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(54) CAM ANGLE SENSOR ATTACHING STRUCTURE FOR INTERNAL COMBUSTION ENGINE

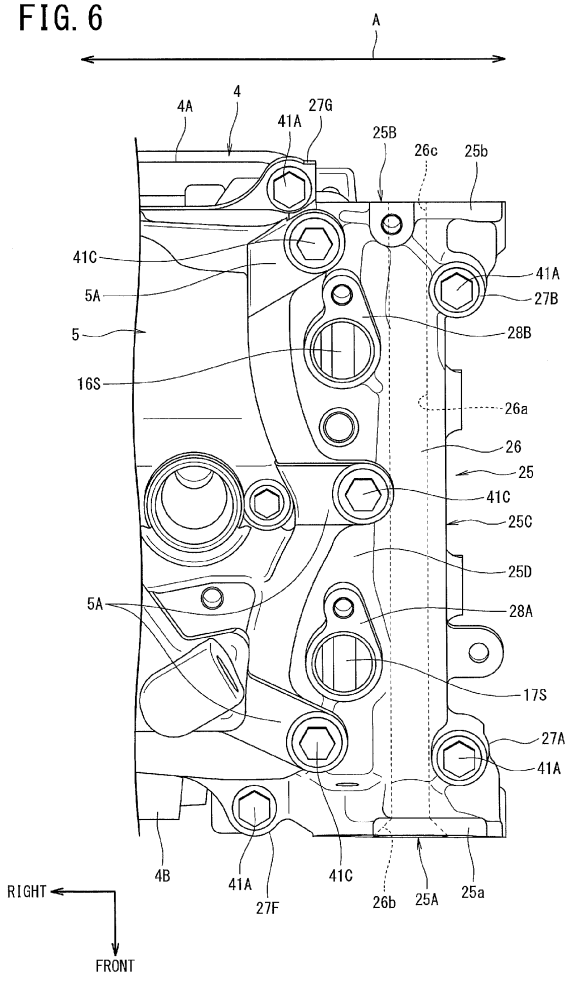
(57) [Problem to be Solved]

It is to provide a cam angle sensor attaching structure for an internal combustion engine capable of enhancing stiffness around a point where a cam angle sensor is attached to suppress vibration of the cam angle sensor to thereby prevent accuracy of detecting a rotational angle of a camshaft from deteriorating.

[Solution]

An EGR housing portion 25 attached to a cylinder head 4 includes: an upper wall 25D with an attaching boss portion 28A, 28B to which a cam angle sensor 31, 32 is attached, the upper wall being connected to a front wall 25A, a rear wall 25B, and a left side wall 25C; and a tubular EGR passage portion 26 with an EGR passage 26a through which an EGR gas flows, the EGR passage portion being located on the same side as the left side wall 25C. The EGR passage portion 26 includes: an EGR gas inlet 26b provided at the front wall 25A, to introduce the EGR gas into the EGR passage 26a; and an EGR gas outlet 26c provided at the rear wall 25B, to discharge the EGR gas from the EGR passage 26a. The attaching boss portion 28A, 28B is connected to the EGR passage portion 26.

FIG. 6



EP 4 265 890 A2

Description

[Technical Field]

[0001] The present invention relates to a cam angle sensor attaching structure for an internal combustion engine.

[Background Art]

[0002] There is known a cam angle sensor which detects rotational positions (rotational angles) of an intake camshaft and an exhaust camshaft in an engine mounted on a vehicle.

[0003] As a conventional cam angle sensor attaching structure for an engine, one in which a cam angle sensor (TDC sensor) is attached to a cylinder head cover covering an upper portion of a cylinder head is known.

[0004] In the cam angle sensor attaching structure, the cam angle sensor is attached to a front surface and an upper surface rear portion of the cylinder head cover from the outside with bolts so as not to interfere with a hood having a forwardly descending slope.

[Citation List]

[Patent Literature]

[0005] [Patent Literature 1] JP H10-37835 A

[Summary of Invention]

[Technical Problem]

[0006] In such a conventional cam angle sensor attaching structure, however, the cam angle sensor is attached to a flat point of the cylinder head cover.

[0007] Since the flat point of the cylinder head cover has a wide area and has low surface stiffness, the cam angle sensor is likely to vibrate due to vibration of an engine, and accuracy of detecting an intake camshaft and an exhaust camshaft may deteriorate.

[0008] The present invention has been made in view of the above-described circumstances, and an object thereof is to provide a cam angle sensor attaching structure for an internal combustion engine capable of enhancing stiffness around a point where a cam angle sensor is attached to suppress vibration of the cam angle sensor to thereby prevent accuracy of detecting a rotational angle of a camshaft from deteriorating.

[Solution to Problem]

[0009] There is provided a cam angle sensor attaching structure for an internal combustion engine, including: a cylinder head with an intake side wall and an exhaust side wall, the intake side wall being formed with an air inlet to suck in an air, the exhaust side wall being formed with an exhaust outlet through which an exhaust gas is discharged; a camshaft extending along a cylinder bank direction, being rotatably supported on the cylinder head; a cylinder head cover and an EGR housing portion both of which are attached to the cylinder head so as to cover an upper portion of the cylinder head; and a cam angle sensor to detect a rotational angle of the camshaft, wherein the EGR housing portion includes: a first side wall located on the same side as the exhaust side wall of the cylinder head; a second side wall located on the same side as the intake side wall of the cylinder head; a third side wall interconnecting end portions of the first and second side walls in the cylinder bank direction; an upper wall with a tubular boss portion to which the cam angle sensor is attached, the upper wall being connected to upper end portions of the first to third side walls; and a tubular EGR passage portion with an EGR passage through which an EGR gas flows, the EGR passage portion being located on the same side as the third side wall, the EGR passage portion includes: an EGR gas inlet formed at the first side wall, to introduce the EGR gas into the EGR passage; and an EGR gas outlet formed at the second side wall, to discharge the EGR gas from the EGR passage, and the boss portion is connected to the EGR passage portion.

[Advantageous Effects of Invention]

[0010] According to the present invention described above, it is possible to enhance stiffness around a point where the cam angle sensor is attached to suppress vibration of the cam angle sensor to thereby prevent accuracy of detecting the rotational angle of the camshaft from deteriorating.

[Brief Description of Drawings]

[0011]

Figure 1 is a left side view of an internal combustion engine according to an embodiment of the present invention.

Figure 2 is a front view of a cylinder head and a cylinder head cover of the internal combustion engine according to the embodiment of the present invention.

Figure 3 is a left side view of the cylinder head and the cylinder head cover of the internal combustion engine according to the embodiment of the present invention.

Figure 4 is a plan view of the internal combustion engine according to the embodiment of the present invention and shows a state where the cylinder head cover is removed.

Figure 5 is a plan view of an EGR housing portion of the internal combustion engine according to the embodiment of the present invention.

Figure 6 is a plan view of the EGR housing portion

of the internal combustion engine according to the embodiment of the present invention and shows a state where an intake cam angle sensor and an exhaust cam angle sensor are removed.

Figure 7 is a sectional view taken along arrows VII-VII in Figure 5.

[Description of Embodiment]

[0012] A cam angle sensor attaching structure for an internal combustion engine according to an embodiment of the present invention includes: a cylinder head with an intake side wall and an exhaust side wall, the intake side wall being formed with an air inlet to suck in an air, the exhaust side wall being formed with an exhaust outlet through which an exhaust gas is discharged; a camshaft extending along a cylinder bank direction, being rotatably supported on the cylinder head; a cylinder head cover and an EGR housing portion both of which are attached to the cylinder head so as to cover an upper portion of the cylinder head; and a cam angle sensor to detect a rotational angle of the camshaft, wherein the EGR housing portion includes: a first side wall located on the same side as the exhaust side wall of the cylinder head; a second side wall located on the same side as the intake side wall of the cylinder head; a third side wall interconnecting end portions of the first and second side walls in the cylinder bank direction; an upper wall with a tubular boss portion to which the cam angle sensor is attached, the upper wall being connected to upper end portions of the first to third side walls; and a tubular EGR passage portion with an EGR passage through which an EGR gas flows, the EGR passage portion being located on the same side as the third side wall, the EGR passage portion includes: an EGR gas inlet formed at the first side wall, to introduce the EGR gas into the EGR passage; and an EGR gas outlet formed at the second side wall, to discharge the EGR gas from the EGR passage, and the boss portion is connected to the EGR passage portion.

[0013] With the above-described configuration, the cam angle sensor attaching structure for the internal combustion engine according to the embodiment of the present invention can enhance stiffness around a point where the cam angle sensor is attached, suppress vibration of the cam angle sensor, and prevent accuracy of detecting the rotational angle of the camshaft from deteriorating.

[Embodiment]

[0014] A cam angle sensor attaching structure for an internal combustion engine according to an embodiment of the present invention will be described below with reference to the drawings.

[0015] Figures 1 to 7 show the cam angle sensor attaching structure for the internal combustion engine according to the embodiment of the present invention. In Figures 1 to 7, up-down, front-rear, and left-right directions correspond to those in an internal combustion engine installed in a vehicle. Hereinafter, a front-rear direction in a vehicle will be simply referred to as front-rear direction; a left-right direction therein (vehicle width direction) will be simply referred to as left-right direction; and an up-down direction therein (vehicle height direction) will be simply referred to as up-down direction.

[0016] A configuration will be described first.

[0017] In Figure 1, an engine 1 is provided in an engine room (not shown) of a vehicle. The engine 1 includes an engine body 2 and a chain cover 10 (see Figure 4).

[0018] The engine body 2 has a cylinder block 3, a cylinder head 4, a cylinder head cover 5, and an oil pan 6, and the chain cover 10 is connected to a right end portion of the engine body 2. The engine 1 according to the present embodiment constitutes an internal combustion engine.

[0019] A plurality of cylinders 3A (indicated by imaginary lines in Figure 4) are provided in the cylinder block 3. The cylinders 3A are arrayed in the vehicle width direction. A direction in which the cylinders 3A are arrayed (the vehicle width direction) will hereinafter be referred to as a cylinder bank direction A.

[0020] Note that although the engine 1 according to the present embodiment is composed of a 3-cylinder engine having three cylinders 3A, the number of cylinders is not limited to three.

[0021] Respective pistons (not shown) are housed in the cylinders 3A, and each piston is connected to a crankshaft 7 via a connecting rod (not shown) (see Figure 1). The crankshaft 7 has a rotation central axis which extends in the vehicle width direction and rotates about the rotation central axis. The engine 1 according to the present embodiment is a transversely mounted engine with the crankshaft 7 extending in the vehicle width direction, and the vehicle is an FF (front-engine, front-wheel drive) vehicle.

[0022] Each piston reciprocates inside the cylinder 3A, thereby rotating the crankshaft 7 via the connecting rod. A plurality of intake ports 4a (see Figure 4) and an exhaust collection portion 4b (see Figure 3) which are not shown are formed in the cylinder head 4.

[0023] Each intake port 4a communicates with the cylinder 3A and introduces incoming air into the cylinder 3A. The exhaust collection portion 4b communicates with the respective cylinders 3A through a plurality of exhaust ports (not shown).

[0024] In other words, the exhaust ports extend from the respective cylinders 3A to the exhaust collection portion 4b, and the exhaust collection portion 4b collects the exhaust ports.

[0025] As indicated by imaginary lines in Figure 2, a coolant passage 20 is provided in the cylinder head 4. The coolant passage 20 extends from a right end portion of the cylinder head 4 toward a left end portion.

[0026] Coolant is introduced from a coolant passage (not shown) which is formed in the cylinder block 3 into a right end portion of the coolant passage 20. The coolant

introduced into the coolant passage 20 flows to the left along the coolant passage 20. For this reason, the cylinder head 4 is cooled by the coolant. The coolant passage 20 according to the present embodiment constitutes a coolant passage.

[0027] As shown in Figure 4, the cylinder head 4 has an intake side wall 4A at which the intake ports 4a open and an exhaust side wall 4B which is located on a side (a front side) opposite to the intake side wall 4A and at which the exhaust collection portion 4b opens.

[0028] As shown in Figure 3, the cylinder head 4 has a coolant discharge side wall 4C that has a coolant discharge port 4c which discharges coolant from the coolant passage 20, and the coolant discharge side wall 4C is connected to a left end portion (an end portion in the cylinder bank direction A) of the intake side wall 4A and a left end portion (an end portion in the cylinder bank direction A) of the exhaust side wall 4B and extends in the front-rear direction.

[0029] A coolant branch unit (not shown) is connected to the coolant discharge port 4c, and the coolant branch unit is connected to a radiator (not shown) and a coolant introduction portion 13A (see Figure 1) of an EGR cooler 13 by a branch pipe (not shown).

[0030] Coolant which is discharged from the coolant discharge port 4c is supplied to the radiator and the coolant introduction portion 13A of the EGR cooler 13 through the coolant branch unit and a coolant pipe.

[0031] The intake ports 4a according to the present embodiment constitute an air inlet to suck in an intake air and the exhaust collection portion 4b constitutes an exhaust outlet through which exhaust gas is discharged from the engine body 2. That is, the cylinder head 4 has the intake side wall 4A that has the intake ports 4a and the exhaust side wall 4B that has the exhaust collection portion 4b.

[0032] As shown in Figure 1, an intake manifold 8 is attached to the intake side wall 4A. The intake manifold 8 has a surge tank 8A and three branch pipes 8B (one of which is shown) corresponding in number to the cylinders 3A. An intake pipe (not shown) is connected to the surge tank 8A via a throttle body (not shown).

[0033] Incoming air which is cleaned by an air cleaner (not shown) is introduced into the intake pipe, and the incoming air is introduced into the surge tank 8A through the throttle body.

[0034] A throttle valve (not shown) is housed in the throttle body, and the throttle valve adjusts the amount of incoming air to be introduced into the surge tank 8A.

[0035] The plurality of branch pipes 8B extend from the surge tank 8A to the respective intake ports 4a and distribute incoming air which is introduced into the surge tank 8A among the respective intake ports 4a.

[0036] An exhaust cleaning device 9 is attached to the exhaust side wall 4B. Exhaust gas which is burned inside the cylinder 3A is discharged from the cylinder 3A through the exhaust port and collected in the exhaust collection portion 4b, and is then discharged from the exhaust collection portion 4b into the exhaust cleaning device 9.

[0037] The exhaust cleaning device 9 cleans exhaust gas which is discharged from the exhaust collection portion 4b and discharges the exhaust gas into the atmosphere through an exhaust pipe (not shown).

[0038] The engine 1 is provided with an EGR (exhaust gas recirculation) device 11. The EGR device 11 includes upstream-side EGR piping 12, the EGR cooler 13, an EGR valve 14, and downstream-side EGR piping 15.

[0039] An upstream end of the upstream-side EGR piping 12 is connected to the exhaust cleaning device 9, and a part of exhaust gas is introduced as EGR gas from the exhaust cleaning device 9 into the upstream-side EGR piping 12. The terms upstream and downstream here refer to upstream and downstream in a direction in which incoming air, exhaust gas, or EGR gas flows.

[0040] The EGR valve 14 is located downstream of the upstream-side EGR piping 12, and the upstream-side EGR piping 12 is located upstream of the EGR valve 14.

[0041] A downstream end of the upstream-side EGR piping 12 is connected to an upstream end of the EGR cooler 13. The EGR cooler 13 has the coolant introduction portion 13A that introduces coolant into the EGR cooler 13 and a coolant discharge portion 13B which discharges the coolant from the EGR cooler 13.

[0042] The EGR cooler 13 cools EGR gas which is introduced from the upstream-side EGR piping 12 by heat exchange between the EGR gas and coolant.

[0043] A downstream end of the EGR cooler 13 is connected to the EGR valve 14. The EGR valve 14 is attached to an EGR housing portion 25 and adjusts a flow rate of EGR gas which flows through an EGR passage portion 26 (to be described later).

[0044] An upstream end of the downstream-side EGR piping 15 is connected to the EGR housing portion 25, and EGR gas which is introduced into the EGR housing portion 25 is discharged into the downstream-side EGR piping 15. A downstream end of the downstream-side EGR piping 15 is connected to the surge tank 8A, and the EGR gas discharged into the downstream-side EGR piping 15 is introduced into the surge tank 8A.

[0045] As shown in Figure 4, the cylinder head 4 is provided with an intake camshaft 16 and an exhaust camshaft 17, and the intake camshaft 16 and the exhaust camshaft 17 extend parallel to the cylinder bank direction A. The intake camshaft 16 and the exhaust camshaft 17 are provided with a plurality of intake cams 16A and a plurality of exhaust cams 17A.

[0046] The intake cams 16A and the exhaust cams 17A are spaced apart in the cylinder bank direction A, and one pair of intake cams 16A and one pair of exhaust cams 17A are provided for each cylinder 3A.

[0047] The intake camshaft 16 and the exhaust camshaft 17 are rotatably supported on the cylinder head 4 by cam caps 18 and 19.

[0048] Specifically, journal bearings (not shown) which are opposed to the cam caps 18 and 19 are provided at an upper surface of the cylinder head 4, and the intake

camshaft 16 and the exhaust camshaft 17 are rotatably attached to the cylinder head 4 so as to be sandwiched between the journal bearings and the cam caps 18 and 19. The intake camshaft 16 and the exhaust camshaft 17 according to the present embodiment constitute a camshaft.

[0049] As shown in Figures 5 and 6, the EGR housing portion 25 is provided on an end portion (the left end portion) in the cylinder bank direction A of the cylinder head 4. The EGR housing portion 25 is located on the opposite side of the cylinder head cover 5 from the chain cover 10. That is, the EGR housing portion 25 is adjacent to the cylinder head cover 5 in the cylinder bank direction A.

[0050] The cylinder head cover 5 is made of resin, and the EGR housing portion 25 is made of metal, such as an aluminum die-casting.

[0051] The EGR housing portion 25 constitutes a first cylinder head cover, and the cylinder head cover 5 constitutes a second cylinder head cover. The EGR housing portion 25 and the cylinder head cover 5 constitute a cylinder head cover.

[0052] As shown in Figures 5 and 6, the EGR housing portion 25 has a front wall 25A, a rear wall 25B, a left side wall 25C, and an upper wall 25D.

[0053] As shown in Figure 3, the front wall 25A is located on a side closer to the exhaust side wall 4B of the cylinder head 4, and the rear wall 25B is located on a side closer to the intake side wall 4A of the cylinder head 4. In other words, the front and rear walls 25A, 25B are located on the same sides as the exhaust and intake side walls 4B, 4A, respectively.

[0054] As shown in Figures 5 and 6, the left side wall 25C connects a left end portion (an end portion in the cylinder bank direction A) of the front wall 25A and a left end portion (an end portion in the cylinder bank direction A) of the rear wall 25B, and the upper wall 25D connects an upper end portion of the front wall 25A, an upper end portion of the rear wall 25B, and an upper end portion of the left side wall 25C.

[0055] The front wall 25A according to the present embodiment constitutes a first side wall, and the rear wall 25B constitutes a second side wall. The left side wall 25C constitutes a third side wall.

[0056] The EGR passage portion 26 is provided in the EGR housing portion 25. The EGR passage portion 26 is formed in a tubular shape, and an EGR passage 26a through which EGR gas flows is formed inside the EGR passage portion 26 (see Figure 7). The upstream-side EGR piping 12, the downstream-side EGR piping 15, and the EGR passage portion 26 according to the present embodiment constitute an EGR passage portion.

[0057] The EGR passage portion 26 has an EGR gas inlet 26b and an EGR gas outlet 26c. The EGR gas introduction port 26b is provided at the front wall 25A (see Figure 2), and the EGR gas outlet 26c is provided at the rear wall 25B.

[0058] The EGR gas inlet 26b is an open end on a front side (upstream side) of the EGR passage 26a, and the EGR gas outlet 26c is an open end on a rear side (downstream side) of the EGR passage 26a.

[0059] The EGR passage portion 26 according to the present embodiment extends linearly in a direction (the front-rear direction) horizontally orthogonal to the cylinder bank direction A and is provided outside the coolant discharge side wall 4C (at the left side of the coolant discharge side wall 4C) in the cylinder bank direction A.

[0060] That is, the EGR passage portion 26 is provided so as to be farther away from the cylinder head cover 5 in the cylinder bank direction A than the coolant discharge side wall 4C is.

[0061] Note that the EGR passage portion 26 is not limited to one extending linearly in the direction horizontally orthogonal to the cylinder bank direction A and may extend obliquely with respect to the cylinder bank direction A. Note that the term horizontal also subsumes a nearly horizontal direction, i.e., a direction slightly inclined with respect to the horizontal.

[0062] As shown in Figure 2, a flange portion 25a is provided at the front wall 25A, and the EGR gas inlet 26b is formed inside the flange portion 25a.

[0063] As shown in Figure 1, a flange portion 14a of the EGR valve 14 is attached to the flange portion 25a. An EGR gas discharge port (not shown) is provided inside the flange portion 14a, and EGR gas which is discharged from the EGR valve 14 is introduced into the EGR passage 26a through the EGR gas inlet 26b.

[0064] As shown in Figures 5 and 6, a flange portion 25b is provided at the rear wall 25B, and the EGR gas outlet 26c is formed inside the flange portion 25b.

[0065] As shown in Figure 1, a flange portion 15a of the downstream-side EGR piping 15 is attached to the flange portion 25b. An EGR gas introduction port (not shown) is provided inside the flange portion 15a, and EGR gas which flows through the EGR passage 26a is discharged into the downstream-side EGR piping 15 through the EGR gas introduction port of the flange portion 15a.

[0066] In other words, in the engine 1 according to the present embodiment, the EGR housing portion 25 is attached to the left end portion of the cylinder head 4 above the cylinder head 4, and EGR gas is introduced from an exhaust side to an intake side by the EGR passage portion 26 provided in the EGR housing portion 25.

[0067] As shown in Figure 4, boss portions 27A and 27B are provided at a front end portion and a rear end portion of the left side wall 25C, and the boss portions 27A and 27B extend along the left side wall 25C in the up-down direction. Boss portions 27F and 27G are provided at the front wall 25A and the rear wall 25B, and the boss portions 27F and 27G extend along the front wall 25A and the rear wall 25B in the up-down direction.

[0068] Bolt grooves (not shown) are provided at an upper left end of the cylinder head 4. Bolts 41A are inserted into the boss portions 27A, 27B, 27F, and 27G, and the bolts 41A are screwed into the bolt grooves of the cylinder

head 4. In this manner, the EGR housing portion 25 is fixed to the cylinder head 4.

[0069] As shown in Figure 4, a flange portion 4F is provided at an upper end portion of the cylinder head 4.

[0070] The flange portion 4F is provided around the cylinder head 4. The cylinder head 4 opens inside the flange portion 4F. That is, an open portion 4h is formed at an upper portion of the cylinder head 4.

[0071] A flange portion 10F is provided at an upper end portion of the chain cover 10, and the flange portion 10F is connected to the flange portion 4F.

[0072] A housing-side flange portion 25c, a front-side flange portion 25d, and a rear-side flange portion 25e are provided in the EGR housing portion 25.

[0073] As shown in Figure 4, the housing-side flange portion 25c extends from the front wall 25A to the rear wall 25B so as to adjoin the upper wall 25D. That is, the housing-side flange portion 25c is connected to a right end portion (an end portion on a side closer to the chain cover 10) of the upper wall 25D.

[0074] A curved portion 25p is provided in the housing-side flange portion 25c, and the curved portion 25p is curved toward the left side wall 25C at a middle portion (a front-rear direction middle portion) in a direction in which the housing-side flange portion 25c extends.

[0075] In the upper wall 25D according to the present embodiment, a width in the cylinder bank direction A of the front-rear direction middle portion of the upper wall 25D is smaller than a width in the cylinder bank direction A on a front side of the upper wall 25D and a width in the cylinder bank direction A on a rear side of the upper wall 25D due to the curved portion 25p.

[0076] An area of a flat portion of the front-rear direction middle portion of the upper wall 25D is formed smaller than areas on the front side and the rear side of the upper wall 25D.

[0077] The front-side flange portion 25d is located at the upper end portion of the front wall 25A and extends from a front end of the housing-side flange portion 25c to the flange portion 4F, and is in contact with the flange portion 4F.

[0078] The rear-side flange portion 25e is located at the upper end portion of the rear wall 25B and extends from a rear end of the housing-side flange portion 25c to the flange portion 4F, and is in contact with the flange portion 4F.

[0079] As shown in Figures 2 and 3, a flange portion 5F is provided at an outer peripheral lower edge of the cylinder head cover 5, and the flange portion 5F extends along the flange portions 4F, 10F, 25c, 25d, and 25e. That is, the flange portion 5F is opposed to the flange portions 4F, 10F, 25c, 25d, and 25e in the up-down direction.

[0080] As shown in Figure 4, a plurality of boss portions 4D are formed at the flange portion 4F, and the boss portions 4D are spaced apart in a direction in which the flange portion 4F extends.

[0081] A plurality of boss portions 10A are formed at the flange portion 10F, and the boss portions 10A are spaced apart in a direction in which the flange portion 10F extends (see Figure 4).

[0082] Boss portions 27C, 27D, and 27E are provided at the upper wall 25D of the EGR housing portion 25. The boss portions 27C, 27D, and 27E protrude upward from the upper wall 25D and are connected to the housing-side flange portion 25c.

[0083] The boss portions 27C, 27D, and 27E are connected to one another by the housing-side flange portion 25c. The housing-side flange portion 25c according to the present embodiment constitutes a flange portion.

[0084] As shown in Figure 2, a plurality of boss portions 5A are provided at the flange portion 5F of the cylinder head cover 5, and the boss portions 5A are spaced apart in a direction in which the flange portion 5F extends.

[0085] The plurality of boss portions 5A coincide with the boss portions 4D, the boss portions 10A, and the boss portions 27C, 27D, and 27E in the up-down direction. Bolts 41B and 41C are inserted in the plurality of boss portions 5A, the boss portions 4D, the boss portions 10A, and the boss portions 27C, 27D, and 27E, and the cylinder head cover 5 is fixed to the cylinder head 4 by the bolts 41B and 41C.

[0086] In other words, the cylinder head cover 5 lies astride and is fixed to the cylinder head 4, the chain cover 10, and the EGR housing portion 25 and covers the open portion 4h of the cylinder head 4.

[0087] As shown in Figure 6, boss portions 28A and 28B for attachment (hereinafter also referred to as attaching boss portion(s)) are provided at the upper wall 25D. As shown in Figure 5, an exhaust cam angle sensor 31 and an intake cam angle sensor 32 are attached to the attaching boss portions 28A and 28B, respectively.

[0088] The exhaust cam angle sensor 31 has a sensor body 31A which is fixed to the attaching boss portion 28A by a bolt 41D and a connector 31B which is attached to an upper end portion of the sensor body 31A.

[0089] The intake cam angle sensor 32 has a sensor body 32A which is fixed to the attaching boss portion 28B by the bolt 41D and a connector 32B which is attached to an upper end portion of the sensor body 32A. The exhaust cam angle sensor 31 and the intake cam angle sensor 32 have the same configurations and are interchangeable.

[0090] As shown in Figure 7, the sensor body 31A of the exhaust cam angle sensor 31 is attached to the attaching boss portion 28A via a sealing member 29, which allows prevention of entry of water and a foreign substance from between the sensor body 31A and the attaching boss portion 28A into the EGR housing portion 25.

[0091] Note that a sealing member (not shown) is also interposed between the sensor body 32A of the intake cam angle sensor 32 and the attaching boss portion 28B. The exhaust cam angle sensor 31 and the intake cam angle sensor 32 according to the present embodiment constitute a cam angle sensor.

[0092] As shown in Figure 4, an intake-side sensing rotor 16S and an exhaust-side sensing rotor 17S are attached to left end portions of the intake camshaft 16 and the exhaust camshaft 17, and the intake-side sensing rotor 16S and the exhaust-side sensing rotor 17S are located below the upper wall 25D of the EGR housing portion 25.

[0093] Projections (not shown) are formed at an outer peripheral portion of each of the intake-side sensing rotor 16S and the exhaust-side sensing rotor 17S. The projections are formed in patterns unique to the respective cylinders 3A.

[0094] The exhaust cam angle sensor 31 and the intake cam angle sensor 32 are opposed to the intake-side sensing rotor 16S and the exhaust-side sensing rotor 17S in the up-down direction. The sensor bodies 31A and 32A detect rotational angles (rotational phases) of the intake camshaft 16 and the exhaust camshaft 17 by detecting the projections of the intake-side sensing rotor 16S and the exhaust-side sensing rotor 17S.

[0095] The connectors 31B and 32B are connected to a controller via a wire harness (not shown), and pieces of cam angle-related information detected by the sensor bodies 31A and 32A are transmitted from the connectors 31B and 32B to the controller (not shown) through the wire harness.

[0096] As shown in Figures 6 and 7, the attaching boss portions 28A and 28B are connected to the EGR passage portion 26.

[0097] As shown in Figure 7, lower end portions 28a of the attaching boss portions 28A and 28B are located above a lower end portion 26d of the EGR passage portion 26 and below an upper end portion 26e of the EGR passage portion 26, and upper end portions 28b of the attaching boss portions 28A and 28B are located above the upper end portion 26e of the EGR passage portion 26.

[0098] In other words, the upper end portion 26e of the EGR passage portion 26 is located above the lower end portions 28a of the attaching boss portions 28A and 28B.

[0099] Although the attaching boss portion 28B is not shown in Figure 7, a positional relationship between the attaching boss portion 28B and the EGR passage portion 26 is the same as a positional relationship between the attaching boss portion 28A and the EGR passage portion 26. The attaching boss portion 28B is located on the far side of (behind) the attaching boss portion 28A in Figure 7.

[0100] In Figure 7, the attaching boss portion 28B located on the far side of the attaching boss portion 28A is indicated by an imaginary line.

[0101] As shown in Figure 4, the boss portion 27C is installed on a side closer to the EGR passage portion 26 than the boss portions 27D and 27E are and is connected to the EGR passage portion 26.

[0102] The boss portion 27D is provided at the upper wall 25D on a side closer to the front wall 25A than the boss portion 27C is and is located on a side closer to the front wall 25A than the attaching boss portion 28A is. In other words, the boss portion 27D is located closer to the front wall 25A than each of the boss portion 27C and the attaching boss portion 28A is.

[0103] The boss portion 27E is provided at the upper wall 25D on a side closer to the rear wall 25B than the boss portion 27C is and is located on a side closer to the rear wall 25B than the attaching boss portion 28B is. In other words, the boss portion 27E is located closer to the rear wall 25B than each of the boss portion 27C and the attaching boss portion 28B is.

[0104] The boss portion 27C according to the present embodiment constitutes a fastening portion and a first fastening portion, and the boss portion 27D constitutes the fastening portion and a second fastening portion. The boss portion 27E constitutes the fastening portion and a third fastening portion, and the bolts 41C constitute a fastener.

[0105] The attaching boss portion 28A is installed between the boss portion 27C and the boss portion 27D. Specifically, the attaching boss portion 28A is installed between the boss portion 27C and the boss portion 27D so as to pass through an imaginary straight line 42A which connects the boss portion 27C and the boss portion 27D. In other words, the attaching boss portion 28A is sandwiched between the boss portion 27C and the boss portion 27D.

[0106] The attaching boss portion 28B is installed between the boss portion 27C and the boss portion 27E. Specifically, the attaching boss portion 28B is installed between the boss portion 27C and the boss portion 27E so as to pass through an imaginary straight line 42B which connects the boss portion 27C and the boss portion 27E. In other words, the attaching boss portion 28B is sandwiched between the boss portion 27C and the boss portion 27E.

[0107] The attaching boss portion 28A overlaps with the boss portion 27D in the cylinder bank direction A, and the attaching boss portion 28B overlaps with the boss portion 27E in the cylinder bank direction A. That is, the attaching boss portions 28A and 28B, the boss portion 27D, and the boss portion 27E overlap in the cylinder bank direction A.

[0108] In other words, the attaching boss portions 28A and 28B, the boss portion 27D, and the boss portion 27E are installed to be lined up in a direction (the front-rear direction) horizontally orthogonal to the cylinder bank direction A.

[0109] Effects of a cam angle sensor attaching structure for the engine 1 according to the present embodiment will be described.

[0110] In the cam angle sensor attaching structure for the engine 1 according to the present embodiment, the EGR housing portion 25 is attached to the cylinder head 4, and the EGR housing portion 25 has the front wall 25A that is located on a side closer to the exhaust side wall 4B of the cylinder head 4, the rear wall 25B that is located on a side closer to the intake side wall 4A of the cylinder head 4, and the left side wall 25C that connects the left

end portion in the cylinder bank direction A of the front wall 25A and the left end portion in the cylinder bank direction A of the rear wall 25B.

[0111] The EGR housing portion 25 also has the attaching boss portions 28A and 28B, to which the exhaust cam angle sensor 31 and the intake cam angle sensor 32 are attached, and has the upper wall 25D that is connected to the upper end portion of the front wall 25A, the upper end portion of the rear wall 25B, and the upper end portion of the left side wall 25C and the tubular EGR passage portion 26 that is provided on a side closer to the left side wall 25C and has the EGR passage 26a, through which EGR gas flows.

[0112] The EGR passage portion 26 includes the EGR gas inlet 26b that is provided at the front wall 25A and introduces EGR gas into the EGR passage 26a and the EGR gas outlet 26c that is provided at the rear wall 25B and discharges the EGR gas from the EGR passage 26a, and the attaching boss portions 28A and 28B are connected to the EGR passage portion 26.

[0113] As described above, the attaching boss portions 28A and 28B are connected to the high-stiffness, tubular EGR passage portion 26, and the attaching boss portions 28A and 28B can be reinforced by the EGR passage portion 26. This allows enhancement of stiffness of the attaching boss portions 28A and 28B.

[0114] For the above-described reason, stiffness in support of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 that are attached to the attaching boss portions 28A and 28B can be enhanced, and vibration of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 due to vibration of the engine 1 can be suppressed. As a result, it is possible to prevent accuracy of detecting the rotational angles of the intake camshaft 16 and the exhaust camshaft 17 by the exhaust cam angle sensor 31 and the intake cam angle sensor 32 from deteriorating.

[0115] In the cam angle sensor attaching structure for the engine 1 according to the present embodiment, the upper end portion 26e of the EGR passage portion 26 is located above the lower end portions 28a of the attaching boss portions 28A and 28B.

[0116] With the above-described configuration, the upper end portion 26e that is formed in an arc shape of the EGR passage portion 26 can be made to bulge from the upper wall 25D of the EGR housing portion 25. The upper end portion 26e of the EGR passage portion 26 allows reduction in a flat portion of the upper wall 25D.

[0117] For the above-described reason, surface stiffness of the upper wall 25D can be enhanced, and vibration of the upper wall 25D due to vibration of the engine 1 can be suppressed. Thus, the stiffness in support of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be further enhanced, and vibration of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be more effectively suppressed.

[0118] As a result, it is possible to more effectively prevent the accuracy of detecting the rotational angles of the intake camshaft 16 and the exhaust camshaft 17 by the exhaust cam angle sensor 31 and the intake cam angle sensor 32 from deteriorating.

[0119] In the cam angle sensor attaching structure for the engine 1 according to the present embodiment, the EGR housing portion 25 has the housing-side flange portion 25c that is in contact with the flange portion 4F of the cylinder head 4, and the housing-side flange portion 25c extends from the front wall 25A to the rear wall 25B so as to adjoin the upper wall 25D.

[0120] Additionally, the housing-side flange portion 25c has the curved portion 25p that is curved toward the left side wall 25C.

[0121] A distance between the curved portion 25p and the EGR passage portion 26 in the cylinder bank direction A is thus set smaller. This allows reduction in the flat portion of the upper wall 25D.

[0122] For the above-described reason, the surface stiffness of the upper wall 25D can be further enhanced, and vibration of the upper wall 25D due to vibration of the engine 1 can be more effectively suppressed.

[0123] Thus, the stiffness in support of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be further enhanced, and vibration of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be more effectively suppressed.

[0124] As a result, it is possible to more effectively prevent the accuracy of detecting the rotational angles of the intake camshaft 16 and the exhaust camshaft 17 by the exhaust cam angle sensor 31 and the intake cam angle sensor 32 from deteriorating.

[0125] In the cam angle sensor attaching structure for the engine 1 according to the present embodiment, the EGR housing portion 25 has the boss portions 27C, 27D, and 27E that are fastened to the cylinder head cover 5 by the bolts 41C, and the boss portions 27C, 27D, and 27E are provided at the upper wall 25D.

[0126] Additionally, the attaching boss portion 28A is provided between the boss portion 27C and the boss portion 27D, and the attaching boss portion 28B is provided between the boss portion 27C and the boss portion 27E.

[0127] The boss portions 27C, 27D, and 27E according to the present embodiment are attached to the cylinder head cover 5 by the bolts 41C and have high stiffness. This allows increase of stiffness of the upper wall 25D around the boss portions 27C, 27D, and 27E and makes the upper wall 25D unlikely to vibrate around the boss portions 27C, 27D, and 27E.

[0128] The attaching boss portion 28A is provided between the high-stiffness boss portions 27C and 27D, and the attaching boss portion 28B is provided between the high-stiffness boss portions 27C and 27E. This allows further enhancement of the stiffness of the attaching boss portions 28A and 28B.

[0129] For the above-described reason, the stiffness in support of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be further enhanced,

and vibration of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be more effectively suppressed.

[0130] As a result, it is possible to more effectively prevent the accuracy of detecting the rotational angles of the intake camshaft 16 and the exhaust camshaft 17 by the exhaust cam angle sensor 31 and the intake cam angle sensor 32 from deteriorating.

[0131] In the cam angle sensor attaching structure for the engine 1 according to the present embodiment, the attaching boss portion 28A overlaps with the boss portion 27D in the cylinder bank direction A, and the attaching boss portion 28B overlaps with the boss portion 27E in the cylinder bank direction A.

[0132] With the above-described configuration, the high-stiffness boss portions 27D and 27E can be brought close to the attaching boss portions 28A and 28B, and the stiffness of the upper wall 25D around the attaching boss portions 28A and 28B can be further enhanced by the boss portions 27D and 27E.

[0133] For the above-described reason, the stiffness of the attaching boss portions 28A and 28B can be further enhanced, and the stiffness in support of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be further enhanced.

[0134] It is thus possible to more effectively suppress vibration of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 and more effectively prevent the accuracy of detecting the rotational angles of the intake camshaft 16 and the exhaust camshaft 17 by the exhaust cam angle sensor 31 and the intake cam angle sensor 32 from deteriorating.

[0135] In the cam angle sensor attaching structure for the engine 1 according to the present embodiment, the boss portion 27C is connected to the EGR passage portion 26.

[0136] Additionally, the boss portion 27D is provided at the upper wall 25D on a side closer to the front wall 25A than the boss portion 27C is, and the boss portion 27E is provided at the upper wall 25D on a side closer to the rear wall 25B than the boss portion 27C is.

[0137] As described above, the high-stiffness boss portion 27C is connected to the EGR passage portion 26 that has high stiffness. This allows further enhancement of the surface stiffness of the upper wall 25D.

[0138] A connection portion between the upper wall 25D and the front wall 25A and a connection portion between the upper wall 25D and the rear wall 25B are bent and thus have high stiffness. For this reason, the provision of the boss portion 27D at the upper wall 25D on a side closer to the high-stiffness front wall 25A and the provision of the boss portion 27E at the upper wall 25D on a side closer to the high-stiffness rear wall 25B allow further enhancement of the surface stiffness of the upper wall 25D.

[0139] For the above-described reason, vibration of the upper wall 25D due to vibration of the engine 1 can be more effectively suppressed. Thus, the stiffness in support of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be further enhanced, and vibration of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be more effectively suppressed.

[0140] As a result, it is possible to more effectively prevent the accuracy of detecting the rotational angles of the intake camshaft 16 and the exhaust camshaft 17 by the exhaust cam angle sensor 31 and the intake cam angle sensor 32 from deteriorating.

[0141] In the cam angle sensor attaching structure for the engine 1 according to the present embodiment, the boss portions 27C, 27D, and 27E are connected to the housing-side flange portion 25c. This allows reinforcement of the housing-side flange portion 25c by the high-stiffness boss portions 27C, 27D, and 27E and enhancement of stiffness of the housing-side flange portion 25c.

[0142] For the above-described reason, stiffness of the upper wall 25D around the boss portions 27C, 27D, and 27E and the housing-side flange portion 25c can be further enhanced, and vibration of the upper wall 25D can be more effectively suppressed.

[0143] Thus, the stiffness of the attaching boss portions 28A and 28B can be further enhanced, and the stiffness in support of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 can be further enhanced.

[0144] As a result, it is possible to more effectively suppress vibration of the exhaust cam angle sensor 31 and the intake cam angle sensor 32 and more effectively prevent the accuracy of detecting the rotational angles of the intake camshaft 16 and the exhaust camshaft 17 by the exhaust cam angle sensor 31 and the intake cam angle sensor 32 from deteriorating.

[0145] Although the embodiment of the present invention has been disclosed, it will be apparent to those skilled in the art that changes may be made without departing from the scope of the present invention. It is intended to cover in the appended claims all such modifications and equivalents.

[Reference Signs List]

[0146]

1: engine (internal combustion engine)
4: cylinder head
4A: intake side wall
4a: intake port (air inlet)
4B: exhaust side wall
4b: exhaust collection portion (exhaust outlet)
5: cylinder head cover
16: intake camshaft (camshaft)
17: exhaust camshaft (camshaft)
25: EGR housing portion
25A: front wall (first side wall)
25B: rear wall (second side wall)
25C: left side wall (third side wall)
25c: housing-side flange portion (flange portion)

25D: upper wall
25p: curved portion
26: EGR passage portion
26a: EGR passage
26b: EGR gas inlet
26c: EGR gas outlet
26e: upper end portion (EGR passage portion upper end portion)
27C: boss portion (fastening portion, first fastening portion)
27D: boss portion (fastening portion, second fastening portion)
27E: boss portion (fastening portion, third fastening portion)
28A, 28B: boss portion for attachment
28a: lower end portion of boss portion
31: exhaust cam angle sensor (cam angle sensor)
32: intake cam angle sensor (cam angle sensor)
41C: bolt (fastener)
A: cylinder bank direction

Claims

1. A cam angle sensor attaching structure for an internal combustion engine (1), comprising:

a cylinder head (4) with an intake side wall (4A) and an exhaust side wall (4B), the intake side wall being formed with an air inlet (4a) to suck in an air, the exhaust side wall being formed with an exhaust outlet (4b) through which an exhaust gas is discharged;
a camshaft (16, 17) extending along a cylinder bank direction (A), being rotatably supported on the cylinder head (4);
a cylinder head cover (5) and an EGR housing portion (25) both of which are attached to the cylinder head (4) so as to cover an upper portion of the cylinder head (4); and
a cam angle sensor (31, 32) to detect a rotational angle of the camshaft (16, 17), wherein
the EGR housing portion (25) includes:

a first side wall (25A) located on the same side as the exhaust side wall (4B) of the cylinder head (4);
a second side wall (25B) located on the same side as the intake side wall (4A) of the cylinder head (4);
a third side wall (25C) interconnecting end portions of the first and second side walls (25A, 25B) in the cylinder bank direction (A);
an upper wall (25D) with a tubular boss portion (28A, 28B) to which the cam angle sensor (31, 32) is attached, the upper wall being connected to upper end portions of the first to third side walls (25A, 25B, 25C); and
a tubular EGR passage portion (26) with an EGR passage (26a) through which an EGR gas flows, the EGR passage portion being located on the same side as the third side wall (25C),

the EGR passage portion (26) includes: an EGR gas inlet (26b) formed at the first side wall (25A), to introduce the EGR gas into the EGR passage (26a); and an EGR gas outlet (26c) formed at the second side wall (25B), to discharge the EGR gas from the EGR passage (26a), and
the boss portion (28A, 28B) is connected to the EGR passage portion (26).

2. The cam angle sensor attaching structure for an internal combustion engine (1) as claimed in claim 1, wherein
an upper end portion (26e) of the EGR passage portion (26) is located above a lower end portion (28a) of the boss portion (28A, 28B).

3. The cam angle sensor attaching structure for an internal combustion engine (1) as claimed in claim 1 or 2, wherein

the EGR housing portion (25) includes a plurality of fastening portions (27C, 27D, 27E) fastened to the cylinder head cover (5) by a fastener (41C), the fastening portions (27C, 27D, 27E) being provided at the upper wall (25D), and
the boss portion (28A, 28B) is located between the fastening portions (27C, 27D, 27E).

4. The cam angle sensor attaching structure for an internal combustion engine (1) as claimed in claim 3, wherein
the fastening portions (27C, 27D, 27E) include:

a first fastening portion (27C) connected to the EGR passage portion (26);
a second fastening portion (27D) provided at the upper wall (25D), closer to the first side wall (25A) than the first fastening portion (27C) is; and
a third fastening portion (27E) provided at the upper wall (25D), closer to the second side wall (25B) than the first fastening portion (27C) is.

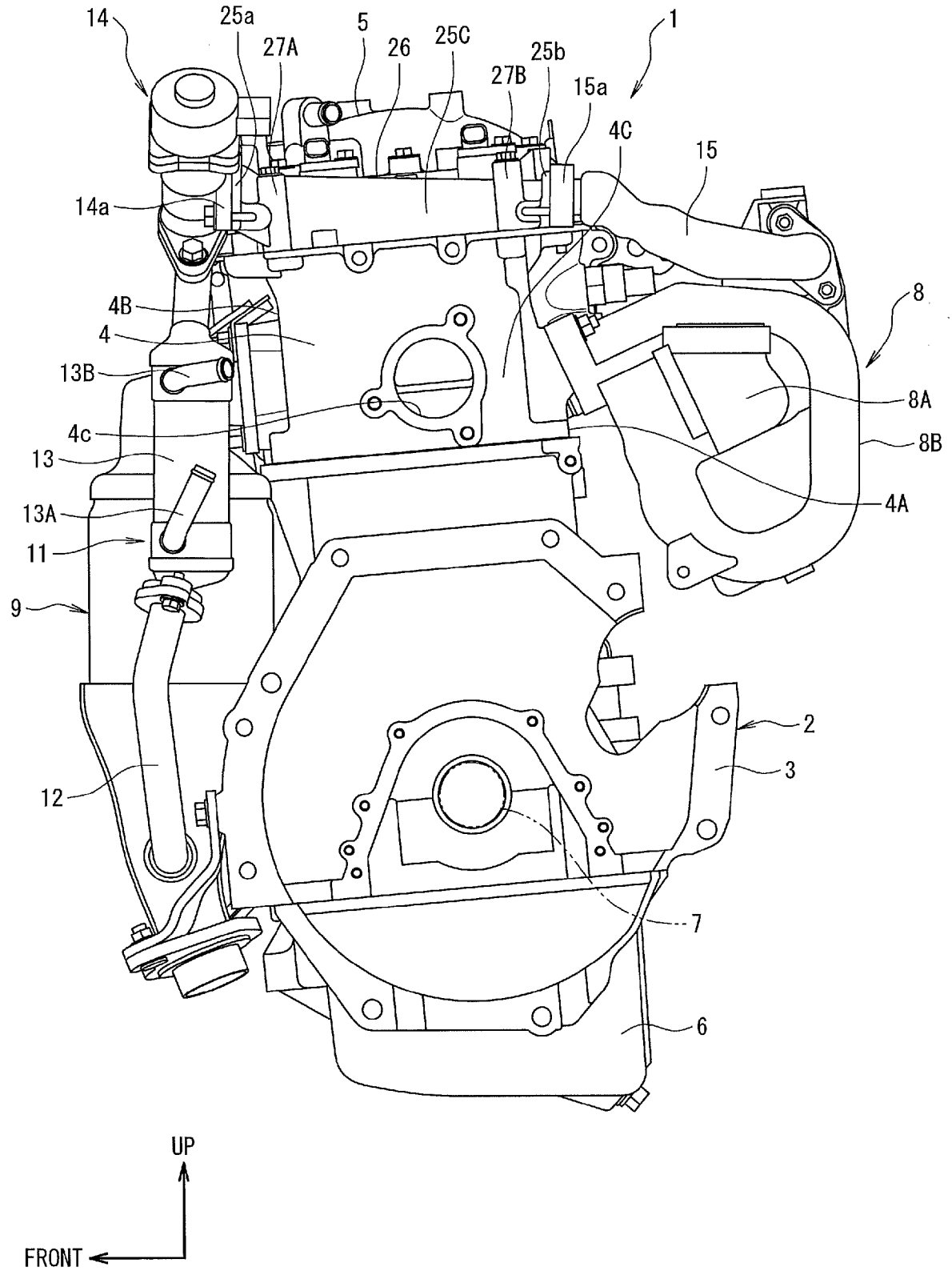
5. The cam angle sensor attaching structure for an internal combustion engine (1) as claimed in claim 3 or 4, wherein

the EGR housing portion (25) includes a flange portion (25c) coming into contact with the cylinder head cover (5), the flange portion (25c) extending from the first side wall (25A) to the second side wall (25B) so as to be adjacent to the

upper wall (25D), and
the flange portion (25c) includes a curved portion (25p) curved toward the third side wall (25C).

6. The cam angle sensor attaching structure for an internal combustion engine (1) as claimed in claim 5, wherein
the fastening portions (27C, 27D, 27E) are connected to the flange portion (25c).

FIG. 1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27A
5
26
25C
27B
25b
15a
1
4C
15
14a
8
4B
4
13B
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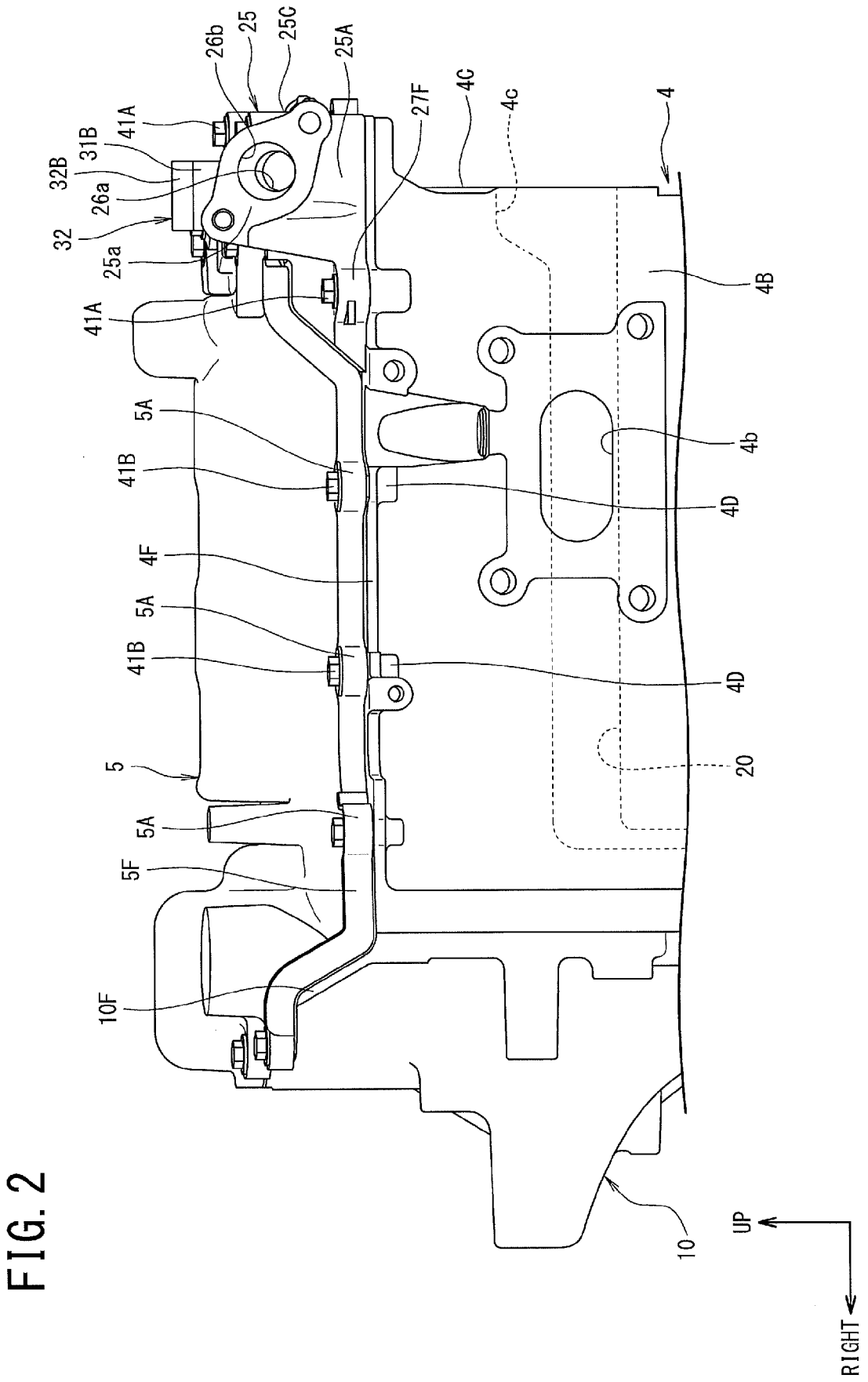
8B
4c
13
4A
13A
11
9
2
3
12
7
6
UP
FRONT

FIG. 2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25
25C
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27F
4C
4c
4
41A
31B
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41B
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4D
4F
5A
41B
4D
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5A
5F
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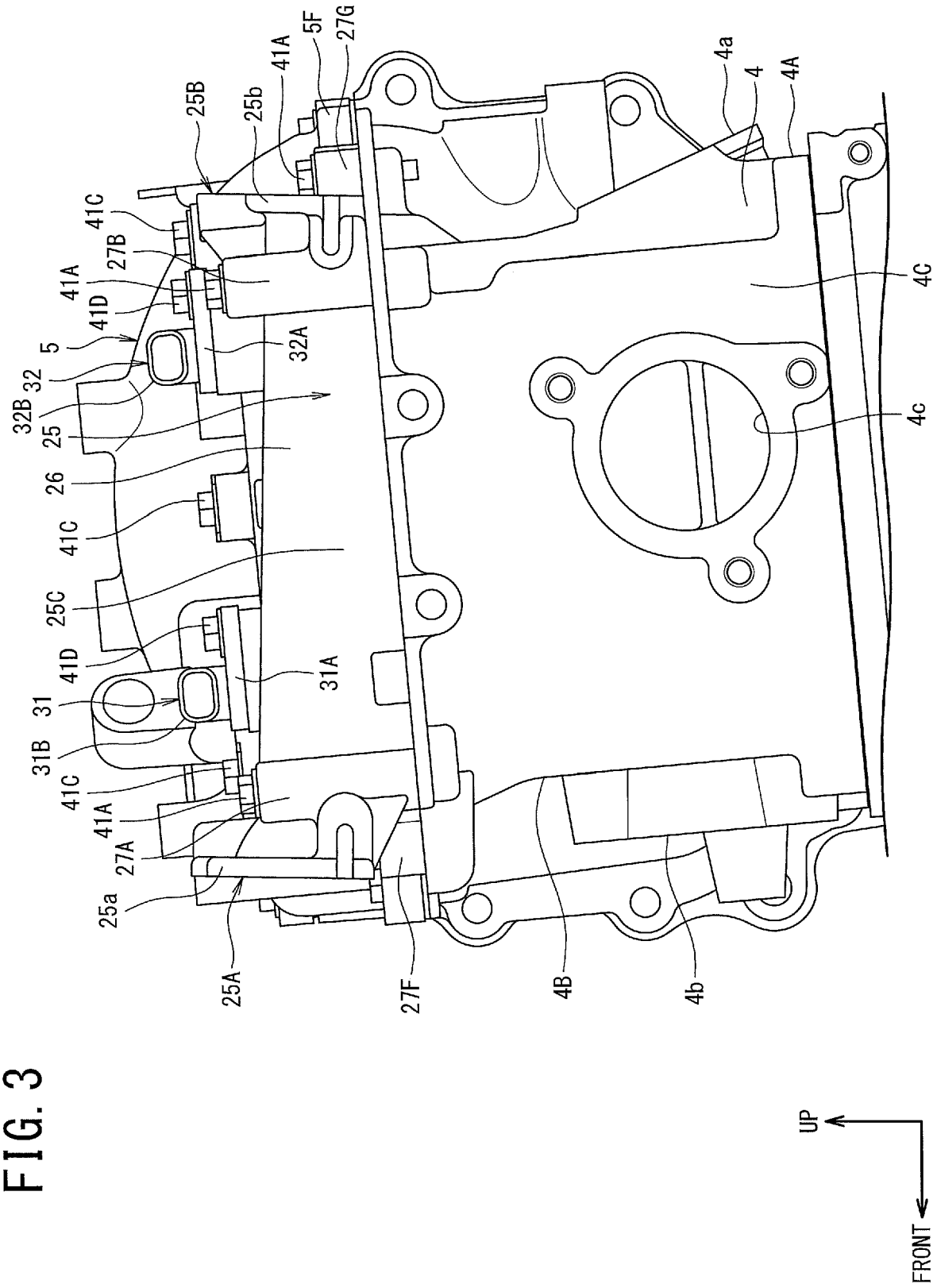
10
UP
RIGHT

FIG. 3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25b
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5F
27G
4a
4
4A
41C
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41D
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25C
41D
31
31B
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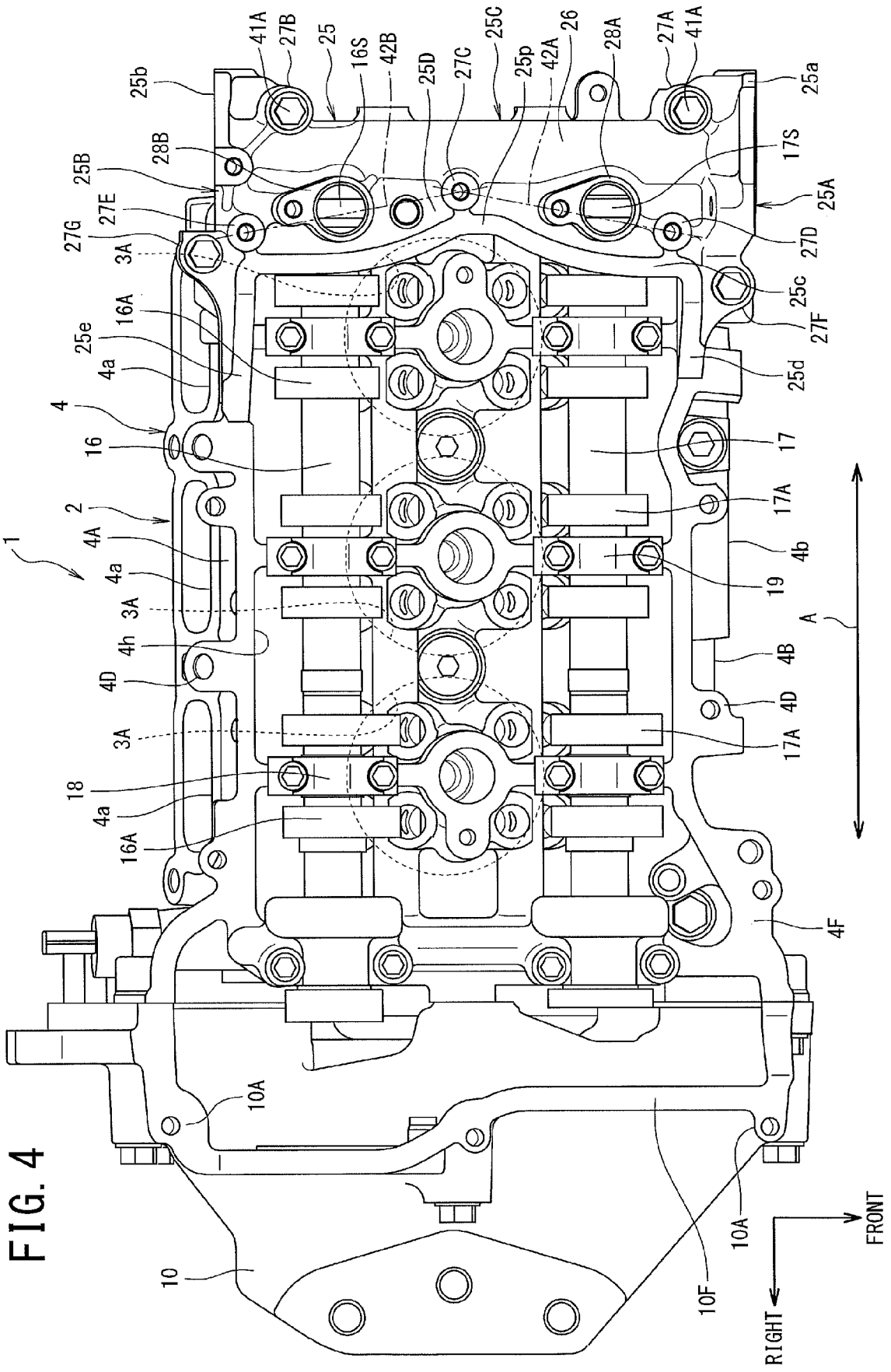
32A
31A
4C
4c
UP
FRONT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28B
17S
25B
25A
27E
27D
27G
3A
25c
27F
16A
25e
25d
4a
4
16
17
2
17A
4A
1
4b
4a
19
3A
A
4h
4B
4D
4D
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18
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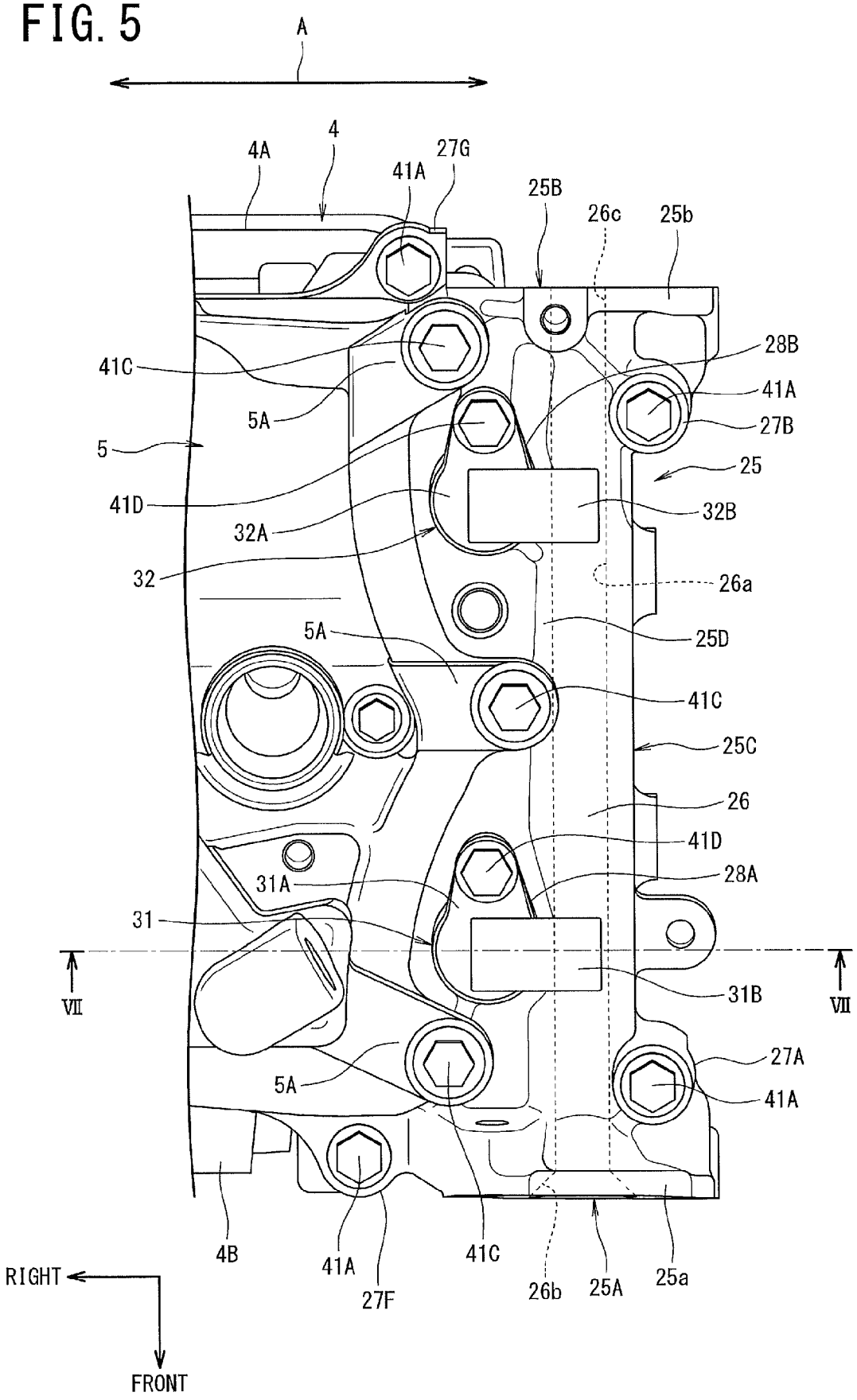
16A
4F
10A
10
10A
10F
FRONT
RIGHT

FIG. 4

FIG. 5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32A
32
26a
5A
25D
41C
25C
26
41D
28A
31A
31
VII
VII
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27F
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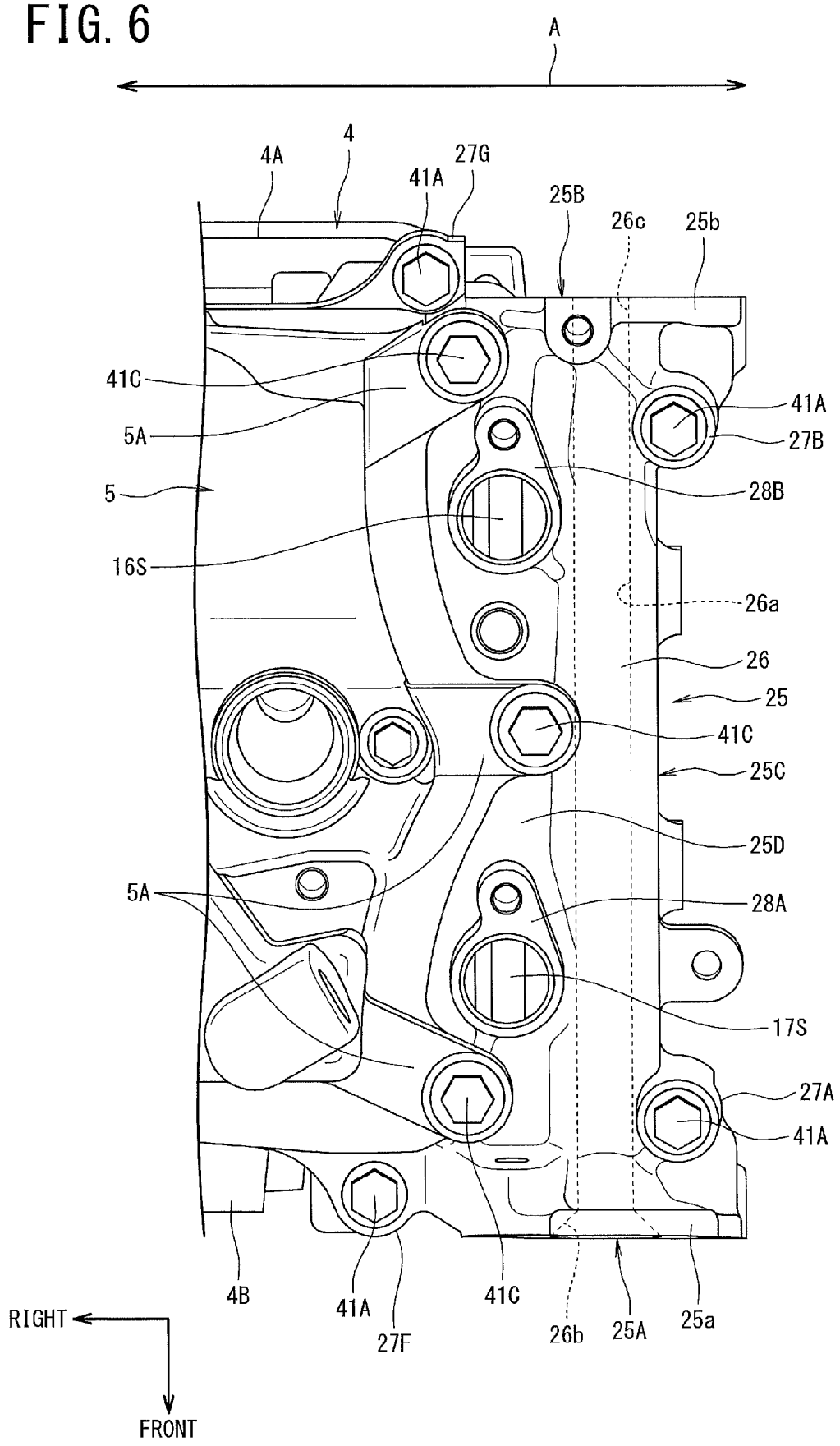
26b
25A
25a
RIGHT
FRONT

FIG. 6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27G
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25B
26c
25b
41C
41A
5A
27B
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28B
16S
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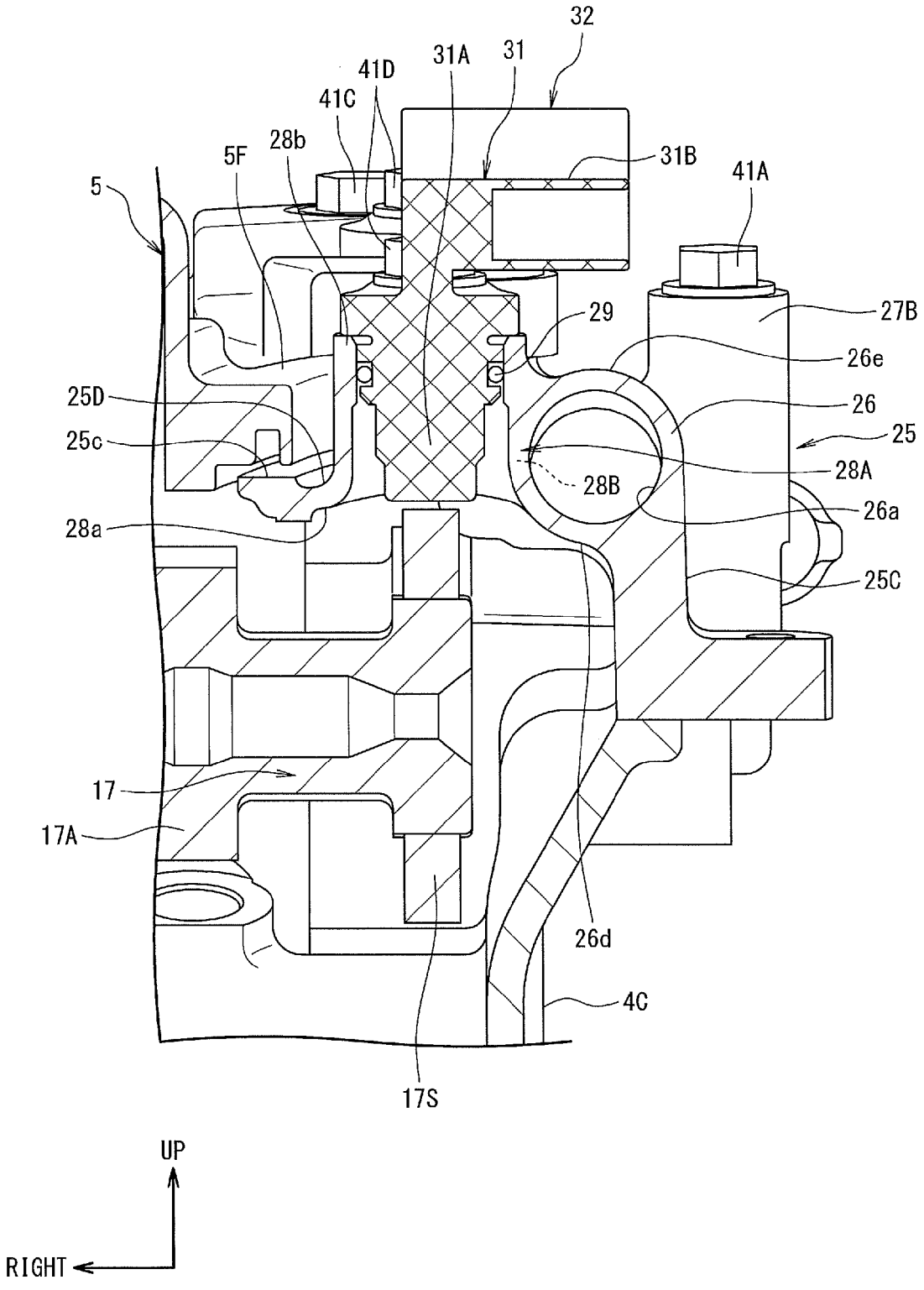
25
41C
25C
25D
5A
28A
17S
27A
41A
4B
41A
27F
41C
26b
25A
25a
RIGHT
FRONT

FIG. 7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31A
31
41D
41C
28b
5F
31B
41A
5
29
27B
26e
25D
26
25c
25
28A
28B
26a
28a
25C
17
17A
26d
4C
17S
UP
RIGHT

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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