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Description

[0001] The present invention relates to an engine.

[0002] In the past, an engine is known where an engaging surface of a cylinder head and a head cover is arranged at the same height as a cam shaft (for example, Japan Patent Laid-open Patent Publication JP-A-2009-52475). Here, "height" has the meaning of height in a case of viewing from above in a direction from the cylinder head toward the head cover in a cylinder axial direction. In an engine such as this, a shaft end of a valve for intake or exhaust which is driven by the cam shaft is arranged at a position which is higher than the engaging surface.

[0003] On the other hand, it is preferable for accessibility to the shaft ends of the valves to be excellent in order to carry out maintenance. It is possible to consider securing a large gap between the side wall of the cylinder head and the valve as a method for improving accessibility to the shaft ends of the valves. However, in this case, there is a problem in that the size of the engine increases.

[0004] In contrast to this, in the engine described above, the shaft ends of the valves are positioned at a position which is higher than the end section of the cylinder head in a state where the head cover is removed. As a result, it is possible to improve accessibility to the shaft ends of the valves without securing a large gap between the side wall of the cylinder head and the valve. As a result, it is possible to reduce the size of the engine.

[0005] However, when the engaging surface is arranged at the same height as the cam shaft, a head section of a fastening bolt which fastens the cylinder head and a crank case is positioned at a position which is higher than the engaging surface. There is a possibility that the head section may interfere with the side surface of the head cover when the head section is positioned at a position which is higher than the engaging surface since an inclination is provided at the inner surface of the wall surface of the head cover due to the demands of manufacturing.

[0006] It is preferable to secure a large distance between the fastening bolt and the side surface of the head cover in order to avoid interference between the head section of the fastening bolt and the side surface of the head cover. However, in this case, the size of the engine increases.

[0007] An object of the present invention is to improve accessibility to a shaft end of a valve while reducing the size of an engine.

[0008] According to the present invention said object is solved by an engine having the features of independent claim 1. Preferred embodiments are laid down in the dependent claims.

[0009] An engine according to an aspect of the present invention is provided with a crank shaft, a crank case, a cylinder body, a cylinder head, a valve, a cam shaft, a head cover, a first fastening bolt, and a second fastening bolt. The crank case accommodates the crank shaft. The cylinder body is connected to the crank case. The cylinder head is connected to the cylinder body. The valve is attached to the cylinder head. The cam shaft is supported by the cylinder head. The head cover includes an end section, which is arranged to face an end section of the cylinder head, and is attached to the cylinder head.

[0010] The first fastening bolt fastens the cylinder head, the cylinder body, and the crank case. The first fastening bolt includes a first head section which is fixed to the cylinder head. The second fastening bolt fastens the cylinder head, the cylinder body, and the crank case. The second fastening bolt includes a second head section which is fixed to the cylinder head. A first virtual plane which includes the end section of the cylinder head and a second virtual plane which includes the end section of the head cover overlap with the cam shaft.

[0011] The cylinder head includes a first cylinder side wall and a second cylinder side wall which are arranged to face the axial direction of the cam shaft. The head cover includes a first cover side wall which is connected to the first cylinder side wall and a second cover side wall which is connected to the second cylinder side wall. An inner surface of the first cover side wall is inclined so that between the first cover side wall and the second cover side wall becomes narrower toward a direction from the cylinder head toward the head cover in the cylinder axial direction of the cylinder body (referred to below as a "head cover side").

[0012] The first head section is arranged between the first cylinder side wall and the second head section in the axial direction of the cam shaft. The second head section is arranged between the second cylinder side wall and the first head section in the axial direction of the cam shaft. The distance between the first cylinder side wall and the first head section in the axial direction of the cam shaft is shorter than the distance between the second cylinder side wall and the second head section in the axial direction of the cam shaft. The distance to the first head section in the cylinder axial direction from a third virtual plane, which includes the axis of the crank shaft and is perpendicular to the cylinder axis, is shorter than the distance to the second head section in the cylinder axial direction from the third virtual plane.

[0013] In the engine according to the present aspect, the end section of the cylinder head and the end section of the head cover, which are the engaging surface of the cylinder head and the head cover, are arranged at a height which overlaps with the cam shaft. As a result, it is possible to improve accessibility to the shaft ends of the valves.

[0014] In addition, the first head section may be arranged at a position which is close to the first cylinder side wall and the inner surface of the first cover side wall, which is connected to the first cylinder side wall, may be inclined in a direction toward the first head section in the axial direction of the cam shaft as the inner surface of the first cover side wall is separated from the end section

of the first cover side wall. Accordingly, the distance between the first head section and the inner surface of the first cover side wall may become shorter as the position of the first head section is positioned to the head cover side. In this case, the size of the engine may increase in order to secure clearance between the inner surface of the first cover side wall and the first head section. However, in the engine according to the present aspect, the distance to the first head section in the cylinder axial direction from the third virtual plane may be shorter than the distance to the second head section in the cylinder axial direction from the third virtual plane. Accordingly, the first head section may be positioned more to the cylinder body side than the second head section in the cylinder axial direction. As a result, it may be possible to reduce the size of the engine. Here, the cylinder body side has the meaning of a direction from the cylinder head to the cylinder body in the cylinder axial direction.

[0015] Furthermore, the second head section may be arranged to be separated from the second cylinder side wall compared to the position of the first head section with regard to the first cylinder side wall. Accordingly, it may be possible to secure clearance between the second cover side wall and the second head section while suppressing an increase in the size of the engine even when the second head section is arranged more to the head cover side than the first head section. In addition, it may be possible to improve rigidity of the cylinder head compared to a case where the second head section is arranged at the same height as the first head section by the second head section being arranged more to the head cover side than the first head section. Due to this, it may be possible to improve accessibility to the shaft ends of the valves while reducing the size of the engine.

[0016] Preferably, the first fastening bolt does not overlap with the head cover when viewed from the axial direction of the cam shaft. In this case, the first fastening bolt is arranged more to the cylinder body side than the end section of the head cover. Due to this, it is possible to reduce the size of the engine.

[0017] Preferably, the engine is further provided with a cam shaft driving section which is provided along with the cam shaft. The cam shaft driving section is arranged between the second cylinder side wall and the second head section in the axial direction of the cam shaft. Due to this, it is possible to secure a large distance between the second head section and the second cylinder side wall compared to a distance between the first head section and the first cylinder side wall since the second head section and the second cylinder side wall are arranged to be separated. Due to this, it is possible to reduce the size of the engine even when high engine rigidity is secured.

[0018] Preferably, the cylinder head includes a support wall which supports the cam shaft. The support wall includes a through hole through which the second fastening bolt is arranged. In this case, it is possible to improve strength of the support wall while suppressing an increase in the size of the support wall since the second fastening bolt is arranged in the through hole in the support wall. Due to this, it is possible to reduce the size of the engine. According to the present invention, the engine is further provided with a rocker shaft, a first rocker arm, a second rocker arm, a switching pin member, and an actuator. The rocker shaft is supported by the cylinder head and is parallel to the cam shaft. The first rocker arm is supported by the rocker shaft. The second rocker arm is supported by the rocker shaft and is arranged to line up with the first rocker arm in the axial direction of the cam shaft. The switching pin member is able to be moved in the axial direction of the cam shaft and is provided to be able to be moved between a first position and a second position. The switching pin member links the first rocker arm and the second rocker arm at the first position and swings together with the first rocker arm and the second rocker arm. The switching pin member does not link the first rocker arm and the second rocker arm at the second position. The actuator switches the position of the switching pin member between the first position and the second position by pressurizing the switching pin member in the axial direction of the cam shaft. The actuator is attached to the head cover at the outer side of the engine. Therefore, the actuator is attached to the head cover. As a result, it is possible to supress the effects of heat from a combustion chamber in the cylinder head on the actuator compared to a case where the actuator is attached to the cylinder head even when the actuator is arranged to be close to the switching pin member. Due to this, it is possible to reduce the size of the engine while supressing the effects of heat on the actuator.

[0019] Preferably, at least a portion of the actuator overlaps with the end section of the head cover when viewed from the cylinder axial direction. In this case, it is possible to reduce the drive force which is necessary for the switching pin member by shortening the distance between the actuator and the switching pin member. Due to this, it is possible to reduce the size of the actuator and it is possible to further reduce the size of the engine. According to the present invention, at least a portion of the first fastening bolt overlaps with the actuator when viewed from the cylinder axial direction. As a result, it is possible to further reduce the size of the engine.

[0020] According to the present invention, it is possible to improve accessibility to an end section of a valve while reducing the size of an engine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a cross sectional diagram of a portion of an engine.

Fig. 2 is a diagram where a cylinder head and a head cover are viewed from a direction which is perpendicular to a cylinder axis and a cam axis.

Fig. 3 is a cross sectional diagram where a cylinder

head and a head cover are viewed from a direction which is perpendicular to a cylinder axis and a cam axis.

Fig. 4 is a perspective diagram of an inner section of a cylinder head.

Fig. 5 is a perspective diagram of an inner section of a cylinder head.

Fig. 6 is a diagram where an inner section of a cylinder head is viewed from a cylinder axial direction.

Fig. 7 is a cross sectional diagram where an inner section of a cylinder head is viewed from a cam axial direction.

Fig. 8 is a cross sectional diagram of the vicinity of a second support wall and a pressing member.

Fig. 9 is a cross sectional diagram where an inner section of a cylinder head is viewed from a cam axial direction.

Fig. 10 is a diagram where a cylinder head and a head cover are viewed from a cylinder axial direction.

Fig. 11 is a cross sectional diagram where a portion of an engine is viewed from a direction which is perpendicular to a cam axis and a cylinder axis.

Fig. 12 is a cross sectional diagram where a portion of an engine is viewed from a direction which is perpendicular to a cam axis and a cylinder axis.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0022] Below, an engine 1 according to an embodiment will be described with reference to the diagrams. The engine 1 according to the present embodiment is a water cooled single cylinder engine. Fig. 1 is a cross sectional diagram of a portion of the engine 1. As shown in Fig. 1, the engine 1 includes a crank shaft 2, a crank case 3, and a cylinder section 4. The crank case 3 accommodates the crank shaft 2. The cylinder section 4 includes a cylinder body 5, a cylinder head 6, and a head cover 7. The cylinder body 5 is connected to the crank case 3. The cylinder body 5 may be integrated with the crank case 3 or the cylinder body 5 and the crank case may be separate. The cylinder body 5 accommodates a piston 8. The piston 8 is joined to the crank shaft 2 via a connecting rod 9.

[0023] Here, in the present embodiment, a direction from the cylinder head 6 toward the head cover 7 in a direction of a cylinder axis Ax1 of the cylinder body 5 is referred to as a "head cover side". A direction from the cylinder head 6 toward the cylinder body 5 in the direction of the cylinder axis Ax1 is referred to as a "cylinder body side".

[0024] The cylinder head 6 is arranged on the head cover side of the cylinder body 5. The cylinder head 6 is attached to the cylinder body 5. The head cover 7 is arranged on the head cover side of the cylinder head 6. The head cover 7 is attached to the cylinder head 6. The cylinder axis Ax1 is perpendicular with regard to a central axis Ax2 of the crank shaft 2 (referred to below as a "crank axis Ax2"). The cylinder head 6 includes a combustion chamber 11. A spark plug 12 is attached to the cylinder head 6. A front end section of the spark plug 12 is arranged to face the combustion chamber 11. A base end section of the spark plug 12 is arranged at an outer section of the engine 1. A valve gear 13 is accommodated in the cylinder head 6 and the head cover 7.

[0025] The valve gear 13 is a mechanism for opening and closing exhaust valves 24 and 25 and intake valves 26 and 27 which will be described later. The valve gear 13 adopts a SOHC (single overhead cam shaft) mechanism. The valve gear 13 adopts a so-called variable valve gear which switches the timing of the opening and closing of the intake valves 26 and 27. The valve gear 13 includes a cam shaft 14. The cam shaft 14 is supported by the cylinder head 6. A central axis Ax3 of the cam shaft 14 (referred to below as a "cam axis Ax3") is perpendicular with regard to the cylinder axis Ax1. The cam axis Ax3 is parallel to the crank axis Ax2.

[0026] The cam shaft 14 includes a first cam shaft end section 141 and a second cam shaft end section 142. A first cam shaft driving section 143 is provided at the first cam shaft end section 141. The first cam shaft driving section 143 is a sprocket. The first cam shaft driving section 143 meshes with a cam chain 15 and the cam chain 15 is joined to the cam shaft 14. A second cam shaft driving section 201 is provided in the crank shaft 2. The second cam shaft driving section 201 is a sprocket. The second cam shaft driving section 201 meshes with the cam chain 15 and the cam chain 15 is joined to the crank shaft 2. That is, the cam chain 15 is wound around the first cam shaft driving section 143 of the cam shaft 14 and the second cam shaft driving section 201 of the crank shaft 2. The cam shaft 14 is rotated by the rotation of the crank shaft 2 being transmitted to the cam shaft 14 via the cam chain 15.

[0027] The cam chain chamber 16 is provided in the cylinder head 6 and the cylinder body 5. The cam chain 15 is arranged in the cam chain chamber 16. The cam chain chamber 16 is arranged in a direction which is perpendicular to the cylinder axis Ax1 with regard to the combustion chamber 11. That is, the cam chain chamber 16 is arranged to line up with the combustion chamber 11 in the direction of the cam axis Ax3.

[0028] A water pump 17 is joined to the first cam shaft end section 141. The water pump 17 is arranged in the direction of the cam axis Ax3 of the cam shaft 14. The water pump 17 is connected to a cooling liquid path which is not shown in the diagrams and a radiator 19 in the engine 1 via a cooling liquid hose 18. The water pump 17 circulates a cooling liquid in the engine 1 due to being driven by the rotation of the cam shaft 14.

[0029] Fig. 2 is a diagram where the cylinder head 6 and the head cover 7 are viewed from a direction which is perpendicular to the cylinder axis Ax1 and the cam axis Ax3. Fig. 3 is a cross sectional diagram where the cylinder head 6 and the head cover 7 are viewed from a direction which is perpendicular to the cylinder axis Ax1 and the cam axis Ax3. Here, the water pump 17 is removed from

the cylinder head 6 and the head cover 7 in Fig. 2 and Fig. 3.

[0030] The cylinder head 6 includes a first end section 601 and a second end section 602. The first end section 601 is arranged to face an end section 701 of the head cover 7 in the direction of the cylinder axis Ax1. The second end section 602 is arranged to face an end section of the cylinder body 5 in the direction of the cylinder axis Ax1. The first end section 601 and the second end section 602 extend in a direction which is perpendicular with regard to the cylinder axis Ax1.

[0031] As shown in Fig. 3, a first virtual plane P1 which includes the first end section 601 of the cylinder head 6 and a second virtual plane P2 which includes the end section 701 of the head cover 7 overlap with the cam shaft 14. In detail, the first virtual plane P1 and the second virtual plane P2 are positioned more to the head cover side than the cam axis Ax3. Here, a gasket 21 is interposed between the first end section 601 of the cylinder head 6 and the end section 701 of the head cover 7.

[0032] The cylinder head 6 includes a first cylinder side wall 603 and a second cylinder side wall 604. The first cylinder side wall 603 and the second cylinder side wall 604 are arranged to face the direction of the cam axis Ax3. The second cylinder side wall 604 is closer to the cam chain chamber 16 than the first cylinder side wall 603. The second cylinder side wall 604 is closer to the first cam shaft driving section 143 than the first cylinder side wall 603.

[0033] The head cover 7 includes a first cover side wall 702 and a second cover side wall 703. The first cover side wall 702 and the second cover side wall 703 are arranged to face the direction of the cam axis Ax3. The first cover side wall 702 is positioned on the head cover side of the first cylinder side wall 603 and is connected to the first cylinder side wall 603. The second cover side wall 703 is positioned on the head cover side of the second cylinder side wall 604 and is connected to the second cylinder side wall 604. The second cover side wall 703 is closer to the cam chain chamber 16 than the first cover side wall 702. The second cover side wall 703 is closer to the first cam shaft driving section 143 than the first cover side wall 702.

[0034] Fig. 4 and Fig. 5 are perspective diagrams of an inner section of the cylinder head 6. Fig. 6 is a diagram where an inner section of the cylinder head 6 is viewed from the direction of the cylinder axis Ax1. As shown in Fig. 6, the first cylinder side wall 603 includes a first protruding wall section 605, a second protruding wall section 606, and a concave section 607. The first protruding wall section 605 and the second protruding wall section 606 have a shape which protrudes to the outside of the cylinder head 6 in the direction of the cam axis Ax3. The concave section 607 is positioned between the first protruding wall section 605 and the second protruding wall section 606. The concave section 607 has a shape which is depressed toward the inside of the cylinder head 6 in the direction of the cam axis Ax3. The spark plug 12 described above is attached to the first cylinder side wall 603. The base end section of the spark plug 12 is positioned in the concave section 607 in the first cylinder side wall 603. That is, the base end section of the spark plug 12 is positioned between the first protruding wall section 605 and the second protruding wall section 606 when viewed from the direction of the cylinder axis Ax1.

[0035] The cylinder head 6 includes a third cylinder side wall 608 and a fourth cylinder side wall 609. The third cylinder side wall 608 and the fourth cylinder side wall 609 are arranged to line up in a direction which is perpendicular to the cam axis Ax3 and the cylinder axis Ax1. A connecting section 610 of an exhaust pipe (which is not shown in the diagram) is provided in the third cylinder side wall 608. As shown in Fig. 4, a connecting section 611 of a intake pipe (which is not shown in the diagram) is provided in the fourth cylinder side wall 609.

[0036] The cylinder head 6 includes a first support wall 612 and a second support wall 613. The first support wall 612 and the second support wall 613 are arranged to line up in the direction of the cam axis Ax3. The first support wall 612 and the second support wall 613 support the cam shaft 14 such that the cam shaft 14 is able to rotate. As shown in Fig. 3, the first support wall 612 supports the cam shaft 14 via a first bearing 22. The second support wall 613 supports the cam shaft 14 via a second bearing 23. The first support wall 612 and the second support wall 613 are arranged between the first cam shaft driving section 143 and the first cylinder side wall 603. The second support wall 613 is closer to the first cam shaft driving section 143 than the first support wall 612. The second support wall 613 is arranged between the first support wall 612 and the first cam shaft driving section 143 in the direction of the cam axis Ax3. The top section of the first support wall 612 is positioned more to the head cover side than the first end section 601 of the cylinder head 6. The top section of the second support wall 613 is positioned more to the head cover side than the first end section 601 of the cylinder head 6.

[0037] Fig. 7 is a cross sectional diagram where an inner section of the cylinder head 6 is viewed from the direction of the cam axis Ax3. As shown in Fig. 4 to Fig. 7, the intake valves 26 and 27 and the exhaust valves 24 and 25 are attached to the cylinder head 6. As shown in Fig. 7, the cylinder head 6 includes a intake port 614 and an exhaust port 615 which are linked to the combustion chamber 11. The intake valves 26 and 27 open and close the intake port 614. As shown in Fig. 6, the intake valves 26 and 27 include a first intake valve 26 and a second intake valve 27. The first intake valve 26 and the second intake valve 27 are arranged to line up in the direction of the cam axis Ax3. As shown in Fig. 7, a intake valve spring 261 is attached to the first intake valve 26. The intake valve spring 261 presses the first intake valve 26 in a direction so that the first intake valve 26 closes the intake port 614. In the same manner, a intake valve spring 271 (refer to Fig. 4) is attached to the second intake valve 27 and the second intake valve 27 is pressed in a

direction so that the second intake valve 27 closes the intake port 614.

[0038] The exhaust valves 24 and 25 open and close the exhaust port 615. As shown in Fig. 6, the exhaust valves 24 and 25 include a first exhaust valve 24 and a second exhaust valve 25. The first exhaust valve 24 and the second exhaust valve 25 are arranged to line up in the direction of the cam axis Ax3. As shown in Fig. 5 and Fig. 7, an exhaust valve spring 241 is attached to the first exhaust valve 24. The exhaust valve spring 241 presses the first exhaust valve 24 in a direction so that the first exhaust valve 24 closes the exhaust port 615. An exhaust valve spring 251 is attached to the second exhaust valve 25 and the second exhaust valve 25 is pressed in a direction so that the second exhaust valve 25 closes the exhaust port 615.

[0039] As shown in Fig. 3, the cam shaft 14 includes a first intake cam 144, a second intake cam 145, and an exhaust cam 146. The first intake cam 144, the second intake cam 145, and the exhaust cam 146 are arranged to line up in the direction of the cam axis Ax3. The exhaust cam 146 is the closest to the first cam shaft driving section 143 out of the first intake cam 144, the second intake cam 145, and the exhaust cam 146. The first intake cam 144 is the farthest from the first cam shaft driving section 143 out of the first intake cam 144, the second intake cam 145, and the exhaust cam 146. The second intake cam 145 is arranged between the first intake cam 144 and the exhaust cam 146 in the direction of the cam axis Ax3.

[0040] As shown in Fig. 7, the valve gear 13 includes an exhaust rocker shaft 31 and an exhaust rocker arm 32. The exhaust rocker shaft 31 is arranged to be parallel to the cam shaft 14. The exhaust rocker shaft 31 is supported by the cylinder head 6. In detail, the exhaust rocker shaft 31 is supported by the first support wall 612 and the second support wall 613. The central axis of the exhaust rocker shaft 31 is positioned more to the head cover side than the cam axis Ax3.

[0041] The exhaust rocker arm 32 is supported by the exhaust rocker shaft 31 so as to be able to swing centered on the exhaust rocker shaft 31. The exhaust rocker arm 32 is provided so as to be able to operate the exhaust valves 24 and 25. The exhaust rocker arm 32 includes an arm body 321, a roller support section 322, a roller 323, and an exhaust valve pressurizing section 324.

[0042] The arm body 321 includes a through hole 327 and the exhaust rocker shaft 31 passes through the through hole 327. The roller support section 322 protrudes from the arm body 321 to the cam shaft 14 side. The roller support section 322 supports the roller 323 so as to be able to rotate. The rotation central axis of the roller 323 is parallel to the cam axis Ax3. The roller 323 is positioned on the cam shaft 14 side of the exhaust rocker shaft 31. The roller 323 comes into contact with the exhaust cam 146 and is rotated due to rotation of the exhaust cam shaft 146.

[0043] The exhaust valve pressurizing section 324 protrudes from the arm body 321 to the opposite side to the cam shaft 14. That is, the exhaust valve pressurizing section 324 protrudes from the arm body 321 to a stem end 242 side of the first exhaust valve 24 (referred to below as "exhaust valve side"). As shown in Fig. 5 and Fig. 6, a first adjusting screw 325 and a second adjusting screw 326 are provided at the tips of the exhaust valve pressurizing section 324. The tip of the first adjusting screw 325 opposes the stem end 242 of the first exhaust valve 24. The tip of the second adjusting screw 326 opposes a stem end 252 of the second exhaust valve 25.

[0044] When the roller 323 is pressed up by the exhaust cam 146, the exhaust valve pressurizing section 324 presses the stem end 242 in the first exhaust valve 24 and the stem end 252 in the second exhaust valve 25 down due to the exhaust rocker arm 32 swinging. Due to this, the exhaust port 615 is opened by the first exhaust valve 24 and the second exhaust valve 25 being pressed down. When the roller 323 is not pressed up by the exhaust cam 146, the exhaust port 615 is closed by the first exhaust valve 24 and the second exhaust valve 25 being pressed up by the exhaust valve springs 241 and 251.

[0045] As shown in Fig. 3, the valve gear 13 includes a intake rocker shaft 33, an exhaust rocker arm 34, a switching pin member 35, and an actuator 39. The intake rocker shaft 33 is arranged to be parallel to the cam shaft 14. The intake rocker shaft 33 is supported by the cylinder head 6. In detail, the intake rocker shaft 33 is supported by the first support wall 612 and the second support wall 613. The central axis of the intake rocker shaft 33 is positioned more to the head cover side than the cam axis Ax3.

[0046] The intake rocker arm 34 includes a first rocker arm 36 and a second rocker arm 37. The first rocker arm 36 is supported by the intake rocker shaft 33 so as to be able to swing centered on the intake rocker shaft 33. The first rocker arm 36 is provided as to be able to operate the intake valves 26 and 27. The first rocker arm 36 includes a first arm body 361 shown in Fig. 3, a first roller support section 362 shown in Fig. 6, a first roller 363, a intake valve pressurizing section 364, and a first linking section 365.

[0047] As shown in Fig. 3, the first arm body 361 includes a through hole 366 and the intake rocker shaft 33 passes through the through hole 366. The first roller support section 362 protrudes from the first arm body 361 to the cam shaft 14 side. The first roller support section 362 supports the first roller 363 so as to be able to rotate. The rotation central axis of the first roller 363 is parallel to the cam axis Ax3. The first roller 363 is positioned on the cam shaft 14 side of the intake rocker shaft 33. The first roller 363 comes into contact with the first intake cam 144 and is rotated due to rotation of the first intake cam 144.

[0048] The intake valve pressurizing section 364 protrudes from the first arm body 361 to the opposite side to the cam shaft 14. That is, the intake valve pressurizing section 364 protrudes from the first arm body 361 to a

stem end 262 side of the first intake valve 26 (referred to below as "intake valve side"). As shown in Fig. 6, a first adjusting screw 367 and a second adjusting screw 368 are provided at the tip of the intake valve pressurizing section 364. The tip of the first adjusting screw 367 opposes the stem end 262 of the first intake valve 26. The tip of the second adjusting screw 368 opposes a stem end 272 of the second intake valve 27.

[0049] The first linking section 365 is connected to the intake valve pressurizing section 364. The first linking section 365 is positioned more to the head cover side than the intake rocker shaft 33. The first linking section 365 is positioned more to the intake valve side than the intake rocker shaft 33. The first linking section 365 is positioned more to the head cover side than the intake valve pressurizing section 364. As shown in Fig. 3, the first linking section 365 includes a through hole 369. The through hole 369 extends in the direction of the cam axis Ax3. The switching pin member 35 is inserted into the through hole 369.

[0050] As shown in Fig. 7, the second rocker arm 37 is supported so as to be able to rotate centered on the intake rocker shaft 33. The second rocker arm 37 is arranged to line up with the first rocker arm 36 in the direction of the cam axis Ax3. The second rocker arm 37 is arranged at the cam chain chamber 16 side of the first rocker arm 36. That is, the second rocker arm 37 is closer to the first cam shaft driving section 143 than the first rocker arm 36. The second rocker arm 37 includes a second arm body 371, a second roller support section 372, a second roller 373, and a second linking section 374.

[0051] The second arm body 371 includes a through hole 375 and the intake rocker shaft 33 passes through the through hole 375. The second roller support section 372 protrudes from the second arm body 371 to the cam shaft 14 side. The second roller support section 372 supports the second roller 373 so as to be able to rotate. The rotation central axis of the second roller 373 is parallel to the cam axis Ax3. The second roller 373 is positioned on the cam shaft 14 side of the intake rocker shaft 33. The second roller 373 comes into contact with the second intake cam 145 and is rotated due to rotation of the second intake cam 145.

[0052] The second linking section 374 protrudes from the second arm body 371 to the opposite side to the cam shaft 14. That is, the second linking section 374 protrudes from the second arm body 371 to the intake valve side. The second linking section 374 is positioned more to the head cover side than the intake rocker shaft 33. The second linking section 374 is positioned more to the head cover side than the intake valve pressurizing section 364. As shown in Fig. 3, the second linking section 374 includes a through hole 376. The through hole 376 extends in the direction of the cam axis Ax3. The through hole 376 of the second linking section 374 is arranged to line up with the through hole 369 of the first linking section 365 in the direction of the cam axis Ax3. Accordingly, it is possible for the switching pin member 35 to be inserted into the through hole 376 of the second linking section 374.

[0053] The valve gear 13 includes a pressing member 38 shown in Fig. 6. The pressing member 38 presses the second rocker arm 37 in a direction where the second roller 373 applies pressure to the cam shaft 14. In the present embodiment, the pressing member 38 is a coil spring and the intake rocker shaft 33 runs through the pressing member 38. The second rocker arm 37 includes a first support member 41. The first support member 41 supports one end of the pressing member 38. The first support member 41 has the shape of a pin and protrudes from the second rocker arm 37 in the direction of the cam axis Ax3. Fig. 8 is a cross sectional diagram of the vicinity of the second support wall 613 and the pressing member 38.

[0054] As shown in Fig. 8, the valve gear 13 includes a second support member 42. The second support member 42 supports the other end of the pressing member 38. The second support member 42 is configured by a member which is bent and has a cross sectional shape with an L shape. A step section 619 is provided in the second support wall 613 and the second support member 42 is supported in the step section 619.

[0055] As shown in Fig. 3, the switching pin member 35 is able to be moved in the axial direction of the cam shaft 14 and is provided to be able to be moved between a first position and a second position. The switching pin member 35 is arranged to span between the through hole 369 of the first linking section 365 and the through hole 376 of the second linking section 374 at the first position. Due to this, the switching pin member 35 links the first rocker arm 36 and the second rocker arm 37 at the first position and the first rocker arm 36 and the second rocker arm 37 swing in an integrated manner. In this state, the switching pin member 35 swings together with the first rocker arm 36 and the second rocker arm 37.

[0056] The switching pin member 35 is arranged at the through hole 369 of the first linking section 365 and is not arranged at the through hole 376 of the second linking member 374 at the second position. Due to this, the switching pin member 35 does not link the first rocker arm 36 and the second rocker arm 37 at the second position and the first rocker arm 36 and the second rocker arm 37 swing independently from each other. In this state, the switching pin member 35 swings together with the first rocker arm 36.

[0057] An elastic member 44 is provided in the first linking section 365. The elastic member 44 is arranged in the through hole 369 of the first linking section 365. The elastic member 44 presses the switching pin member 35 in a direction from the first position toward the second position. Accordingly, when the switching pin member 35 is not pressurized by the actuator 39, the switching pin member 35 is held at the second position by the elastic member 44. When the switching pin member 35 is pressurized by the actuator 39, the switching pin member 35 moves from the second position to the

first position against the pressing force of the elastic member 44.

[0058] As shown in Fig. 7, the switching pin member 35 is positioned more to the head cover side than the first end section 601 of the cylinder head 6 and the end section 701 of the head cover 7. Accordingly, the switching pin member 35 overlaps with the head cover 7 when viewed from the axial direction of the cam shaft 14. As shown in Fig. 7, the switching pin member 35 is positioned on the intake valve side of the intake rocker shaft 33. That is, the switching pin member 35 is positioned between the intake rocker shaft 33 and the stem end 262 of the first intake valve 26 in a direction which is perpendicular to the cylinder axis Ax1 and the axis of the cam shaft 14. The distance between the shaft center of the intake rocker shaft 33 and the shaft center of the switching pin member 35 is shorter than the distance between the shaft center of the intake rocker shaft 33 and the stem end 262 of the first intake valve 26 when viewed from the axial direction of the cam shaft 14. In addition, the intake rocker shaft 33 is positioned between the switching pin member 35 and the first roller 363 in a direction which is perpendicular to the cylinder axis Ax1 and the axis of the cam shaft 14. In the same manner, the intake rocker shaft 33 is positioned between the switching pin member 35 and the second roller 372 in a direction which is perpendicular to the cylinder axis Ax1 and the axis of the cam shaft 14.

[0059] Fig. 9 illustrates a state where the first rocker arm 36 and the second rocker arm 37 swing using dashed lines. When the switching pin member 35 is positioned at the first position, the first rocker arm 36 is linked to the second rocker arm 37 and swings with the second rocker arm 367 in an integrated manner. As a result, when the second roller 373 is pressed up by the second intake cam 145, due to the second rocker arm 37 swinging centered on the intake rocker shaft 33, the first rocker arm 35 also swings in a direction which lowers the intake valve pressurizing section 364. Due to this, the tip of the first adjusting screw 367 presses down the stem end 262 of the first intake valve 26 and the tip of the second adjusting screw 368 presses down the stem end 272 of the second intake valve 27. Due to this, the first intake valve 26 and the second intake valve 27 open the intake port 614. When the second roller 373 is not pressed up by the second intake cam 145, the intake port 614 is closed off by the first intake valve 26 and the second intake valve 27 being pressed up by the intake valve springs 261 and 271.

[0060] When the switching pin member 35 is positioned at the second position, the first rocker arm 36 swings independently of the second rocker arm 37. As a result, when the first roller 363 is pressed up by the first intake cam 144, the first rocker arm 36 swings centered on the intake rocker shaft 33 in a direction where the intake valve pressurizing section 364 is lowered. Due to this, the tip of the first adjusting screw 367 presses down the stem end 262 of the first intake valve 26 and the tip of the second adjusting screw 368 presses down the stem end 272 of the second intake valve 27. Due to this, the first intake valve 26 and the second intake valve 27 open the intake port 614. When the first roller 363 is not pressed up by the first intake cam 144, the intake port 614 is closed off by the first intake valve 26 and the second intake valve 27 being pressed up by the intake valve springs 261 and 271.

[0061] Here, the shapes of the first intake cam 144 and the second intake cam 145 are set so that the second intake cam 145 presses up the second roller 373 before the tip of the first intake cam 144 reaches the first roller 363. As a result, when the switching pin member 35 is positioned at the first position, the rotation of the first intake cam 144 is not transmitted to the first rocker arm 36 due to the operation of the first rocker arm 36 by rotating of the second intake cam 145. Accordingly, when the switching pin member 35 is positioned at the first position, the opening and closing operation of the first intake valve 26 and the second intake valve 27 are performed according to the rotation of the second intake cam 145. On the other hand, when the switching pin member 35 is positioned at the second position, the rotation of the second intake cam 145 is not transmitted to the first rocker arm 36. As a result, when the switching pin member 35 is positioned at the second position, the opening and closing operation of the first intake valve 26 and the second intake valve 27 is performed according to the rotation of the first intake cam 144.

[0062] The actuator 39 is an electromagnetic solenoid and switches the position of the switching pin member 35 from the second position to the first position by pressurizing the switching pin member 35 in the axial direction of the cam shaft 14 due to the flow of electricity. When the flow of electricity to the actuator 39 stops, the position of the switching pin member 35 is returned from the first position to the second position due to the elasticity of the elastic member 44.

[0063] As shown in Fig. 6, the actuator 39 overlaps with the first end section 601 of the cylinder head 6 when viewed from the direction of the cylinder axis Ax1. That is, a portion of the actuator 39 is positioned more to the inner side of the cylinder head 6 than the first end section 601 of the cylinder head 6. The actuator 39 is arranged at the opposite side to the cam chain chamber 16 with regard to the cam shaft 14 when viewed from the direction of the cylinder axis Ax1. An extended line of the cam axis Ax3 is positioned between the connecting section 610 of the exhaust pipe and the actuator 39 when viewed from the direction of the cylinder axis Ax1. As shown in Fig. 3, the actuator 39 is positioned more to the head cover side than the first end section 601 of the cylinder head 6.

[0064] The actuator 39 includes a rod 391 which pressurizes the switching pin member 35 and a body section 392 which drives the rod 391. The central axis of the rod 391 is parallel to the cam axis Ax3. The rod 391 is arranged so as to overlap with the switching pin member 35 in the swinging range of the switching pin member 35

when viewed from the direction of the cam axis Ax3. The rod 391 pressurizes the switching pin member 35 by being driven by the body section 392. The rod 391 is arranged to be close to the first support wall 612 described above. As shown in Fig. 4, the first support wall 612 includes a concave section 620 which opposes the side surface of the rod 391. The concave section 620 has a shape which is depressed so as to avoid the rod 391.

[0065] The actuator 39 is arranged on the outside of the engine 1. The actuator 39 is attached to the head cover 7. In detail, the body section 392 is attached to the head cover 7. The rod 391 is supported by the head cover 7. As shown in Fig. 3, a through hole 704 is provided in the head cover 7 and the rod 391 runs through the through hole 704.

[0066] Fig. 10 is a diagram where the cylinder head 6 and the head cover 7 are viewed from the direction of the cylinder axis Ax1. As shown in Fig. 2 and Fig. 10, the actuator 39 is attached to the head cover 7 at the outside of the engine 1. The actuator 39 is attached to the first cover side wall 702. The actuator 39 is arranged so as to not overlap with an extended line of the axis of the spark plug 12. A first boss section 705 and a second boss section 706 are provided in the first cover side wall 702. The first boss section 705 and the second boss section 706 protrude from the first cover side wall 702 toward the outside of the cylinder head 6 in the direction of the cam axis Ax3. The first boss section 705 and the second boss section 706 are arranged to line up in a direction which is perpendicular to the cam axis Ax3 and the cylinder axis Ax1. The actuator 39 includes a flange section 393 which protrudes from the body section 392. The flange section 393 is fixed to the first boss section 705 and the second boss section 706 using bolts 51 and 52. Due to this, the actuator 39 is fixed to the first cover side wall 702.

[0067] Fig. 11 is a cross sectional diagram of a portion of the engine 1 which is viewed from a direction which is perpendicular to the cam axis Ax3 and the cylinder axis Ax1. As shown in Fig. 11, the cylinder head 6, the cylinder body 5, and the crank case 3 are fastened by a first fastening bolt 61 and a second fastening bolt 62. The cylinder head 6, the cylinder body 5, and the crank case 3 are fastened by a third fastening bolt and a fourth fastening bolt which are not shown in the diagram. The first fastening bolt 61 includes a first head section 65. The second fastening bolt 62 includes a second head section 66. The third fastening bolt includes a third head section 67 which is shown in Fig. 6. The fourth fastening bolt includes a fourth head section 68 which is shown in Fig. 6. The first to the fourth head sections 65 to 68 fix the cylinder head 6. The first head section 65 is configured by a shaft section of the first fastening bolt 61 and a nut which is separate but may be integral with the shaft section of the first fastening bolt 61. The second to the fourth head sections 66 to 68 are the same as the first head section 65.

[0068] The first head section 65 and the second head section 66 are arranged to line up in the direction of the cam axis Ax3. The third head section 67 and the fourth head section 68 are arranged to line up in the direction of the cam axis Ax3. The first head section 65 and the third head section 67 are arranged to line up in a direction which is perpendicular to the cam axis Ax3 and the cylinder axis Ax1. The second head section 66 and the fourth head section 68 are arranged to line up in a direction which is perpendicular to the cam axis Ax3 and the cylinder axis Ax1.

[0069] The first head section 65 is arranged between the first cylinder side wall 603 and the second head section 66 in the direction of the cam axis Ax3. The first cylinder side wall 603 is closer to the first head section 65 than the second cylinder side wall 604. The first head section 65 is arranged in the first protruding wall section 605 of the first cylinder side wall 603. The first head section 65 overlaps with the actuator 39 when viewed from the direction of the cylinder axis Ax1 of the cylinder body 5. The axis of the switching pin member 35 is positioned on the intake rocker shaft 33 side with regard to the center of the first head section 65 in a direction which is perpendicular to the cam axis Ax3 and the cylinder axis Ax1. The axis of the switching pin member 35 is positioned between the center of the first head section 65 and the intake rocker shaft 33 in a direction which is perpendicular to the cam axis Ax3 and the cylinder axis Ax1.

[0070] The second head section 66 is arranged between the second cylinder side wall 604 and the first head section 65 in the direction of the cam axis Ax3. The second cylinder side wall 604 is closer to the second head section 66 than the first cylinder side wall 603. The cam shaft driving section 143 is arranged between the second cylinder side wall 604 and the second head section 66 in the direction of the cam axis Ax3. The second head section 66 is arranged on the second support wall 613. The first head section 65 and the second head section 66 are arranged on the intake valve side with regard to the cam axis Ax3. The distance between the first cylinder side wall 603 and the first head section 65 in the direction of the cam axis Ax3 is shorter than the distance between the second cylinder side wall 604 and the second head section 66 in the direction of the cam axis Ax3.

[0071] The third head section 67 is arranged between the first cylinder side wall 603 and the fourth head section 68 in the direction of the cam axis Ax3. The first cylinder side wall 603 is closer to the third head section 67 than the second cylinder side wall 604. The third head section 67 is arranged in the second protruding wall section 606 of the first cylinder side wall 603.

[0072] The fourth head section 68 is arranged between the second cylinder side wall 604 and the third head section 67 in the direction of the cam axis Ax3. The second cylinder side wall 604 is closer to the fourth head section 68 than the first cylinder side wall 603. The cam shaft driving section 143 is arranged between the second cylinder side wall 604 and the fourth head section 68 in the direction of the cam axis Ax3. The fourth head section 68 is arranged on the second support wall 613. The third head section 67 and the fourth head section 68 are ar-

ranged on the exhaust valve side with regard to the cam axis Ax3. The distance between the first cylinder side wall 603 and the third head section 67 in the direction of the cam axis Ax3 is shorter than the distance between the second cylinder side wall 604 and fourth head section 68 in the direction of the cam axis Ax3.

[0073] As shown in Fig. 11, the inner surface of the first cover side wall 702 and the inner surface of the second cover side wall 703 are inclined so that between the first cover side wall 702 and second cover side wall 703 becomes narrower toward the head cover side.

[0074] The cylinder head 6 includes a first through hole 621 where the first fastening bolt 61 is arranged and a second through hole 622 through which the second fastening bolt 62 is arranged. The first through hole 621 and the second through hole 622 extend in the direction of the cylinder axis Ax1. The second through hole 622 is provided to pass through the second support wall 613. As shown in Fig. 12, a distance D1 to the first head section 65 in a direction of the cylinder axis Ax1 from the third virtual plane P3 which includes the crank axis Ax2 and is perpendicular to the cylinder axis Ax1 of the cylinder body 5 is shorter than a distance D2 to the second head section 66 in a direction of the cylinder axis Ax1 from the third virtual plane P3. That is, the first head section 65 is positioned more to the cylinder body side than the second head section 66.

[0075] The first fastening bolt 61 does not overlap with the head cover 7 when viewed from the direction of the cam axis Ax3. That is, the first head section 65 is positioned more to the cylinder body side than the first end section 601 of the cylinder head 6. The second fastening bolt 62 overlaps with the head cover 7 when viewed from the direction of the cam axis Ax3. That is, the second head section 66 is positioned more to the head cover side than the first end section 601 of the cylinder head 6.

[0076] Although omitted in the diagram, the third head section 67 is positioned at the same height as the first head section 65 and the fourth head section 68 is positioned at the same height as the second head section 66. Accordingly, the third head section 67 is positioned more to the cylinder body side than the fourth head section 68.

[0077] In the engine 1 in the present embodiment, the first end section 601 of the cylinder head 6 and the end section 701 of the head cover 7 are arranged at a height which overlaps with the cam shaft 14. As a result, it is possible to improve accessibility to the shaft ends of the exhaust valves 24 and 25 and the intake valves 26 and 27 while reducing the size of the engine 1.

[0078] In addition, the inner surface of the first cover side wall 702 which is connected to the first cylinder side wall 603 is inclined in a direction toward the first head section 65 in the cam axial direction as the inner surface of the first cover side wall 702 is separated to the head cover side from the end section of the first cover side wall 702. Accordingly, the distance between the first head section 65 and the inner surface of the first cover side wall 702 becomes shorter as the position of the first head section 65 is positioned to the head cover side. In this case, the size of the engine 1 increases in order to secure clearance between the inner surface of the first cover side wall 702 and the first head section 65.

[0079] However, in the engine 1 according to the present embodiment, it is possible to reduce the size of the engine 1 by the first head section 65 being positioned more to the cylinder body side than the second head section 66.

[0080] Furthermore, the second head section 66 is arranged to be separated from the second cylinder side wall 604 compared to the position of the first head section 65 with regard to the first cylinder side wall 603. Accordingly, it is possible to secure clearance between the second cover side wall 703 and the second head section 66 while suppressing an increase in the size of the engine 1 even when the second head section 66 is arranged more to the head cover side than the first head section 65. In addition, it is possible to improve rigidity of the cylinder head 6 by the second head section 66 being arranged more to the head cover side than the first head section 65.

[0081] As above, in the engine 1 in the present embodiment, it is possible to improve accessibility to the shaft ends of the exhaust valves 24 and 25 and the intake valves 26 and 27 while reducing the size of the engine 1.

[0082] The first fastening bolt 61 does not overlap with the head cover 7 when viewed from the direction of the cam axis Ax3. Due to this, it is possible to reduce the size of the engine 1.

[0083] The second support wall 613 includes the through hole 622 through which the second fastening bolt 62 is arranged. As a result, it is possible to improve strength of the second support wall 613 using the second fastening bolt 62 while suppressing an increase in the size of the second support wall 613. Due to this, it is possible to reduce the size of the engine 1.

[0084] The actuator 39 is attached to the head cover 7. As a result, it is possible to supress the effects of heat from the combustion chamber 11 in the cylinder head 6 on the actuator 39 compared to a case where the actuator 39 is attached to the cylinder head 6 even when the actuator 39 is arranged to be close to the switching pin member 35. Due to this, it is possible to reduce the size of the engine 1 while supressing the effects of heat on the actuator 39.

[0085] The actuator 39 overlaps with the first end section 601 of the cylinder head 6 and the end section 701 of the head cover 7 when viewed from the direction of the cylinder axis Ax1. In this case, it is possible to reduce drive force which is necessary for the switching pin member 35 by shortening the distance between the actuator 39 and the switching pin member 35. Due to this, it is possible to reduce the size of the actuator 39 and it is possible to further reduce the size of the engine 1.

[0086] The first fastening bolt 61 overlaps with the actuator 39 when viewed from the direction of the cylinder

axis Ax1. That is, it is possible to arrange the actuator 39 to be closer with regard to the cylinder head 6 by using a space on the head cover side of the first fastening bolt 61. Due to this, it is possible to further reduce the size of the engine 1.

[0087] Above, an embodiment of the present teaching has been described, but the present teaching is not limited to the embodiment described above and various modifications are possible in a scope which does not depart from the scope of the teaching.

[0088] The engine 1 is not limited to a water cooled single cylinder engine. For example, the engine 1 may be an air cooled engine. The engine 1 may be provided with a plurality of cylinders.

[0089] The number of exhaust valves is not limited to two and may be one or three or more. The number of intake valves is not limited to two and may be one or three or more.

[0090] The positions of the first head section 65, the second head section 66, the third head section 67, and the fourth head section 68 are not limited to the positions in the embodiment described above and may be modified. For example, in the embodiment described above, the first head section 65 does not overlap with the head cover 7 in the direction of the cam shaft 14, but the first head section 65 may overlap with the head cover 7 in the direction of the cam shaft 14. That is, the first head section 65 may be arranged more to the head cover side than the end section 701 of the head cover 7. Alternatively, the third head section 67 may be arranged at a height which is different to the first head section 65. For example, the third head section 67 may be positioned at the same height as the second head section 66. In the same manner, the fourth head section 68 may be positioned at a height which is different to the second head section 66.

[0091] It is sufficient if the first virtual plane P1 which includes the first end section 601 of the cylinder head 6 and the second virtual plane P2 which includes the end section 701 of the head cover 7 overlap with the cam shaft 14 and the first virtual plane P1 and the second virtual plane P2 may be arranged at the same height as the cam axis Ax3 or more to the cylinder body side than the cam axis Ax3.

[0092] The configuration and arrangement of the valve gear 13 are not limited to the embodiment described above and may be modified. For example, the actuator 39 may be attached to the cylinder head 6. Alternatively, the actuator 39 may be arranged so as to not overlap with the end section 701 of the head cover 7 when viewed from the direction of the cylinder axis Ax1. Alternatively, the actuator 39 may be arranged so as to not overlap with the first head section 65 when viewed from the direction of the cylinder axis Ax1. Without being limited to a portion of the actuator 39, all of the actuator 39 may be positioned more to the inner side than the first end section 601 of the cylinder head 6.

[0093] In the embodiment described above, the mechanism which switches the timing of the opening and closing of the valves using the actuator is adopted in the intake valves but may be adopted in the exhaust valves. That is, a mechanism which is the same as the mechanism which includes the first rocker arm 36, the second rocker arm 37, the switching pin member 35, and the actuator 39 described above may be provided in order to open and close the exhaust valves. Alternatively, the mechanism which switches the timing of the opening and closing of the valves using the actuator may be adopted in neither of the intake valves nor the exhaust valves.

Claims

1. An engine comprising:

a crank shaft (2);
a crank case (3) accommodating the crank shaft (2);
a cylinder body (5) connected to the crank case (3);
a cylinder head (6) connected to the cylinder body (5);
a valve (24, 25, 26, 27) attached to the cylinder head (6);
a cam shaft (14) supported by the cylinder head (6);
a head cover (7) including an end section (701) arranged to face an end section (601) of the cylinder head (6), the head cover (7) being attached to the cylinder head (6);
a first fastening bolt (61) including a first head section (65) fixed to the cylinder head (6), the first fastening bolt (61) fastening the cylinder head (6), the cylinder body (5), and the crank case (3);
a second fastening bolt (62) including a second head section (66) fixed to the cylinder head (6), the second fastening bolt (62) fastening the cylinder head (6), the cylinder body (5), and the crank case (3);
a rocker shaft (33) supported by the cylinder head (6), the rocker shaft (33) being parallel to the cam shaft (14);
a first rocker arm (36) supported by the rocker shaft (33);
a second rocker arm (37) supported by the rocker shaft (33), the second rocker arm (37) being arranged to line up with the first rocker arm (36) in the axial direction of the cam shaft (14);
a switching pin member (35) configured to be moved in the axial direction of the cam shaft (14), the switching pin member (35) being configured to be moved between a first position at which the first rocker arm (36) and the second rocker arm (37) are linked and a second position at which the first rocker arm (36) and the second

rocker arm (37) are not linked, the switching pin member (35) being configured to swing together with the first rocker arm (36) and the second rocker arm (37) at the first position; and
an actuator (39) configured to switch the position of the switching pin member (35) between the first position and the second position by pressurizing the switching pin member (35) in the axial direction of the cam shaft (14),
wherein a first virtual plane (P1) including the end section of the cylinder head (6) and a second virtual plane (P2) including the end section of the head cover (7) overlap with the cam shaft (14),
wherein the cylinder head (6) includes a first cylinder side wall (603) and a second cylinder side wall (604) which are arranged to face each other in an axial direction of the cam shaft (14),
wherein the head cover (7) includes a first cover side wall (702) connected to the first cylinder side wall (603) and a second cover side wall (703) connected to the second cylinder side wall (604), and
wherein an inner surface of the first cover side wall (702) is inclined so that a space between the first cover side wall (702) and the second cover side wall (703) becomes narrower toward a direction from the cylinder head (6) toward the head cover (7) in a cylinder axial direction of the cylinder body (5).
wherein the first head section (65) is arranged between the first cylinder side wall (603) and the second head section (66) in the axial direction of the cam shaft (14),
wherein the second head section (66) is arranged between the second cylinder side wall (604) and the first head section (65) in the axial direction of the cam shaft (14),
wherein the distance between the first cylinder side wall (603) and the first head section (65) in the axial direction of the cam shaft (14) is shorter than the distance between the second cylinder side wall (604) and the second head section (66) in the axial direction of the cam shaft (14),
wherein the distance to the first head section (65) in the cylinder axial direction from a third virtual plane (P3), which includes the axis of the crank shaft (2) and is perpendicular to the cylinder axis (Ax1), is shorter than the distance to the second head section (66) in the cylinder axial direction from the third virtual plane (P3),
wherein the actuator (39) is attached to the head cover (7) at the outer side of the engine,
and
wherein at least a portion of the first fastening bolt (61) overlaps with the actuator (39) when viewed from the cylinder axial direction.

2. The engine according to Claim 1,
wherein the first head section (65) is positioned more to the cylinder body side than the second head section (66) in the cylinder axial direction.

3. The engine according to any one of Claims 1 or 2,
wherein the first fastening bolt (61) does not overlap with the head cover (7) when viewed from the axial direction of the cam shaft (14).

4. The engine according to any of Claims 1 to 3, further comprising:

a cam shaft driving section (143) provided with the cam shaft (14),
wherein the cam shaft driving (143) section is arranged between the second cylinder side wall (604) and the second head section (66) in the axial direction of the cam shaft (14).

5. The engine according to Claim 4,
wherein the cylinder head (6) includes a support wall (613) supporting the cam shaft (14), and
the support wall (613) includes a through hole (622) through which the second fastening bolt (62) is arranged.

6. The engine according to Claim 1,
wherein at least a portion of the actuator (39) overlaps with the end section of the head cover (7) when viewed from the cylinder axial direction.

Patentansprüche

1. Motor, der umfasst:

eine Kurbelwelle (2),
ein Kurbelgehäuse (3), in dem die Kurbelwelle (2) aufgenommen ist,
einen Zylinderkörper (5), der mit dem Kurbelgehäuse (3) verbunden ist,
einen Zylinderkopf (6), der mit dem Zylinderkörper (5) verbunden ist,
ein Ventil (24, 25, 26, 27), das an dem Zylinderkopf (6) befestigt ist,
eine Nockenwelle (14), die durch den Zylinderkopf (6) gehalten wird,
eine Kopfabdeckung (7) mit einem Endabschnitt (701), der einem Endabschnitt (601) des Zylinderkopfs (6) zugewandt angeordnet ist, wobei die Kopfabdeckung (7) an dem Zylinderkopf (6) befestigt ist,
eine erste Befestigungsschraube (61) mit einem ersten Kopfabschnitt (65), der an dem Zylinderkopf (6) fixiert ist, wobei die erste Befestigungsschraube (61) den Zylinderkopf (6), den Zylinderkörper (5) und das Kurbelgehäuse (3) befes-

tigt,
eine zweite Befestigungsschraube (62) mit einem zweiten Kopfabschnitt (66), der an dem Zylinderkopf (6) fixiert ist, wobei die zweite Befestigungsschraube (62) den Zylinderkopf (6), den Zylinderkörper (5) und das Kurbelgehäuse (3) befestigt,
eine Kipphebelwelle (33), die durch den Zylinderkopf (6) gehalten wird, wobei die Kipphebelwelle (33) parallel zu der Nockenwelle (14) ist,
einen ersten Kipphebel (36), der durch die Kipphebelwelle (33) gehalten wird,
einen zweiten Kipphebel (37), der durch die Kipphebelwelle (33) gehalten wird, wobei der zweite Kipphebel (37) mit dem ersten Kipphebel (36) in der Achsenrichtung der Nockenwelle (14) ausgerichtet angeordnet ist,
ein Schaltstiftglied (35), das konfiguriert ist, um in der Achsenrichtung der Nockenwelle (14) bewegt zu werden, wobei das Schaltstiftglied (35) konfiguriert ist, um zwischen einer ersten Position, an welcher der erste Kipphebel (36) und der zweite Kipphebel (37) verbunden sind, und einer zweiten Position, an welcher der erste Kipphebel (36) und der zweite Kipphebel (37) nicht verbunden sind, bewegt zu werden, wobei das Schaltstiftglied (35) konfiguriert ist, um zusammen mit dem ersten Kipphebel (36) und dem zweiten Kipphebel (37) an der ersten Position zu schwenken, und
ein Stellglied (39), das konfiguriert ist, um die Position des Schaltstiftglieds (35) zwischen der ersten Position und der zweiten Position zu schalten, indem das Schaltstiftglied (35) in der Achsenrichtung der Nockenwelle (14) unter Druck gesetzt wird,
wobei eine erste virtuelle Ebene (P1), in welcher der Endabschnitt des Zylinderkopfs (6) enthalten ist, und eine zweite virtuelle Ebene (P2), in welcher der Endabschnitt der Kopfabdeckung (7) enthalten ist, mit der Nockenwelle (14) überlappen,
wobei der Zylinderkopf (6) eine erste Zylinderseitenwand (603) und eine zweite Zylinderseitenwand (604) umfasst, die derart angeordnet sind, dass sie einander in einer Achsenrichtung der Nockenwelle (14) zugewandt sind,
wobei die Kopfabdeckung (7) eine erste Abdeckungsseitenwand (702), die mit der ersten Zylinderseitenwand (603) verbunden ist, und eine zweite Abdeckungsseitenwand (703), die mit der zweiten Zylinderseitenwand (604) verbunden ist, umfasst, und
wobei eine Innenfläche der ersten Abdeckungsseitenwand (702) geneigt ist, sodass ein Zwischenraum zwischen der ersten Abdeckungsseitenwand (702) und der zweiten Abdeckungsseitenwand (703) in der Richtung von dem Zylinderkopf (6) zu der Kopfabdeckung (7) in einer Zylinderachsenrichtung des Zylinderkörpers (5) schmäler wird,
wobei der erste Kopfabschnitt (65) zwischen der ersten Zylinderseitenwand (603) und dem zweiten Kopfabschnitt (66) in der Achsenrichtung der Nockenwelle (14) angeordnet ist,
wobei der zweite Kopfabschnitt (66) zwischen der zweiten Zylinderseitenwand (604) und dem ersten Kopfabschnitt (65) in der Achsenrichtung der Nockenwelle (14) angeordnet ist,
wobei die Distanz zwischen der ersten Zylinderseitenwand (603) und dem ersten Kopfabschnitt (65) in der Achsenrichtung der Nockenwelle (14) kürzer ist als die Distanz zwischen der zweiten Zylinderseitenwand (604) und dem zweiten Kopfabschnitt (66) in der Achsenrichtung der Nockenwelle (14),
wobei die Distanz zu dem ersten Kopfabschnitt (65) in der Zylinderachsenrichtung von einer dritten virtuellen Ebene (P3), die die Achse der Kurbelwelle (2) enthält und senkrecht zu der Zylinderachse (Ax1) ist, kürzer ist als die Distanz zu dem zweiten Kopfabschnitt (66) in der Zylinderachsenrichtung von der dritten virtuellen Ebene (P3),
wobei das Stellglied (39) an der Kopfabdeckung (7) an der Außenseite des Motors befestigt ist, und
wobei wenigstens ein Teil der ersten Befestigungsschraube (61) mit dem Stellglied (39) aus der Zylinderachsenrichtung gesehen überlappt.

2. Motor nach Anspruch 1,
wobei der erste Kopfabschnitt (65) in der Zylinderachsenrichtung mehr auf der Seite des Zylinderkörpers als der zweite Kopfabschnitt (66) angeordnet ist.

3. Motor nach Anspruch 1 oder 2,
wobei die erste Befestigungsschraube (61) nicht mit der Kopfabdeckung (7) aus der Achsenrichtung der Nockenwelle (14) gesehen überlappt.

4. Motor nach einem der Ansprüche 1 bis 3, der weiterhin umfasst:

einen Nockenwellen-Antriebsabschnitt (143), der mit der Nockenwelle (14) versehen ist,
wobei der Nockenwellen-Antriebsabschnitt (143) zwischen der zweiten Zylinderseitenwand (604) und dem zweiten Kopfabschnitt (66) in der Achsenrichtung der Nockenwelle (14) angeordnet ist.

5. Motor nach Anspruch 4,
wobei der Zylinderkopf (6) eine Haltewand (613), die die Nockenwelle (14) hält, umfasst, und

die Haltewand (613) ein Durchgangsloch (622), durch die die zweite Befestigungsschraube (62) angeordnet ist, enthält.

6. Motor nach Anspruch 1,
wobei wenigstens ein Teil des Stellglieds (39) mit dem Endabschnitt der Kopfabdeckung (7) von der Zylinderachsenrichtung gesehen überlappt.

Revendications

1. Moteur thermique comprenant :

un vilebrequin (2),
un carter moteur (3) accueillant le vilebrequin (2),
un corps de cylindre (5) relié au carter moteur (3),
une culasse (6) reliée au corps de cylindre (5),
une soupape (24, 25, 26, 27) fixée à la culasse (6),
un arbre à cames (14) supporté par la culasse (6),
un couvre culasse (7) incluant une section terminale (701) agencée pour faire face à une section terminale (601) de la culasse (6), le couvre culasse (7) étant fixé sur la culasse (6),
un premier boulon de fixation (61) incluant une première section formant tête (65) fixée à la culasse (6), le premier boulon de fixation (61) immobilisant la culasse (6), le corps de cylindre (5) et le carter moteur (3),
un second boulon de fixation (62) incluant une seconde section formant tête (66) fixée à la culasse (6), le second boulon de fixation (62) immobilisant la culasse (6), le corps de cylindre (5) et le carter moteur (3),
un arbre oscillant (33) supporté par la culasse (6), l'arbre oscillant (33) étant parallèle à l'arbre à cames (14),
un premier culbuteur (36) supporté par l'arbre oscillant (33),
un second culbuteur (37) supporté par l'arbre oscillant (33), le second culbuteur (37) étant agencé pour s'aligner avec le premier culbuteur (36) dans la direction axiale de l'arbre à cames (14),
un élément de broche de commutation (35) configuré pour être déplacé dans la direction axiale de l'arbre à cames (14), l'élément de broche de commutation (35) étant configuré pour être déplacé entre une première position à laquelle le premier culbuteur (36) et le second culbuteur (37) sont reliés et une seconde position à laquelle le premier culbuteur (36) et le second culbuteur (37) ne sont pas reliés, l'élément de broche de commutation (35) étant configuré pour osciller avec le premier culbuteur (36) et le second culbuteur (37) au niveau de la première position, et
un actionneur (39) configuré pour faire basculer la position de l'élément de broche de commutation (35) entre la première position et la seconde position en comprimant l'élément de broche de commutation (35) dans la direction axiale de l'arbre à cames (14),
dans lequel un premier plan virtuel (P1) incluant la section terminale de la culasse (6) et un second plan virtuel (P2) incluant la section terminale du couvre culasse (7) se chevauchent avec l'arbre à cames (14),
dans lequel la culasse (6) inclut une première paroi latérale de cylindre (603) et une seconde paroi latérale de cylindre (604) qui sont agencées pour se faire face l'une à l'autre dans la direction axiale de l'arbre à cames (14),
dans lequel le couvre culasse (7) inclut une première paroi latérale de couvercle (701) reliée à la première paroi latérale de cylindre (603) et une seconde paroi latérale de couvercle (703) reliée à la seconde paroi latérale de cylindre (604), et
dans lequel la surface interne de la première paroi latérale de couvercle (702) est inclinée de telle sorte que l'espace entre la première paroi latérale de couvercle (702) et la seconde paroi latérale de couvercle (103) se rétrécit dans la direction allant de la culasse (6) au couvre culasse (7) dans une direction cylindrique axiale du corps de cylindre (5),
dans lequel la première section formant tête (65) est agencée entre la première paroi latérale de cylindre (603) et la seconde section formant tête (66) dans la direction axiale de l'arbre à cames (14),
dans lequel la seconde section formant tête (66) est agencée entre la seconde paroi latérale de cylindre (604) et la première section formant tête (65) dans la direction axiale de l'arbre à cames (14),
dans lequel la distance entre la première paroi latérale de cylindre (103) et la première section formant tête (65) dans la direction axiale de l'arbre à cames (14) est plus courte que la distance entre la seconde paroi latérale de cylindre (604) et la seconde section formant tête (66) dans la direction axiale de l'arbre à cames (14),
dans lequel la distance à la première section formant tête (65) dans la direction axiale de cylindre à partir d'un troisième plan virtuel (P3), qui inclut l'axe du vilebrequin (2) et qui est perpendiculaire à l'axe de cylindre (Ax1), est plus courte que la distance à la seconde section formant tête (66) dans la direction axiale de cylindre à partir du troisième plan virtuel (P3),

dans lequel l'actionneur (39) est fixé sur le couvre culasse (7) du côté extérieur du moteur, et dans lequel au moins une partie du premier boulon de fixation (61) est en chevauchement avec l'actionneur (39) lorsqu'il est vu depuis la direction axiale de cylindre.

2. Moteur selon la revendication 1,
dans lequel la première section formant tête (65) est plus positionnée vers le côté du corps de cylindre que la seconde section formant tête (66) dans la direction axiale de cylindre.

3. Moteur selon l'une quelconque des revendications 1 ou 2,
dans lequel le premier boulon de fixation (61) n'est pas en chevauchement avec le couvre culasse (7) lorsqu'il est vu de la direction axiale de l'arbre à cames (14).

4. Moteur selon l'une quelconque des revendications 1 à 3, comprenant en outre :

une section d'entraînement d'arbre à cames (143) dotée de l'arbre à cames (14),
dans lequel la section d'entraînement d'arbre à cames (143) est agencée entre la seconde paroi latérale de cylindre (604) et la seconde section formant tête (66) dans la direction axiale de l'arbre à cames (14).

5. Moteur selon la revendication 4,
dans lequel la culasse (6) inclut une paroi de support (613) soutenant l'arbre à cames (14), et
la paroi de support (113) inclut un trou traversant (622) au travers duquel est agencé le second boulon de fixation (62).

6. Moteur selon la revendication 1,
dans lequel au moins une partie de l'actionneur (39) et en chevauchement avec la section terminale du couvre culasse (7), lorsqu'il est vu depuis la direction axiale de cylindre.

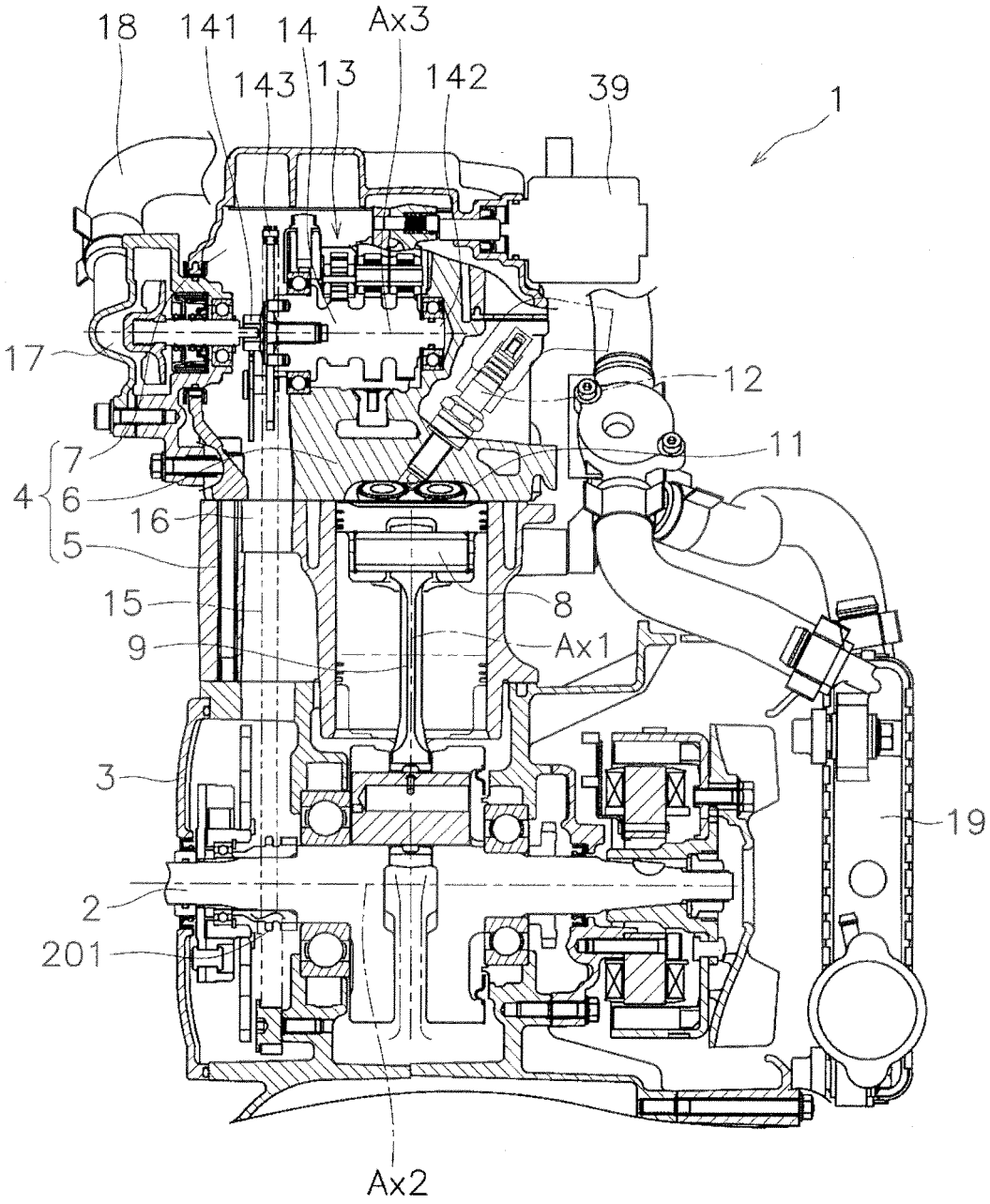

18
141
14
Ax3
143
13
142
39
1
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12
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Ax1
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19
2
201
Ax2

FIG. 1

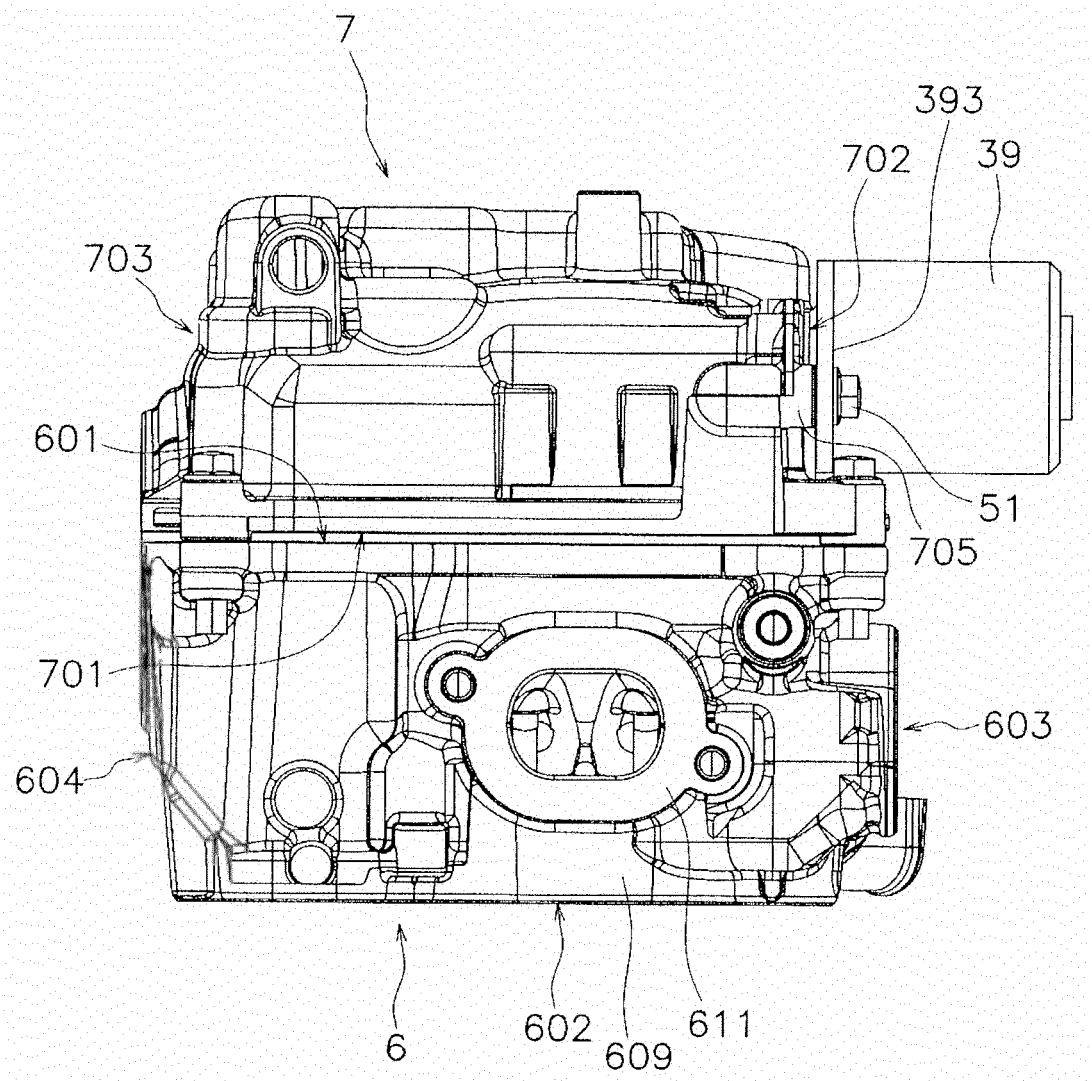


FIG. 2

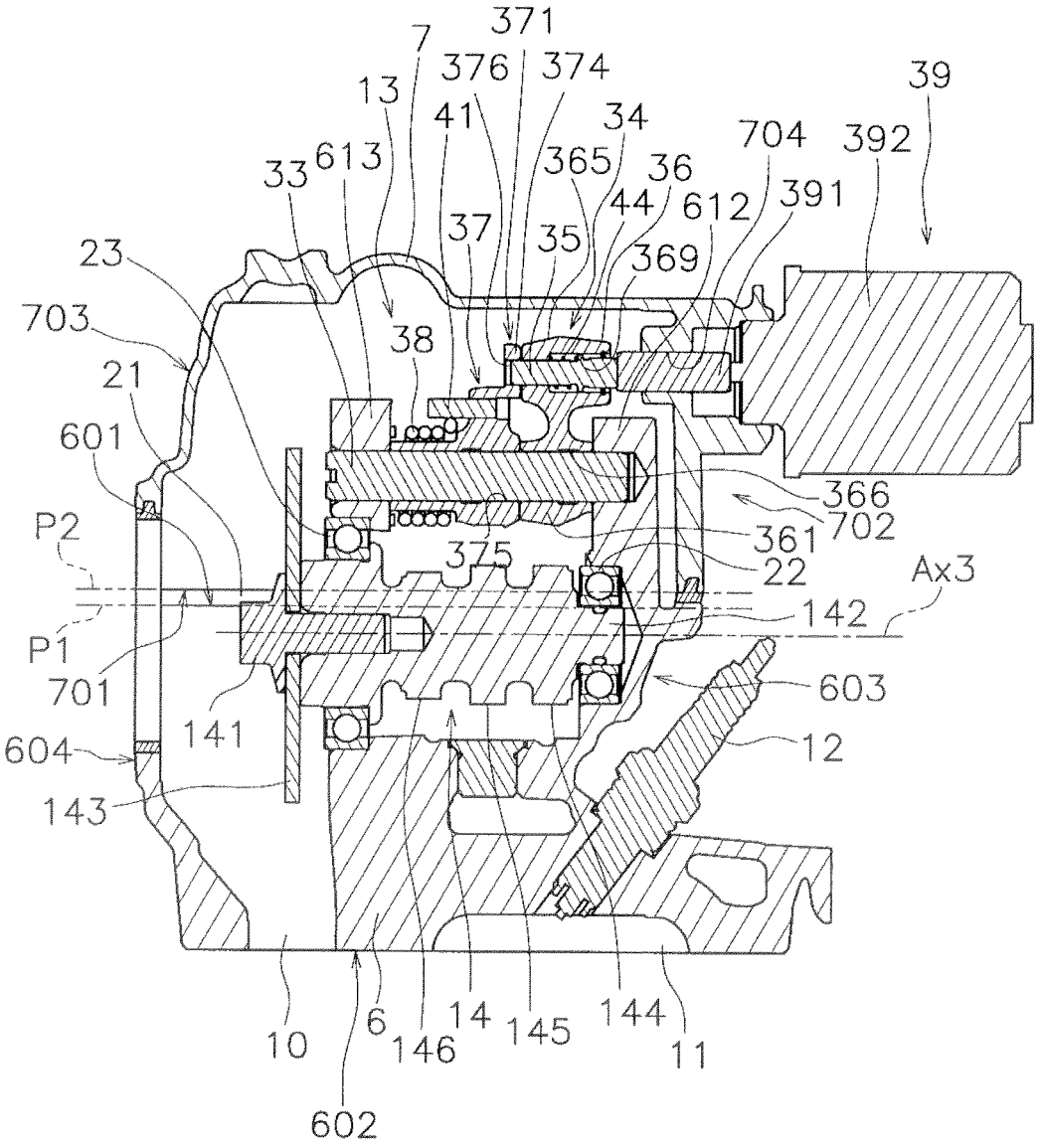

371
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376
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41
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704
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33
613
365
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391
44
612
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35
369
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703
38
21
601
366
702
361
P2
375
22
Ax3
142
P1
701
603
141
12
604
143
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145
144
11
146
602

FIG. 3

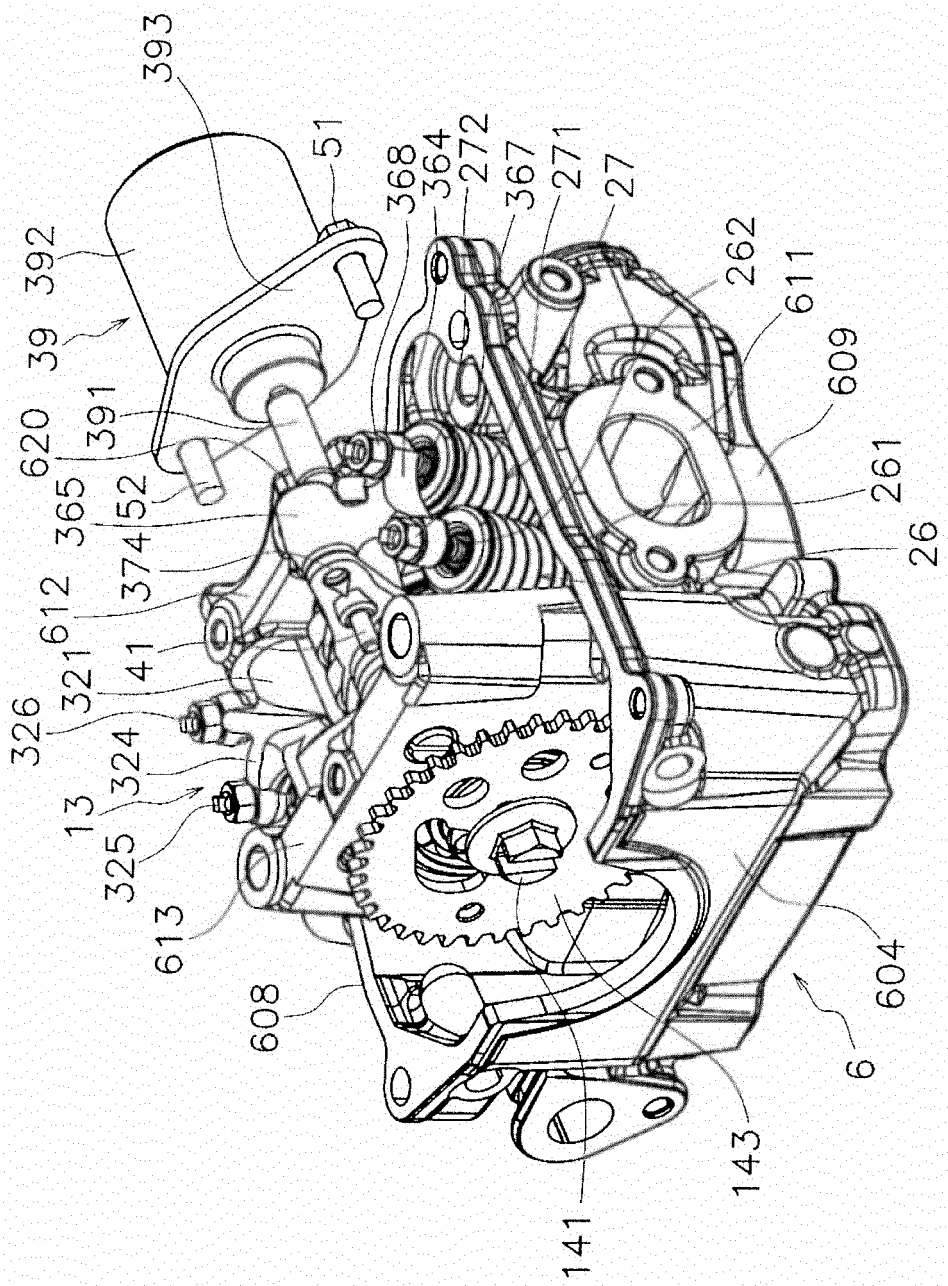

393
51
368
364
272
367
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27
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611
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261
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392
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325
613
608
604
6
143
141

FIG. 4

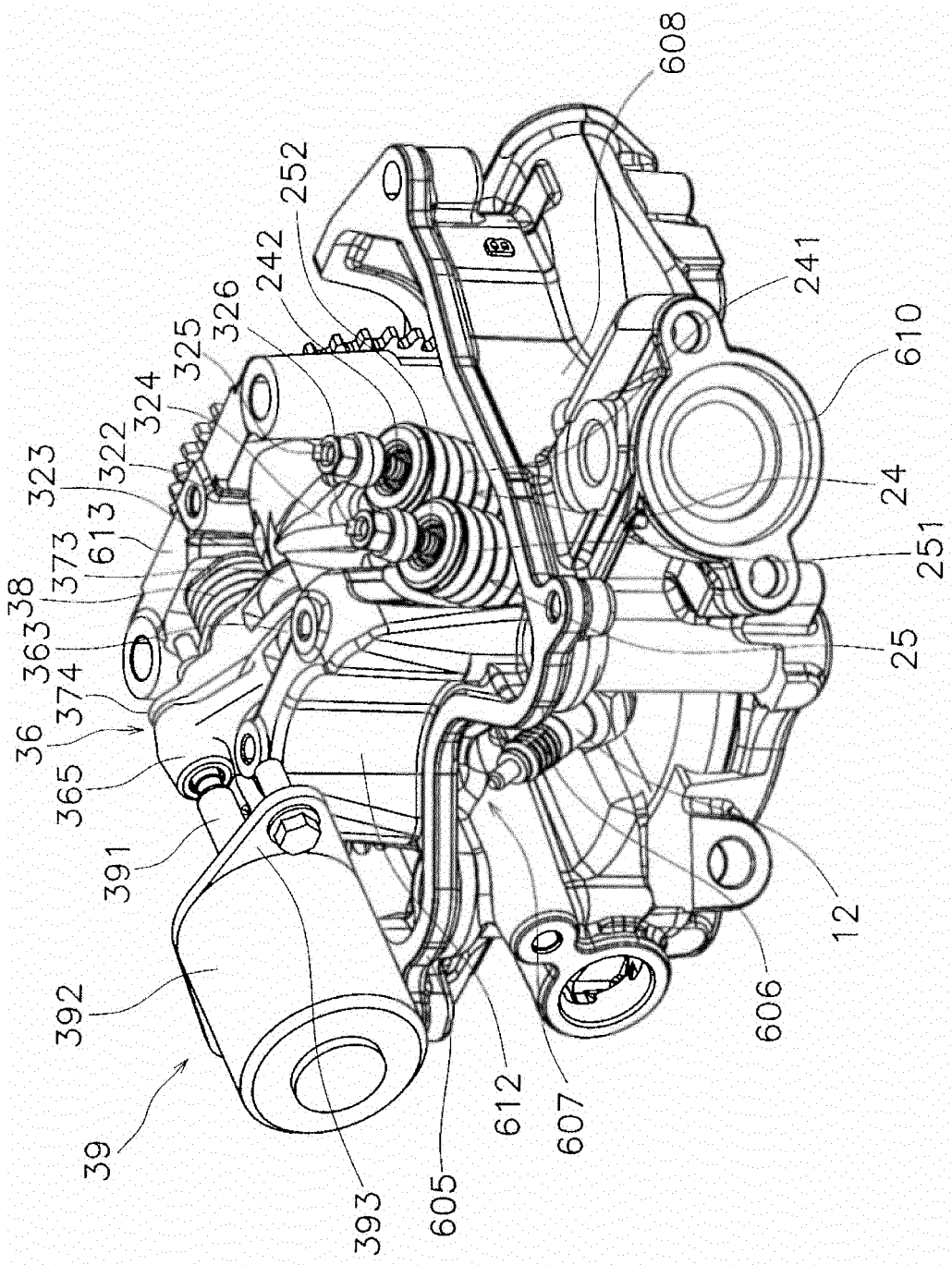

608
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242
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610
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613
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393

FIG. 5

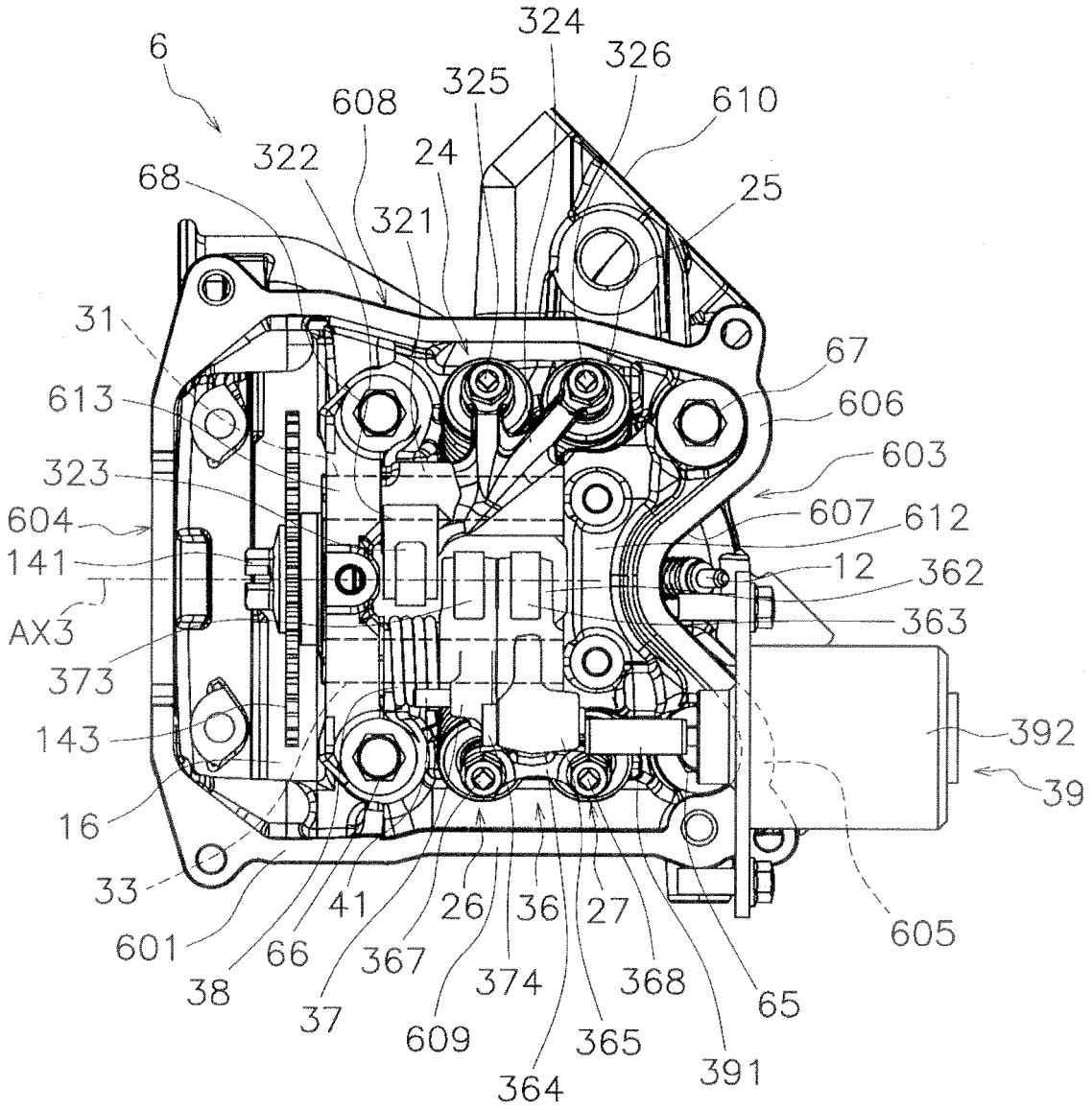

6
324
326
325
608
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68
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603
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604
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362
141
363
AX3
373
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143
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605
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FIG. 6

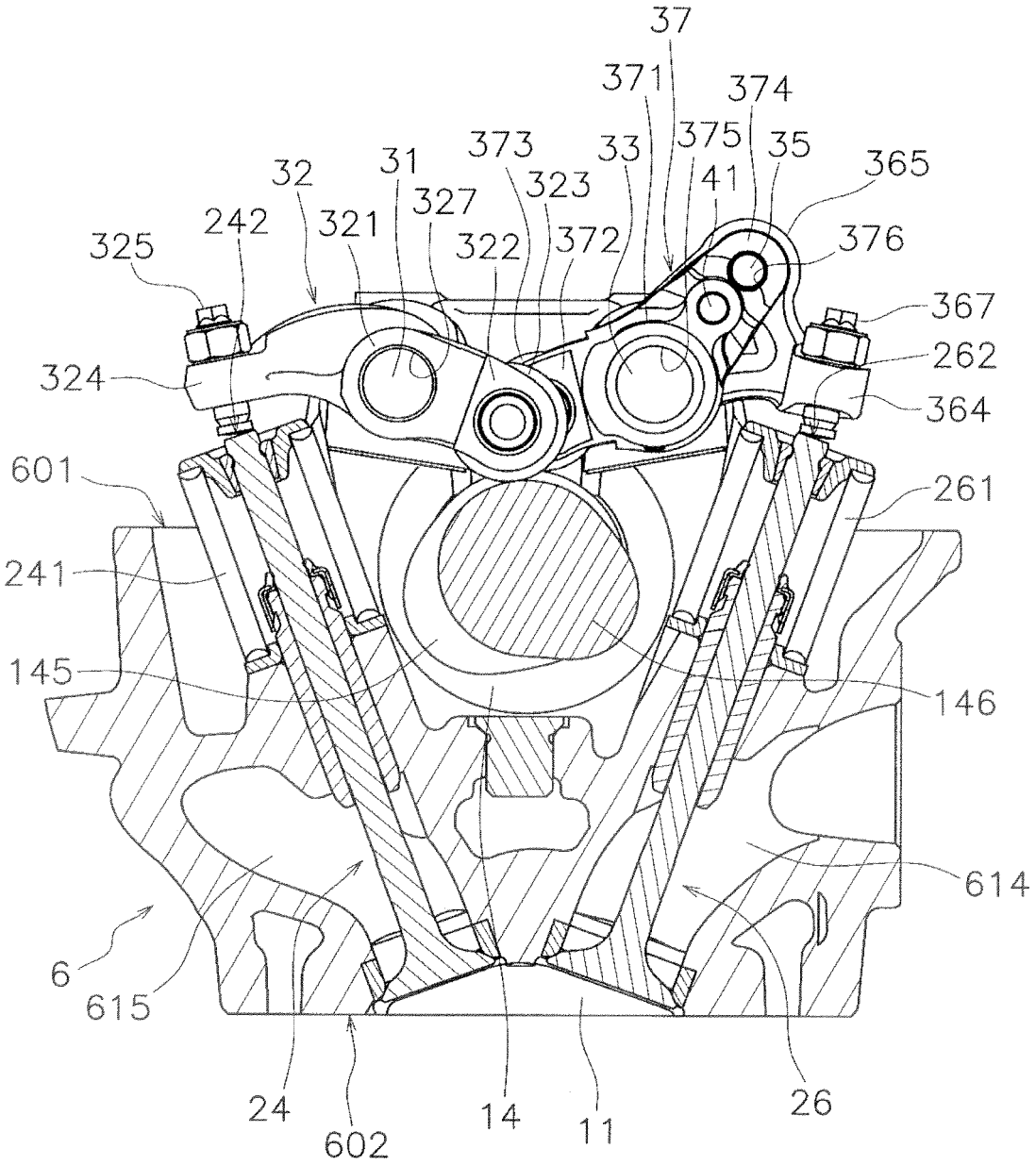

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601
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241
145
146
614
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615
24
602
14
11
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FIG. 7

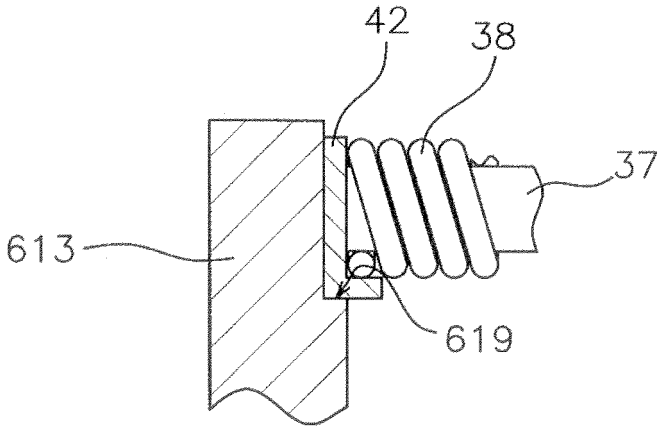


FIG. 8

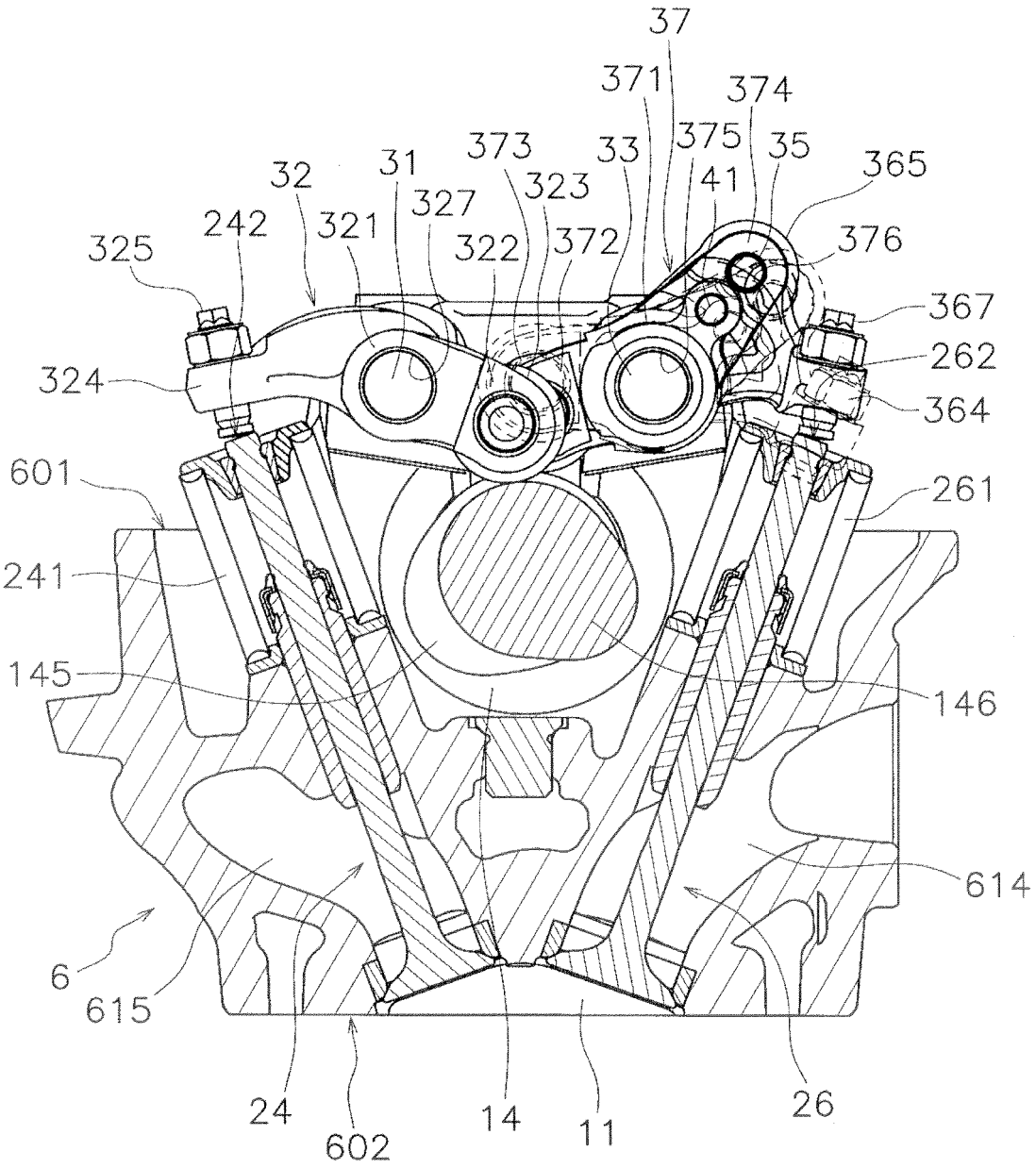

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145
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FIG. 9

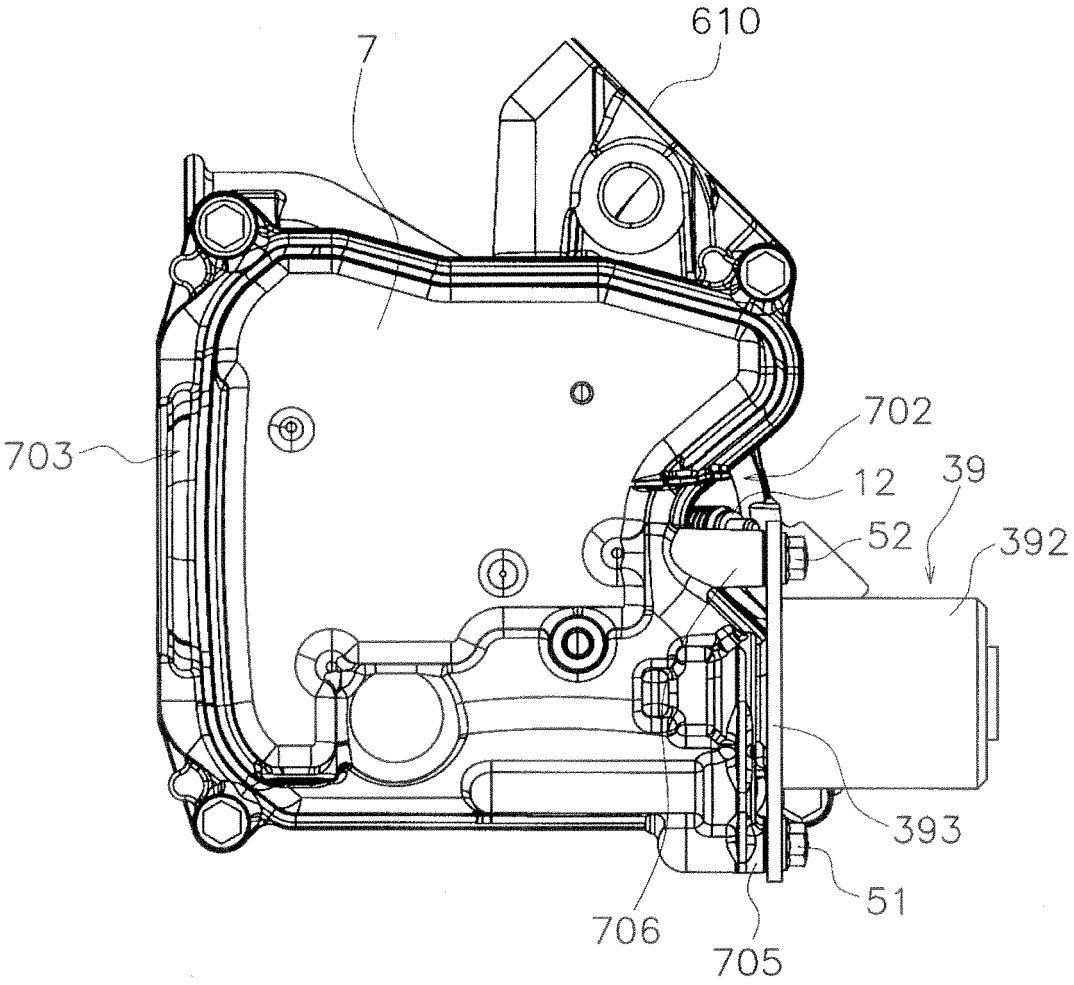


FIG. 10

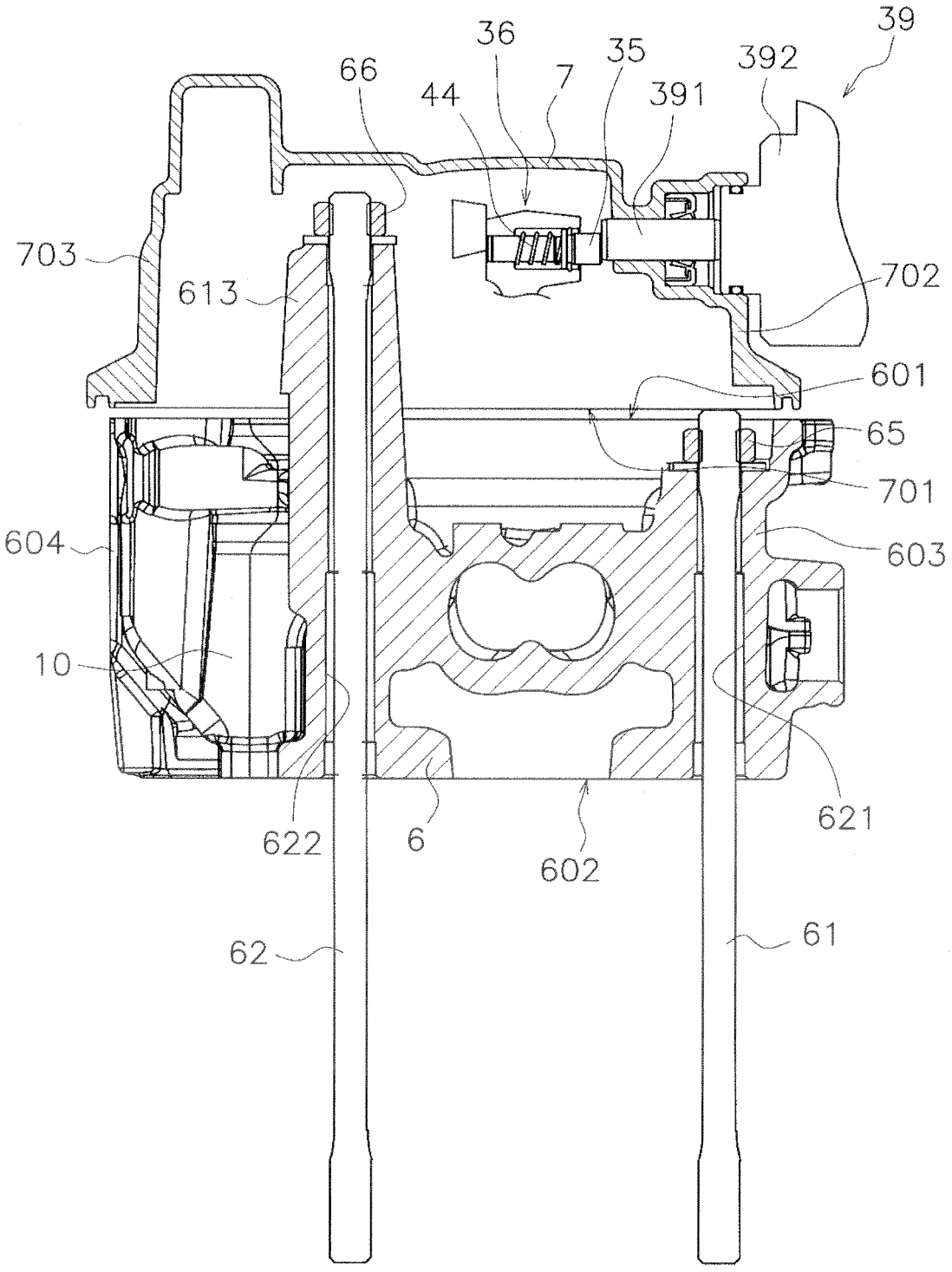

39
36
35
392
66
44
7
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703
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702
601
65
701
604
603
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621
622
6
602
62
61

FIG. 11

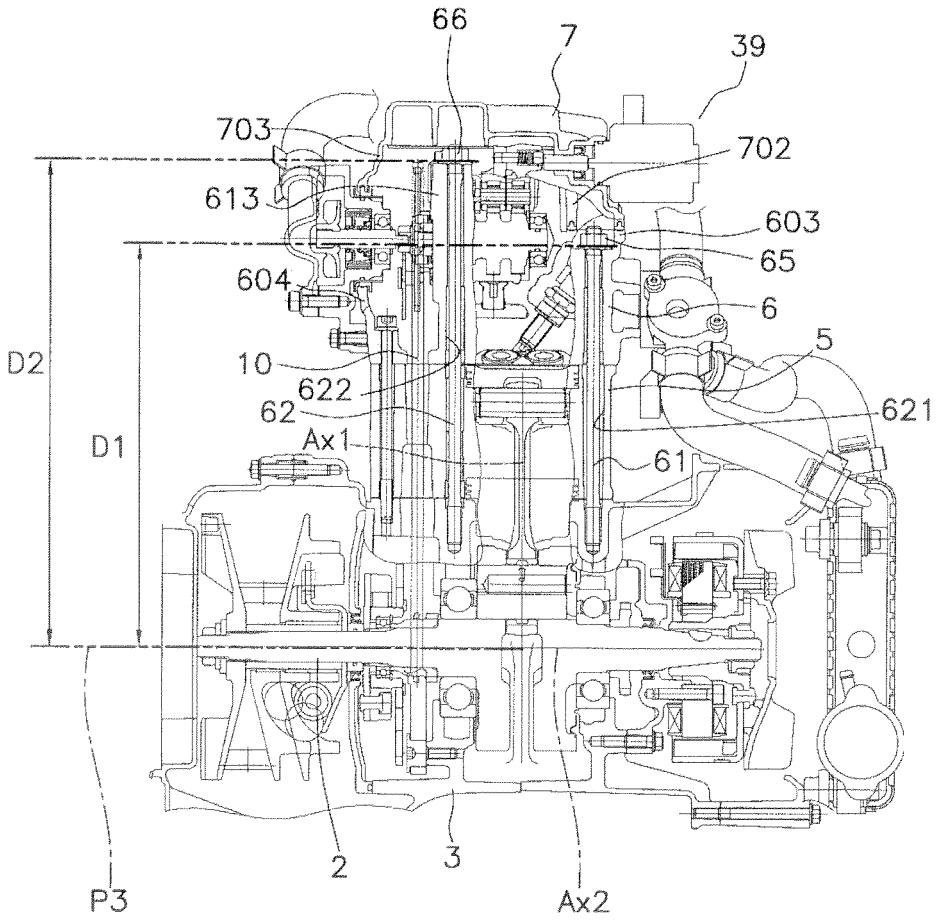

66
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39
703
702
613
603
65
604
6
5
10
622
621
62
Ax1
61
D2
D1
2
3
P3
Ax2

FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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