flexible pipe **43** overlaps the first exhaust manifold **17** and the second exhaust manifold **18** as viewed in the upward-downward direction of the outboard motor main body **101**. Accordingly, in the forward-rearward direction perpendicular to the upward-downward direction of the outboard motor main body **101**, the power unit **10** and the flexible pipe **43** are compactly configured.

[0068] According to an example embodiment of the present invention, the power unit **10** includes the exhaust pipe **19** below the first exhaust manifold **17** and the second exhaust manifold **18** in the upward-downward direction of the outboard motor main body **101** and connected to the first exhaust manifold **17** and the second exhaust manifold **18** to allow the exhaust gas that has passed through the first exhaust manifold **17** and the exhaust gas that has passed through the second exhaust manifold **18** to pass therethrough. Furthermore, at least a portion of the flexible pipe **43** overlaps the exhaust pipe **19** as viewed in the forward-rearward direction of the outboard motor main body **101**. Accordingly, in the upward-downward direction perpendicular to the forward-rearward direction of the outboard motor main body **101**, the power unit **10** and the flexible pipe **43** are compactly configured.

[0069] According to an example embodiment of the present invention, at least a portion of the

flexible pipe **43** is forward of at least a portion of the exhaust pipe **19** in the forward-rearward direction of the outboard motor main body **101**. Accordingly, at least a portion of the flexible pipe **43** easily overlaps the exhaust pipe **19** as viewed in the forward-rearward direction of the outboard motor main body **101**.

[0070] According to an example embodiment of the present invention, the power unit **10** includes the first cylinder head cover **13***a* and the second cylinder head cover **14***a* attached to the rear sides of the first cylinder head **13** and the second cylinder head **14**, respectively, in the forward-rearward direction of the outboard motor main body **101**. Furthermore, at least a portion of the flexible pipe **43** is between the exhaust pipe **19** and both the first cylinder head cover **13***a* and the second cylinder head cover **14***a* in the forward-rearward direction of the outboard motor main body **101**. Accordingly, a space between the exhaust pipe **19** and both the first cylinder head cover **13***a* and the second cylinder head cover **14***a* in the forward-rearward direction of the outboard motor main body **101** is effectively used to locate the flexible pipe **43**.

[0071] According to an example embodiment of the present invention, the outboard motor **100** includes the third pipe **46** made of metal and connected to the first pipe **41** and the flexible pipe **43** via the first joint **44** to allow high-pressure hydrogen to be supplied therethrough to the first pipe **41** and the flexible pipe **43**. Accordingly, the third pipe allows high-pressure hydrogen to be easily supplied to the first pipe **41** and the flexible pipe **43**.

[0072] According to an example embodiment of the present invention, the outboard motor main body **101** includes the cowling **31** to house the power unit **10**. Furthermore, the outboard motor **100** includes the hydrogen detection sensor **51** inside the cowling **31** to detect hydrogen. Accordingly, when hydrogen leaks from the pipes, the hydrogen detection sensor **51** detects the hydrogen, and thus leakage of the hydrogen from the pipes is dealt with promptly.

[0073] According to an example embodiment of the present invention, the hydrogen detection sensor **51** is at the upper end **31***a* of the cowling **31** and in the vicinity of the ventilation opening **31***b* on the surface of the cowling **31** that connects the inside of the cowling **31** to the outside of the cowling **31**. Accordingly, the hydrogen detection sensor **51** is at a location inside the cowling **31** at which hydrogen is relatively easy to detect, and thus when hydrogen leaks from the pipes, the hydrogen detection sensor **51** easily detects the hydrogen.

[0074] The example embodiments of the present invention described above are illustrative in all points and not restrictive. The extent of the present invention is not defined by the above description of the example embodiments but by the scope of the claims, and all modifications within the meaning and range equivalent to the scope of the claims are further included.

[0075] For example, while the flexible pipe **43** preferably extends along the right-left direction of the outboard motor main body **101** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the flexible pipe may alternatively extend along a direction other than the right-left direction of the outboard motor main body.

[0076] While at least a portion of the flexible pipe **43** preferably overlaps the first exhaust manifold **17** and the second exhaust manifold **18** as viewed in the upward-downward direction of the outboard motor main body **101** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the flexible pipe may not overlap the first exhaust manifold and the second exhaust manifold as viewed in the upward-downward direction of the outboard motor main body.

[0077] While at least a portion of the flexible pipe **43** preferably overlaps the exhaust pipe **19** as viewed in the forward-rearward direction of the outboard motor main body **101** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the flexible pipe may not overlap the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body.

[0078] While at least a portion of the flexible pipe **43** is preferably located forward of at least a

portion of the exhaust pipe **19** in the forward-rearward direction of the outboard motor main body **101** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, at least a portion of the flexible pipe may not be located forward of at least a portion of the exhaust pipe in the forward-rearward direction of the outboard motor main body.

[0079] While at least a portion of the flexible pipe **43** is preferably located between the exhaust pipe **19** and both the first cylinder head cover **13***a* and the second cylinder head cover **14***a* in the forward-rearward direction of the outboard motor main body **101** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the flexible pipe may not be located between the exhaust pipe and both the first cylinder head cover and the second cylinder head cover in the forward-rearward direction of the outboard motor main body.

[0080] While the outboard motor **100** preferably includes the hydrogen detection sensor **51** inside the cowling **31** to detect hydrogen in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the outboard motor may not include the hydrogen detection sensor inside the cowling to detect hydrogen.

[0081] While the hydrogen detection sensor **51** is preferably located at the upper end **31***a* of the cowling **31** and in the vicinity of the ventilation opening **31***b* on the surface of the cowling **31** that connects the inside of the cowling **31** to the outside of the cowling **31** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the hydrogen detection sensor may alternatively be located in the cowling at a location other than the upper end, or may alternatively be located other than the vicinity of the ventilation opening on the surface of the cowling that connects the inside of the cowling to the outside of the cowling.

[0082] While the ventilation opening **31***b* is preferably located at the upper end **31***a* of the cowling **31** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the ventilation opening may alternatively be located at a location other than the upper end of the cowling.

[0083] While the cylinder banks in which the plurality of cylinder rows are provided in the power unit **10** are preferably aligned along the right-left direction of the outboard motor main body **101** in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, at least one cylinder bank in which a plurality of cylinder rows are provided is only required to be provided. In such a case, the outboard motor preferably includes the power unit including at least one cylinder bank in which a plurality of cylinder rows are provided, and a fuel injector to inject hydrogen into combustion chambers inside the cylinder rows of the cylinder bank and to be driven by hydrogen as fuel, a fuel pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to the fuel injector, a flexible pipe made of bendable metal, having a corrugated or braided structure, connected to the fuel pipe so as to allow the high-pressure hydrogen to flow therethrough to the fuel pipe, and a joint to connect the fuel pipe to the flexible pipe such that a central axis extending in the longitudinal direction of the fuel pipe and a central axis extending in the longitudinal direction of the flexible pipe intersect with each other, and the flexible pipe preferably acts as a rigid structural body when high-pressure hydrogen is supplied therethrough. Accordingly, when the flexible pipe is connected to the fuel pipe, the bendable flexible pipe absorbs the misalignment of the connection position of the flexible pipe to the fuel pipe even when the connection position of the flexible pipe to the fuel pipe is misaligned due to an assembly error of the fuel pipe to the outboard motor. That is, the flexible pipe made of metal is easily connected to the fuel pipe made of metal. Consequently, similarly to the example embodiments described above, even when the connection position between the high-pressure metal pipes to allow the high-pressure hydrogen to be supplied therethrough to the fuel injector of the power unit to be driven by hydrogen as fuel is misaligned, the misalignment of the

connection position is absorbed, and the connection is easily made. Furthermore, similarly to the example embodiments described above, when a pressure from the high-pressure hydrogen is not acting on the flexible pipe, the flexible pipe is bendable, and thus the flexible pipe is easily connected to the fuel pipe. In addition, the fuel injector includes the joint to connect the fuel pipe to the flexible pipe such that the central axis extending in the longitudinal direction of the fuel pipe and the central axis extending in the longitudinal direction of the flexible pipe intersect with each other, and the flexible pipe acts as a rigid structural body when high-pressure hydrogen is supplied therethrough. Thus, the strength against vibrations generated in the flexible pipe due to vibrations of the power unit, external disturbances (such as waves) acting on an outboard motor main body, etc. is increased.

[0084] While the power unit **10** preferably includes an engine in example embodiments described above, the present invention is not restricted to this. In an example embodiment of the present invention, the power unit may alternatively be a hybrid power unit including a motor and an engine, or may be a range extender.

[0085] While example embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

Claims

1. An outboard motor comprising: an outboard motor main body; a power unit configured to be driven by hydrogen as a fuel and including a first cylinder head and a second cylinder head aligned along a right-left direction of the outboard motor main body, and a first fuel injector and a second fuel injector attached to the first cylinder head and the second cylinder head to inject the hydrogen into combustion chambers inside the first cylinder head and the second cylinder head, respectively; a propeller to be driven via a drive shaft and a propeller shaft both below the power unit; a first pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to the first fuel injector; a second pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the second fuel injector; and a flexible pipe made of bendable metal, having a corrugated or braided structure, to connect the first pipe to the second pipe so as to allow the high-pressure hydrogen to flow therethrough to both the first pipe and the second pipe.

2. The outboard motor according to claim 1, further comprising: a first joint airtight against the high-pressure hydrogen to connect the first pipe to a first end of the flexible pipe; and a second joint airtight against the high-pressure hydrogen to connect the second pipe to a second end of the flexible pipe.

3. The outboard motor according to claim 1, wherein the flexible pipe extends along the right-left direction of the outboard motor main body.

4. The outboard motor according to claim 1, wherein the power unit includes: a first exhaust manifold rearward of the first cylinder head in a forward-rearward direction of the outboard motor main body and connected to the first cylinder head to allow exhaust gas to pass therethrough from the first cylinder head; and a second exhaust manifold rearward of the second cylinder head in the forward-rearward direction of the outboard motor main body and connected to the second cylinder head to allow exhaust gas to pass therethrough from the second cylinder head; and at least a portion of the flexible pipe overlaps the first exhaust manifold and the second exhaust manifold as viewed in an upward-downward direction of the outboard motor main body.

5. The outboard motor according to claim 4, wherein the power unit includes an exhaust pipe below the first exhaust manifold and the second exhaust manifold in the upward-downward direction of the outboard motor main body and connected to the first exhaust manifold and the second exhaust manifold to allow the exhaust gas that has passed through the first exhaust manifold and the

exhaust gas that has passed through the second exhaust manifold to pass therethrough; and at least a portion of the flexible pipe overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body.

6. The outboard motor according to claim 5, wherein at least a portion of the flexible pipe is forward of at least a portion of the exhaust pipe in the forward-rearward direction of the outboard motor main body.

7. The outboard motor according to claim 6, wherein the power unit includes a first cylinder head cover and a second cylinder head cover attached to rear sides of the first cylinder head and the second cylinder head, respectively, in the forward-rearward direction of the outboard motor main body; and at least a portion of the flexible pipe is between the exhaust pipe and both the first cylinder head cover and the second cylinder head cover in the forward-rearward direction of the outboard motor main body.

8. The outboard motor according to claim 2, further comprising: a third pipe made of metal and connected to the first pipe and the flexible pipe via the first joint to allow the high-pressure hydrogen to be supplied therethrough to the first pipe and the flexible pipe.

9. The outboard motor according to claim 1, wherein the outboard motor main body includes a cowling to house the power unit; and the outboard motor further comprises a hydrogen detection sensor inside the cowling to detect the hydrogen.

10. The outboard motor according to claim 9, wherein the hydrogen detection sensor is at least either at an upper end of the cowling or in a vicinity of a ventilation opening on a surface of the cowling that connects an inside of the cowling to an outside of the cowling.

11. A marine vessel comprising: a hull including a hydrogen tank filled with hydrogen; and an outboard motor attached to the hull; wherein the outboard motor includes: an outboard motor main body; a power unit configured to be driven by the hydrogen as fuel and including a first cylinder head and a second cylinder head aligned along a right-left direction of the outboard motor main body, and a first fuel injector and a second fuel injector attached to the first cylinder head and the second cylinder head to inject the hydrogen into combustion chambers inside the first cylinder head and the second cylinder head, respectively; a propeller to be driven via a drive shaft and a propeller shaft both below the power unit; a first pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to the first fuel injector; a second pipe made of metal to allow the high-pressure hydrogen to be supplied therethrough to the second fuel injector; and a flexible pipe made of bendable metal, having a corrugated or braided structure, to connect the first pipe to the second pipe so as to allow the high-pressure hydrogen to flow therethrough to both the first pipe and the second pipe.

12. The marine vessel according to claim 11, further comprising: a first joint airtight against the high-pressure hydrogen to connect the first pipe to a first end of the flexible pipe; and a second joint airtight against the high-pressure hydrogen to connect the second pipe to a second end of the flexible pipe.

13. The marine vessel according to claim 11, wherein the flexible pipe extends along the right-left direction of the outboard motor main body.

14. The marine vessel according to claim 11, wherein the power unit includes: a first exhaust manifold rearward of the first cylinder head in a forward-rearward direction of the outboard motor main body and connected to the first cylinder head to allow exhaust gas to pass therethrough from the first cylinder head; and a second exhaust manifold rearward of the second cylinder head in the forward-rearward direction of the outboard motor main body and connected to the second cylinder head to allow exhaust gas to pass therethrough from the second cylinder head; and at least a portion of the flexible pipe overlaps the first exhaust manifold and the second exhaust manifold as viewed in an upward-downward direction of the outboard motor main body.

15. The marine vessel according to claim 14, wherein the power unit includes an exhaust pipe below the first exhaust manifold and the second exhaust manifold in the upward-downward

direction of the outboard motor main body and connected to the first exhaust manifold and the second exhaust manifold to allow the exhaust gas that has passed through the first exhaust manifold and the exhaust gas that has passed through the second exhaust manifold to pass therethrough; and at least a portion of the flexible pipe overlaps the exhaust pipe as viewed in the forward-rearward direction of the outboard motor main body.

16. The marine vessel according to claim 15, wherein at least a portion of the flexible pipe is forward of at least a portion of the exhaust pipe in the forward-rearward direction of the outboard motor main body.

17. The marine vessel according to claim 16, wherein the power unit includes a first cylinder head cover and a second cylinder head cover attached to rear sides of the first cylinder head and the second cylinder head, respectively, in the forward-rearward direction of the outboard motor main body; and at least a portion of the flexible pipe is between the exhaust pipe and both the first cylinder head cover and the second cylinder head cover in the forward-rearward direction of the outboard motor main body.

18. The marine vessel according to claim 12, further comprising: a third pipe made of metal and connected to the first pipe and the flexible pipe via the first joint to allow the high-pressure hydrogen supplied from the hydrogen tank of the hull to be supplied therethrough to the first pipe and the flexible pipe.

19. The marine vessel according to claim 11, wherein the outboard motor main body includes a cowling to house the power unit; and the marine vessel further comprises a hydrogen detection sensor inside the cowling to detect the hydrogen.

20. An outboard motor comprising: a power unit configured to be driven by hydrogen as fuel and including at least one cylinder bank including a plurality of cylinder rows, and a fuel injector to inject hydrogen into combustion chambers inside the plurality of cylinder rows of the cylinder bank; a propeller to be driven via a drive shaft and a propeller shaft both below the power unit; a fuel pipe made of metal to allow high-pressure hydrogen to be supplied therethrough to the fuel injector; a flexible pipe made of bendable metal, having a corrugated or braided structure, and connected to the fuel pipe so as to allow the high-pressure hydrogen to flow therethrough to the fuel pipe; and a joint to connect the fuel pipe to the flexible pipe such that a central axis extending in a longitudinal direction of the fuel pipe and a central axis extending in a longitudinal direction of the flexible pipe intersect with each other; wherein the flexible pipe is a rigid structural body when the high-pressure hydrogen is supplied therethrough.