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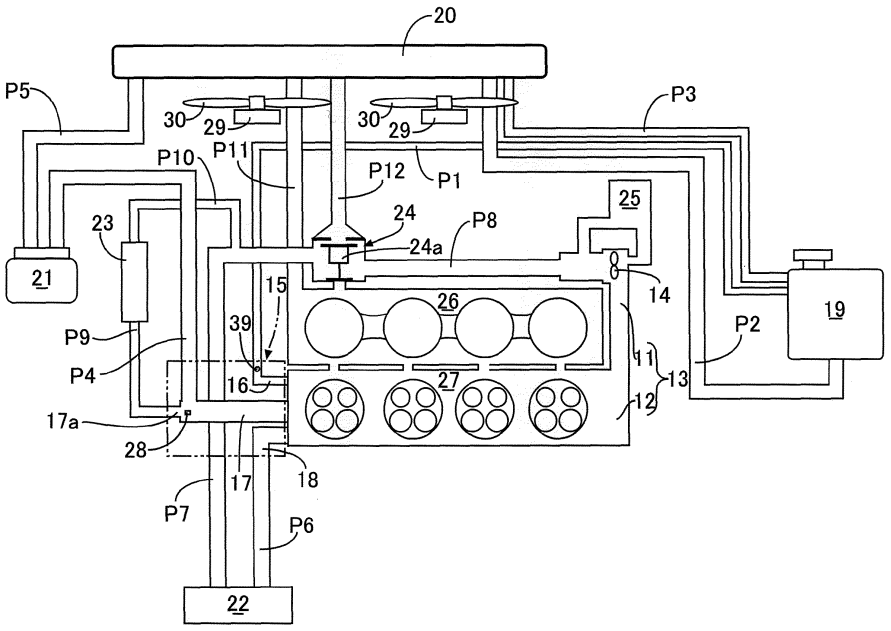
(54) Coolant passage structure for engine

(57) Coolant from a coolant passage of an engine body to respective auxiliaries and the like outside an engine can be supplied with a compact structure. Since first to third internal coolant passages (34, 35, and 36) diverging from a coolant collection section (12e) formed inside a cylinder head (12) are open into an outer wall surface (12c) of the cylinder head (12), and first to third external coolant passages (16, 17, and 18) are independently formed inside a external coolant passage formation member (15) joined integrally with the outer wall surface (12c) with bolts (31, 32, 33) so that the upstream sides thereof can respectively communicate with the multiple internal coolant passages (34, 35, and 36), the external coolant passage formation member (15) can be reduced in size to improve the degree of freedom in layout, as compared to a case where the external coolant passage formation member (15) has a coolant collection section inside or a case where the multiple external coolant passages (16, 17, and 18) are individually joined with the cylinder head (12).

FIG.1



EP 2 034 155 A1

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a coolant passage structure for an engine, in which downstream ends of a plurality of internal coolant passages diverging from a coolant collection section formed in an engine body are open into an outer wall surface of the engine body, and a plurality of external coolant passages are formed inside an external coolant passage formation member in such a way that upstream sides thereof respectively communicate with openings of the plurality of internal coolant passages, the external coolant passage formation member being integrally joined with the outer wall surface.

DESCRIPTION OF THE RELATED ART

[0002] Japanese Patent Application Laid-open No. 2002-349261 discloses a structure in which a coupling (external coolant passage formation member) is fixed to an outer wall surface of an engine body so as to supply coolant discharged from a water jacket provided inside the engine body to a radiator, a water pump, a heater core, a turbo charger, an EGR cooler, and the like through the external coolant passage formation member.

[0003] In the conventional structure described above, the water jacket provided inside the engine body and the external coolant passage formation member fixed to the outer wall surface of the engine body communicate with each other through a single opening, and multiple coolant passages diverging from a coolant collection section formed inside the external coolant passage formation member are connected to the radiator, the water pump, the heater core, the turbo charger, the EGR cooler, and the like, whereby the dimensions of the external coolant passage formation member increase, thus possibly making it difficult to arrange it in a small-spaced engine room.

SUMMARY OF THE INVENTION

[0004] The present invention has been made in view of the circumstance described above, and an object of the present invention is to enable supply of coolant from a coolant passage of an engine body to external auxiliaries and the like with a compact structure.

[0005] In order to achieve the object, according to a first feature of the present invention, there is provided a coolant passage structure for an engine, in which downstream ends of a plurality of internal coolant passages diverging from a coolant collection section formed in an engine body are open into an outer wall surface of the engine body, and a plurality of external coolant passages are formed inside an external coolant passage formation member in such a way that upstream sides thereof respectively communicate with openings of the plurality of internal coolant passages, the external coolant passage formation member being integrally joined with the outer wall surface, characterized in that among the plurality of external coolant passages, a downstream side of a first external coolant passage, which communicates with a highest position of the coolant collection section, communicates with a gas-liquid separation device, and an air bleed system is provided to the first external coolant passage.

[0006] According to a second feature of the present invention, in addition to the first feature, there is provided the coolant passage structure for an engine, characterized in that the air bleed system is formed of an opening formed in the first external coolant passage, a first boss section around the opening, and a plug member which occludes the opening, and a second boss section into which a fixing member is inserted is connected to the first boss section by a rib, the fixing member fixing the external coolant passage formation member to the outer wall surface of the engine body.

[0007] According to a third feature of the present invention, in addition to the first or second feature, there is provided the coolant passage structure for an engine, characterized by further comprising a coolant pump which circulates coolant, characterized in that a coolant temperature sensor is provided to a second external coolant passage, whose downstream side constantly communicates with an intake side of the coolant pump, among the plurality of external coolant passages.

[0008] According to a fourth feature of the present invention, in addition to the third feature, there is provided the coolant passage structure for an engine, characterized by further comprising: a radiator cooling the coolant; and a thermostat, which is provided to a coolant passage, and which controls a distribution of the coolant in the coolant passage, the radiator and a coolant passage in the engine body communicating with each other via the coolant passage, wherein the second external coolant passage provided with the coolant temperature sensor communicates with the intake side of the coolant pump regardless of an opening/closing state of the thermostat.

[0009] According to a fifth feature of the present invention, in addition to the third or fourth feature, there is provided the coolant passage structure for an engine, **characterized in that** the coolant temperature sensor includes a body section, which is exposed to outside of the external coolant passage formation member, and a temperature-sensitive section, which is housed inside the external coolant passage formation member, and the temperature-sensitive section is attached so as to be located on an upper side in a vertical direction with respect to the body section.

[0010] Note that, a cylinder head 12 in the embodiment corresponds to the engine body of the present invention, first to third external coolant passages 16 to 18 in the embodiment correspond to the external coolant passages of the present invention, an expansion tank 19 in the embodiment corresponds to the gas-liquid separation

device of the present invention, a water jacket 26 and a pipe P12 in the embodiment correspond to the coolant passages of the present invention, a bolt 31 in the embodiment corresponds to the fixing member of the present invention, first to third internal coolant passages 34 to 36 in the embodiment correspond to the internal coolant passages of the present invention, and a breathing bolt 39 in the embodiment corresponds to the plug member of the present invention.

[0011] With the first feature, the downstream ends of multiple internal coolant passages diverging from a coolant collection section formed in an engine body are open into an outer wall surface of the engine body, and multiple external coolant passages are formed inside an external coolant passage formation member, which is joined integrally with the outer wall surface, such that the upstream sides thereof respectively communicate with openings of the multiple internal coolant passages, the downstream side of a first external coolant passage, which communicates with the highest position of the coolant collection section among the multiple external coolant passages, communicates with a gas-liquid separation device, and an air bleed system is provided to the first coolant passage, whereby the external coolant passage formation member can be reduced in size to improve the degree of freedom in layout, as compared to a case where the external coolant passage formation member has a coolant collection section inside or a case where the multiple external coolant passages are individually joined with the engine body. Further, bubbles which naturally move upward due to lighter weight than the coolant can reliably be lead to the gas-liquid separation device via the first external coolant passage located in the high position. In addition, since the air bleed system is provided in the first external coolant passage in which the bubbles tend to gather when the coolant is filled in the cooling system of the engine, air can effectively be bled from the air bleed system to completely fill the cooling system of the engine with the coolant.

[0012] With the second feature, the air bleed system is formed of an opening formed in the first external coolant passage, a first boss section around the opening, and a plug member which occludes the opening, and a second boss section, into which a fixing member fixing the external coolant passage formation member to the outer wall surface of the engine body is inserted, and the first boss section are connected by a rib, whereby the rigidity of the external coolant passage formation member can be improved by the reinforcement effect of the rib.

[0013] With the third feature, a coolant pump which circulates the coolant is provided, and a coolant temperature sensor is provided to a second coolant passage, whose downstream side constantly communicates with the intake side of the coolant pump, among the multiple external coolant passages, whereby the coolant temperature sensor can be located in a portion where the coolant constantly flows so as to detect the coolant temperature with high precision.

[0014] With the fourth feature, in addition to the third feature, a thermostat is provided to the coolant passage connecting the radiator and the coolant passage in the engine body to control the distribution of the coolant in the coolant passage, and the second external coolant passage provided with the coolant temperature sensor communicates with the intake side of the coolant pump regardless of the opening/closing state of the thermostat, whereby the coolant temperature sensor can be located in the portion where the coolant constantly flows so as to detect the coolant temperature with high precision regardless of whether the thermostat is in the opening state or in the closing state.

[0015] With the fifth feature, the coolant temperature sensor includes a body section, which is exposed to outside of the external coolant passage formation member, and a temperature-sensitive section, which is housed inside the external coolant passage formation member, and the temperature-sensitive section is attached so as to be located on the upper side in the vertical direction with respect to the body section, whereby a situation can be avoided in which bubbles are accumulated around the temperature-sensitive section so that the temperature of the coolant cannot be measured accurately.

[0016] An embodiment of the present invention will be described below based on the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Figs. 1 to 6 show the embodiment of the present invention.

Fig. 1 is a schematic view of a cooling system of an engine.

Fig. 2 is a view showing an outer wall surface of a cylinder head mounted with an external coolant passage formation member.

Fig. 3 is a view as viewed along an arrow 3 in Fig. 2.

Fig. 4 is a view as viewed along a line 4-4 in Fig. 3.

Fig. 5 is a sectional view taken along a line 5-5in Fig. 3.

Fig. 6 is a sectional view taken along a line 6-6 in Fig. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] As shown in Fig. 1, an in-line four-cylinder engine includes an engine block 13 formed of a cylinder block 11 and a cylinder head 12, and coolant is supplied from a coolant pump 14, provided on one end side of the engine block 13, to one end side of the cylinder head 12. An external coolant passage formation member 15 to be described later in detail is fixed to the other end side of the cylinder head 12, and the coolant is distributed in four directions through the external coolant passage formation member 15.

[0019] The external coolant passage formation member 15 includes a first external coolant passage 16, a second external coolant passage 17, and a third external coolant passage 18 independently, and a diverging passage 17a diverges from the second external coolant passage 17 along the way.

[0020] The first external coolant passage 16 communicates with an upper section of an expansion tank 19 via a pipe P1, and a lower section of the expansion tank 19 communicates with a lower section of a radiator 20 via a pipe P2. An upper section of the radiator 20 also communicates with the upper section of the expansion tank 19 via a pipe P3. The second external coolant passage 17 communicates with a turbo charger 21 via a pipe P4, and further communicates with the upper section of the radiator 20 via a pipe P5. The third external coolant passage 18 communicates with a heater core 22 via a pipe P6, further communicates with a thermostat 24 via a pipe P7, and further communicates with an intake side of the coolant pump 14 via a pipe P8. The diverging passage 17a diverging from the second external coolant passage 17 is connected to an intermediate section of the pipe P7, which connects the heater core 22 and the thermostat 24, via a pipe P9, a breathalyzer 23, and a pipe P 10.

[0021] An oil cooler 25 is arranged so as to bypass the intake side and a discharge side of the coolant pump 14. A water jacket 26 of the cylinder block 11 and a water jacket 27 of the cylinder head 12 are connected with each other. The water jacket 26 of the cylinder block 11 communicates with the upper section of the radiator 20 via a pipe P11, and communicates with the lower section of the radiator 20 via the thermostat 24 and a pipe P12. A coolant temperature sensor 28 is provided to the second external coolant passage 17. On the rear of the radiator 20, a coolant fan 30, 30 rotated by a motor 29, 29 is provided.

[0022] However, in a low temperature state before a warm-up operation of the engine is completed, a valve 24a of the thermostat 24 is in an ascended position in Fig. 1, whereby the pipe P12 on the downstream side of the radiator 20 and the thermostat 24 are disconnected from each other, and the water jacket 26 of the cylinder block 11 communicates with the pipe P8 on the upstream side of the coolant pump 14. As a result, a closed circuit is formed to have a connection in the order specified as follows: the water jacket 27 of the cylinder head 12; the water jacket 26 of the cylinder block 11; the thermostat 24; the pipe P8; the coolant pump 14; and the water jacket 27 of the cylinder head 12. Thereby, the coolant bypasses the radiator 20, so that the temperature of the coolant is promptly increased to facilitate the warm-up of the engine.

[0023] On the other hand, in a high temperature state after the warm-up operation of the engine is completed, the valve 24a of the thermostat 24 is in a descended position in Fig. 1, whereby the pipe P12 on the downstream side of the radiator 20 communicates with the pipe P8 on the upstream side of the coolant pump 14, and the water jacket 26 of the cylinder block 11 is disconnected from the pipe P8 on the upstream side of the coolant pump 14. As a result, a closed circuit is formed to have a connection in the order specified as follows: the water jacket 27 of the cylinder head 12; the water jacket 26 of the cylinder block 11; the pipe P11; the radiator 20; the pipe P12; the thermostat 24; the pipe P8; the coolant pump 14; and the water jacket 27 of the cylinder head 12. Thereby, the coolant passes through the radiator 20, so that the temperature of the coolant is decreased to prevent an overheating of the engine.

[0024] Further, the coolant which has come out of the water jacket 27 of the cylinder head 12 flows in a closed circuit having a connection in the order specified as follows: the third external coolant passage 18 of the external coolant passage formation member 15; the pipe P6; the heater core 22; the pipe P7; the thermostat 24; the pipe P8; the coolant pump 14; and the water jacket 27 of the cylinder head 12. Thereby, a vehicle compartment can be heated by heat exchange with air performed by the heater core 22.

[0025] Furthermore, the coolant which has come out of the water jacket 27 of the cylinder head 12 is supplied to the radiator 20 via the second external coolant passage 17 of the external coolant passage formation member 15, the pipe P4, the turbo charger 21, and the pipe P5 in this order, whereby the turbo charger 21 is cooled. Meanwhile, the coolant diverged from the second external coolant passage 17 flows to the intermediate section of the pipe P7 via the diverging passage 17a, the pipe P9, the breathalyzer 23, and the pipe P 10 in this order, while a breather is heated by the breathalyzer 23 along the way.

[0026] Still furthermore, the coolant which has come out of the water jacket 27 of the cylinder head 12 is supplied to the expansion tank 19 from the first external coolant passage 16 of the external coolant passage formation member 15 via the pipe P1. Moreover, the coolant which has come out of the radiator 20 is supplied to the expansion tank 19 via the pipe P3, and the coolant whose bubbles are separated thereat returns to the radiator 20 via the pipe P2.

[0027] Additionally, owing to the coolant flowing through the oil cooler 25 by a pressure difference between the front and rear of the coolant pump 14, oil is cooled in the oil cooler 25.

[0028] Next, the structure of the external coolant passage formation member 15 will be described in detail based on Figs. 2 to 6.

[0029] As is clear from Figs. 2 to 4, the cylinder head 12 includes a flat lower surface 12a joined with the cylinder block 11 and a flat upper surface 12b joined with a head cover (not shown), and a cylinder axis L, which is orthogonal to the lower surface 12a and the upper surface 12b, is inclined at θ degrees with respect to a horizontal surface H. On an outer wall surface 12c on the other end side of the coolant supply side of the cylinder head 12, a flat seat surface 12d is formed. A flat attachment sur-

face 15a of the external coolant passage formation member 15 is pressed against the seat surface 12d, and is fixed by three bolts 31, 32, and 33.

[0030] Inside the cylinder head 12 facing the external coolant passage formation member 15, a coolant collection section 12e is formed in a position on a downstream end of the water jacket 27, and short first to third internal coolant passages 34, 35, and 36 independently penetrate from the coolant collection section 12e to the seat surface 12d.

[0031] The first to third external coolant passages 16, 17, and 18 are opened from the attachment surface 15a of the external coolant passage formation member 15. The first internal coolant passage 34 communicates with the first external coolant passage 16, the second internal coolant passage 35 communicates with the second external coolant passage 17, and the third internal coolant passage 36 communicates with third external coolant passage 18. Moreover, on the attachment surface 15a of the external coolant passage formation member 15, sealing members 37 are arranged so as to surround the circumferences of the first to third external coolant passages 16, 17, and 18.

[0032] As is clear from Figs. 2, 3, and 5, the first external coolant passage 16 communicates with the highest position of the coolant collection section 12e of the cylinder head 12 among the first to third external coolant passages 16, 17, and 18 of the external coolant passage formation member 15, and the height increases from the upstream side to the downstream side. A first boss section 15b is formed around an opening 38 which diverges upward from the intermediate section of the first external coolant passage 16, and a breathing bolt 39 is screwed to the opening 38.

[0033] The opening 38 has a small diameter section 38a, a large diameter section 38b, and an internal thread section 38c in this order from bottom to top. The breathing bolt 39 has a small diameter section 39a, an external thread section 39b, and a hexagonal section 39c in this order from bottom to top. A second breathing hole 39e, which extends in the radial direction from near a lower end of a first breathing hole 39d extending downward from an upper end of the breathing bolt 39, is open into the small diameter section 39a.

[0034] A second boss section 15c is formed in a portion where the bolt 31 penetrates, the bolt 31 being the closest one to the first boss section 15b, to which the breathing bolt 39 is screwed, among the three bolts 31, 32, and 33, which fix the external coolant passage formation member 15 to the cylinder head 12. The first boss section 15b and the second boss section 15c are coupled by a rib 15d.

[0035] In this manner, the first boss section 15b which mounts the breathing bolt 39 and the second boss section 15c which mounts the bolt 31 fixing the external coolant passage formation member 15 to the cylinder head 12 are coupled by the rib 15d, whereby the rigidity of the external coolant passage formation member 15 can be improved by the reinforcement effect of the rib 15d.

[0036] As is clear from Figs. 2, 4, and 6, a third boss section 15e is provided so as to protrude obliquely downward from the intermediate section of the second external coolant passage 17 of the external coolant passage formation member 15, and a body section 28a of the coolant temperature sensor 28 is screwed to an opening 15f of the third boss section 15e. A temperature-sensitive section 28b which protrudes obliquely upward from the body section 28a of the coolant temperature sensor 28 extends toward the inside of the second external coolant passage 17.

[0037] In this manner, in the coolant temperature sensor 28, the temperature-sensitive section 28b housed inside the external coolant passage formation member 15 is attached so as to be located on the upper side in the vertical direction with respect to the body section 28a exposed to the outside of the external coolant passage formation member 15, whereby a situation can be avoided in which bubbles are accumulated around the temperature-sensitive section 28b such that the temperature of the coolant cannot be measured accurately.

[0038] Meanwhile, in the case of filling the coolant in the cooling system for factory shipment of the engine or the like, a cap of the expansion tank 19 located in the highest position of the cooling system is removed to pour the coolant therein. At this time, in Fig. 5, loosening the breathing bolt 39 provided to the first external coolant passage 16 of the external coolant passage formation member 15 causes the small diameter section 39a thereof to move upward from the large diameter section 38b of the opening 38, whereby the first external coolant passage 16 communicates with the atmosphere via the small diameter section 38a and the large diameter section 38b of the opening 38, and the second breathing hole 39e and the first breathing hole 39d of the breathing bolt 39. Thereby, air in the cooling system can be discharged into the atmosphere, so that the coolant can be smoothly supplied.

[0039] As is clear from Fig. 2, since the breathing bolt 39 is arranged in the highest position of the inclined cylinder head 12, i.e., the highest position in the cooling system of the engine body, it is confirmed that the coolant has spread over the entire cooling system of the engine body when the coolant has spilled out from the breathing bolt 39. Thus, by tightening the breathing bolt 39 in this state, the supply of the coolant to the cooling system of the engine body can reliably be completed.

[0040] Further, since the external coolant passage formation member 15 does not have a coolant collection section, the external coolant passage formation member can be reduced in size to improve the degree of freedom in layout. In addition, since the first to third external coolant passages 16 to 18 are provided inside the external coolant passage formation member 15, the space efficiency can further be improved as compared to a case where they are provided separately. Moreover, since the first external coolant passage 16 which is located in the highest position in the external coolant passage forma-

tion member 15 communicates with the expansion tank 19, the bubbles generated inside the engine can reliably be led to the expansion tank 19.

[0041] Furthermore, among the first to third external coolant passages 16 to 18, the coolant temperature sensor 28 is provided to the second external coolant passage 17, whose downstream side communicates with the intake side of the coolant pump 14 constantly (regardless of the opening/closing state of the thermostat 24) via the diverging passage 17a, the coolant temperature sensor 28 can be located in a portion where the coolant constantly flows so as to detect a coolant temperature with high precision.

[0042] The embodiment of the present invention has been described above. However, various modifications in design may be made in the present invention without departing from the gist thereof.

[0043] For example, the external coolant passage formation member 15 of the embodiment includes the first to third external coolant passages 16, 17, and 18, but the number of the external coolant passages is not limited to three.

[0044] The thermostat 24 of the embodiment is provided in the coolant passage connecting the entrance of the engine body and the exit of the radiator 20 (for entrance control), but the thermostat 24 may also be provided to a coolant passage connecting the exit of the engine body and the entrance of the radiator 20 (for exit control).

Claims

1. A coolant passage structure for an engine, in which downstream ends of a plurality of internal coolant passages (34, 35, 36) diverging from a coolant collection section (12e) formed in an engine body (12) are open into an outer wall surface (12c) of the engine body (12), and a plurality of external coolant passages (16, 17, 18) are formed inside an external coolant passage formation member (15) in such a way that upstream sides thereof respectively communicate with openings of the plurality of internal coolant passages (34, 35, 36), the external coolant passage formation member (15) being integrally joined with the outer wall surface (12c),
   characterized in that
   among the plurality of external coolant passages (16, 17, 18), a downstream side of a first external coolant passage (16), which communicates with a highest position of the coolant collection section (12e), communicates with a gas-liquid separation device (19), and
   an air bleed system (40) is provided to the first external coolant passage (16).

2. The coolant passage structure for an engine according to claim 1, **characterized in that**
   the air bleed system (40) is formed of an opening (38) formed in the first external coolant passage (16), a first boss section (15b) around the opening (38), and a plug member (39) which occludes the opening (38), and
   a second boss section (15c) into which a fixing member (31) is inserted is connected to the first boss section (15b) by a rib (15d), the fixing member (31) fixing the external coolant passage formation member (15) to the outer wall surface (12c) of the engine body (12).

3. The coolant passage structure for an engine according to any one of claims 1 and 2, **characterized by** further comprising a coolant pump (14) which circulates coolant, **characterized in that**
   a coolant temperature sensor (28) is provided to a second external coolant passage (17), whose downstream side constantly communicates with an intake side of the coolant pump (14), among the plurality of external coolant passages (16, 17, 18).

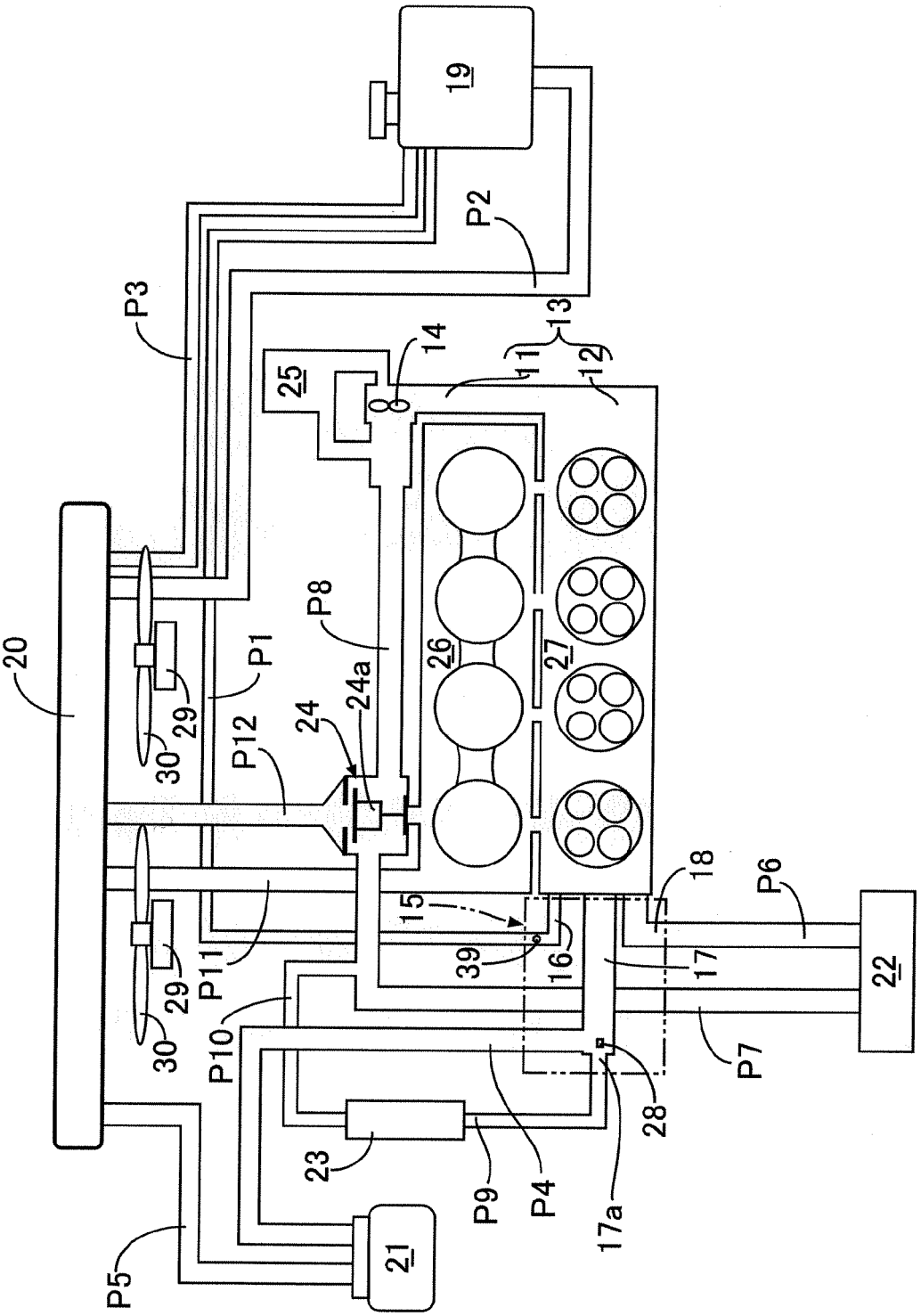
4. The coolant passage structure for an engine according to claim 3, **characterized by** further comprising:

   a radiator (20) cooling the coolant; and
   a thermostat (24), which is provided to a coolant passage (P12), and which controls a distribution of the coolant in the coolant passage (P12), the radiator (20) and a coolant passage (26) in the engine body (12) communicating with each other via the coolant passage (P12),

   wherein the second external coolant passage (17) provided with the coolant temperature sensor (28) communicates with the intake side of the coolant pump (14) regardless of an opening/closing state of the thermostat (24).

5. The coolant passage structure for an engine according to any one of claims 3 and 4, **characterized in that**
   the coolant temperature sensor (28) includes a body section (28a), which is exposed to outside of the external coolant passage formation member (15), and a temperature-sensitive section (28b), which is housed inside the external coolant passage formation member (15), and
   the temperature-sensitive section (28b) is attached so as to be located on an upper side in a vertical direction with respect to the body section (28a).

FIG.1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P6
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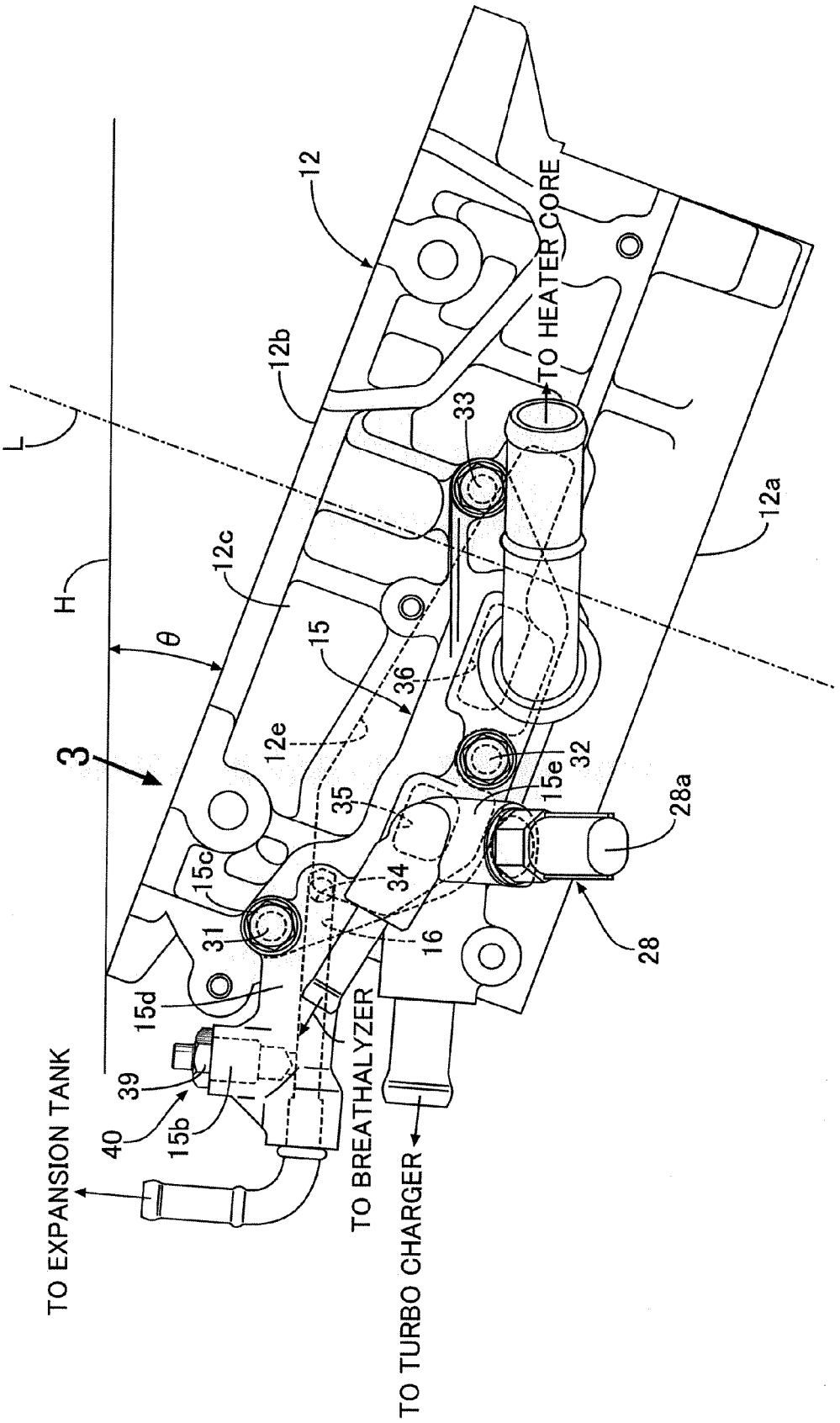
P9
P4
17a
21
P5

FIG.2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12
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TO HEATER CORE
33
15
36
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32
15e
35
28a
15c
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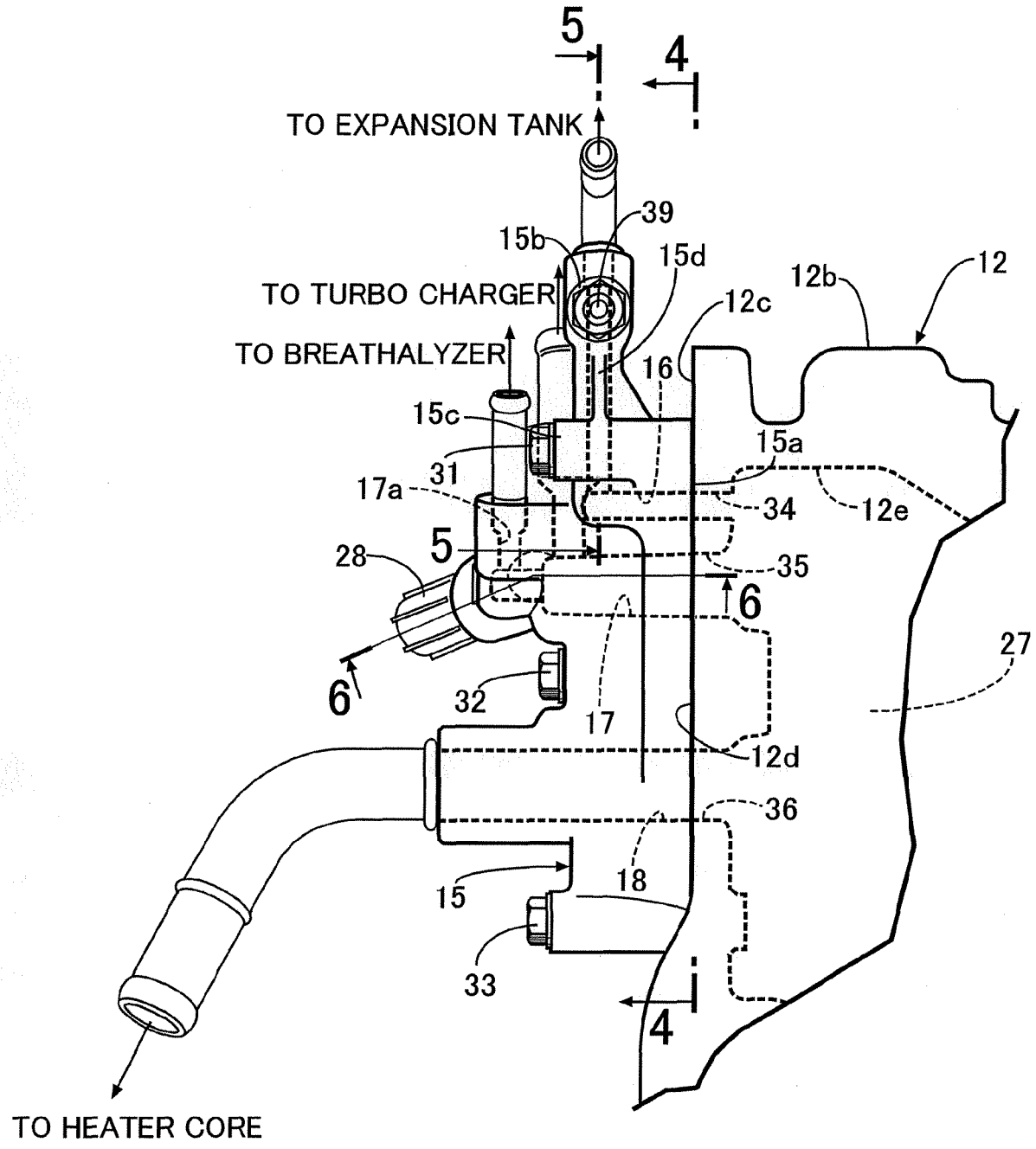
31
16
28
15d
39
40
15b
TO EXPANSION TANK
TO BREATHALYZER
TO TURBO CHARGER

FIG.3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TO EXPANSION TANK
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15b
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TO TURBO CHARGER
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TO BREATHALYZER
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31
17a
34
12e
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12d
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18
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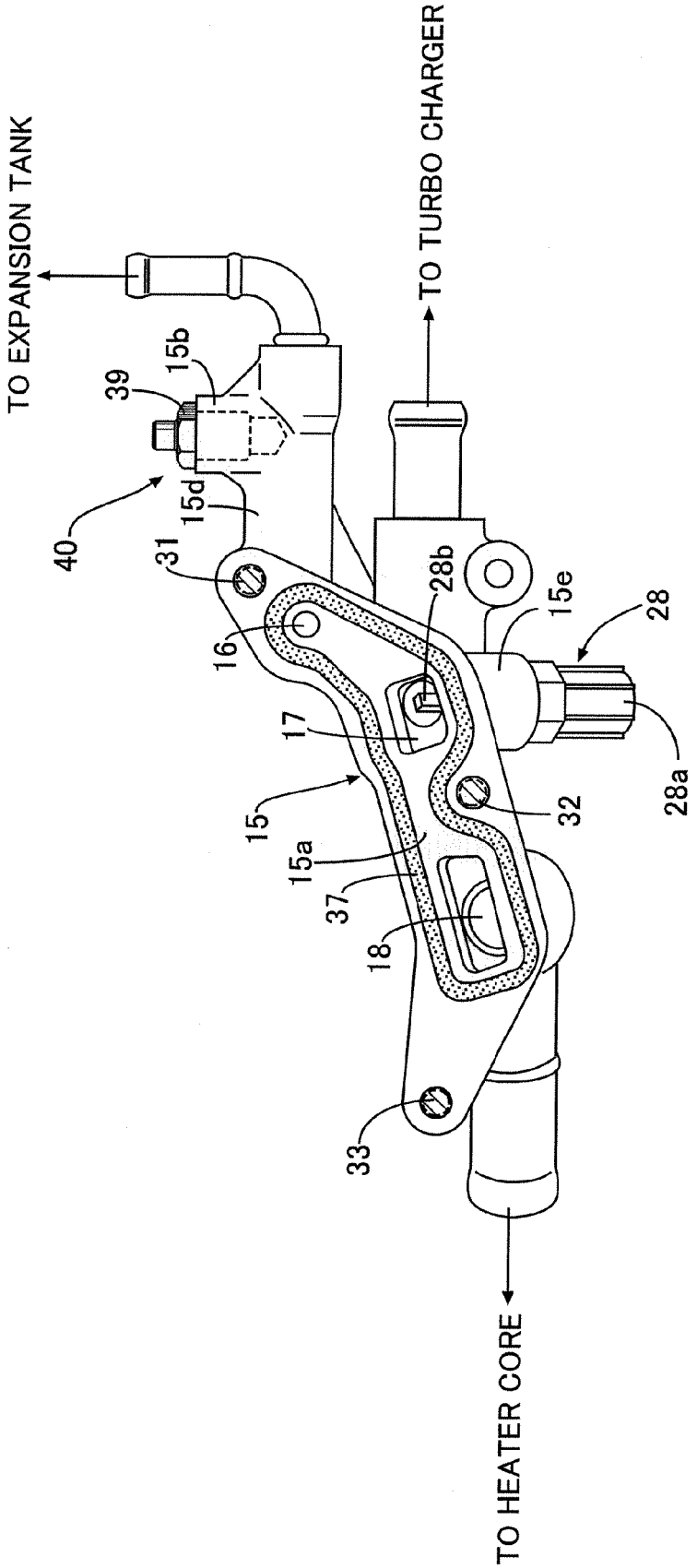
4
TO HEATER CORE

FIG.4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TO TURBO CHARGER
TO HEATER CORE
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28b
15e
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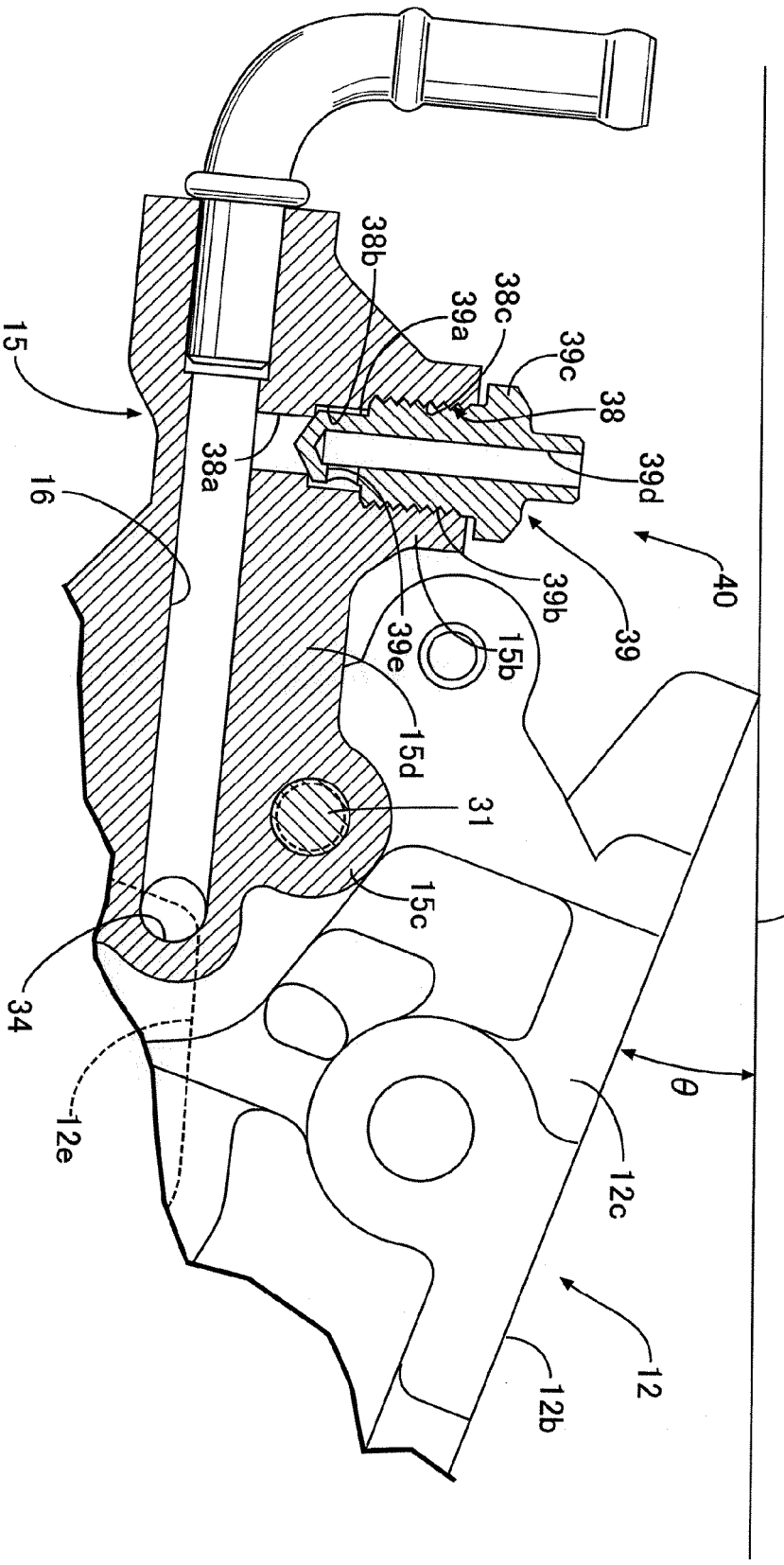
28a
32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16
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39c
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15d
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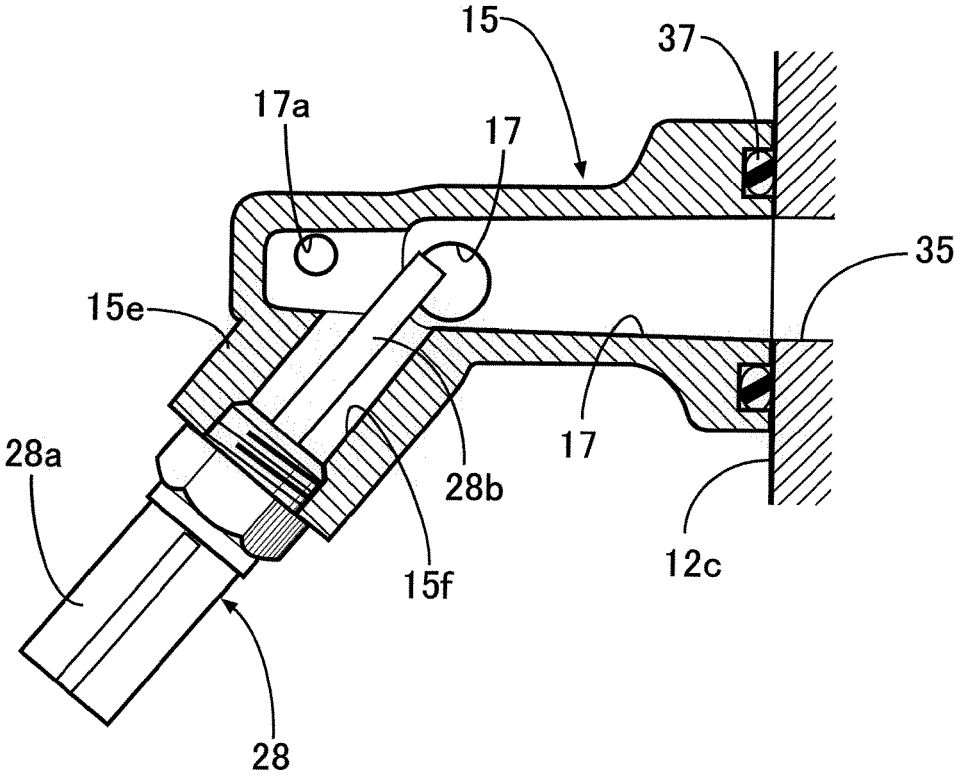
15c
H
θ
12c
12
12b

FIG.5

FIG.6



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EUROPEAN SEARCH REPORT

Application Number
EP 08 16 2508

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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F01P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 October 2008	Luta, Dragos

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