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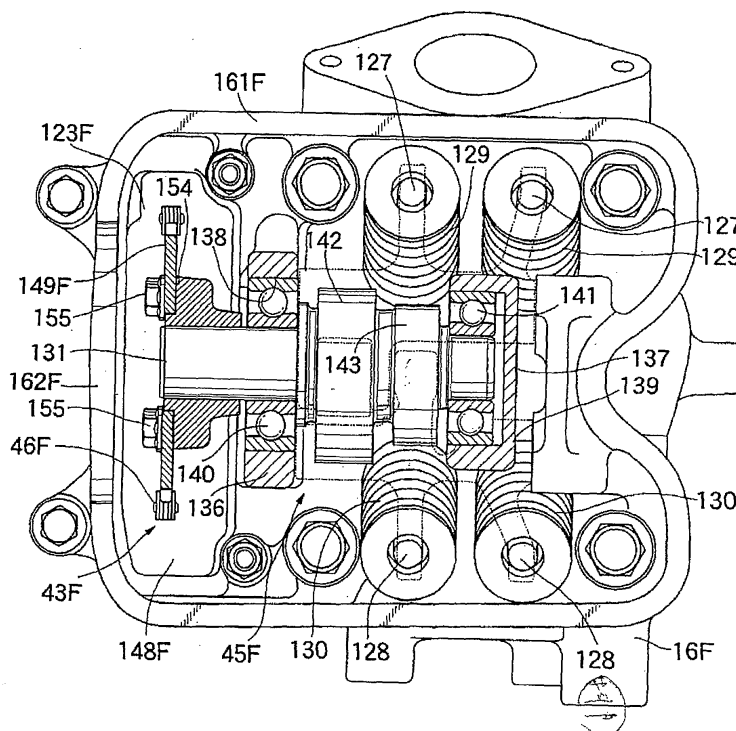
(54) **Overhead cam engine**

(57) To compact a combustion chamber and down-size a cylinder head (16F) in an overhead cam engine, wherein a cam shaft (131) is provided between intake and exhaust valve springs (129, 130) and is rotatably supported by the cylinder head (16F); and wherein the cam shaft (131) is provided with a first cam (142) to drive one of an intake valve (127) and an exhaust valve (128) and is provided with a second cam (143) to drive the other of the intake valve (127) and the exhaust valve

(128).

A cylinder head (16F) supports a cam shaft (131) with its axis line approximately disposed above a cylinder axis line. A second cam (143) is disposed between intake and exhaust valve springs (129, 130) and is formed to be smaller than a first cam (142). The first cam (142) is disposed farther from the position between the intake and exhaust valve springs (129, 130) along the direction of the axis line of the cam shaft (131).

FIG. 6



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Description

Industrial Field

[0001] The present invention relates to an overhead cam engine, wherein a cylinder head constituting part of an engine main unit is provided with an intake valve and an exhaust valve capable of being opened and closed freely; wherein the intake valve and the exhaust valve are supplied with forces by intake and exhaust valve springs toward a valve closing direction; wherein a cam shaft is provided between the intake and exhaust valve springs and is rotatably supported by the cylinder head; and wherein the cam shaft is provided with a first cam to drive one of the intake valve and the exhaust valve and is provided with a second cam to drive the other of the intake valve and the exhaust valve.

Prior Art

[0002] According to patent document JP-A No. 25861/1984, for example, there is already known an overhead cam engine in which a cam shaft is provided between intake and exhaust valves and near to one of the intake and exhaust valves away from the cylinder axis.

[0003] According to the above-mentioned prior art, however, a relatively large valve included angle is formed between axes of the intake and exhaust valves. This is disadvantageous to compacting a combustion chamber and may enlarge a cylinder head.

Summary of the Invention

[0004] The present invention has been made in consideration of the foregoing. It is therefore an object of the present invention to provide an overhead cam engine capable of compacting the combustion chamber and downsizing the cylinder head.

[0005] In order to achieve the above-mentioned object, the present invention according to claim 1 provides an overhead cam engine, wherein cylinder heads constituting part of an engine main unit are provided with an intake valve and an exhaust valve capable of being opened and closed freely; wherein the intake and exhaust valves are supplied with forces by coil type intake and exhaust valve springs toward a valve closing direction; wherein a cam shaft is provided between the intake valve spring and the exhaust valve spring and is rotatably supported by the cylinder heads; wherein the cam shaft is provided with a first cam to drive one of the intake valve and the exhaust valve and is provided with a second cam to drive the other of the intake valve and the exhaust valve; wherein the cylinder heads support the cam shaft with its axis line approximately disposed above cylinder axis lines; wherein a second cam is disposed between the intake and exhaust valve springs and is formed to be smaller than a first cam; and wherein

the first cam is disposed farther from a position between the intake and exhaust valve springs along the direction of the axis line of the cam shaft.

[0006] According to this constitution, it is possible to prevent the first and second cams and the intake and exhaust valve springs from interfering with each other. Further, it is possible to provide a relatively small valve included angle between the intake and exhaust valves. Moreover, the combustion chamber can be compacted for a higher compression ratio. Furthermore, it is possible to compact the valve trains including the cam shaft and to downsize the cylinder heads.

[0007] In addition to the constitution of the invention according to claim 1, the present invention according to claim 2 is characterized in that a pair of intake valves and a pair of exhaust valves are arranged on both sides of the cam shaft along the axis line thereof; and that these valves are provided on the cylinder heads so as to be capable of being opened and closed freely. According to this constitution, the combustion chamber can be compacted for a higher compression ratio in a 4-valve overhead cam engine. In addition, it is possible to compact the valve trains including the cam shaft and to downsize the cylinder heads.

[0008] In addition to the constitution of the invention according to claim 1 or 2, the present invention according to claim 3 is characterized in that an engine main unit including the cylinder head is mounted on a body frame in the rear of a small vehicle's front wheel; that the vehicle is positioned by sloping the cylinder axis line with the front raised and by keeping the axis line of the crankshaft horizontal; that a first rocker arm is driven by one of the first and second cams and is oscillatably supported by a first rocker shaft having an axis line parallel to the cam shaft; that a second rocker arm is driven by the other of the first and second cams and is oscillatably supported by a second rocker shaft which has an axis line parallel to the cam shaft and is disposed below the first rocker shaft; and that a distance between the second rocker shaft and the crankshaft 12 is set to be smaller than a distance between the first rocker shaft and the crankshaft. According to this constitution, the front bank makes it possible to minimize a distance between the crankshaft and the bottom of the front end though the cylinder axis line slopes with the front raised. The engine main unit can be positioned near the front wheel by avoiding interference with the front wheel, thus shortening the motorcycle's wheel base. Alternatively, it is possible to elongate a wheel stroke of the front wheel.

[0009] In addition to the constitution of the invention according to claim 3, the present invention according to claim 4 is characterized in that the first rocker arm axially supports the roller which rollingly contacts with the first cam; and that the second rocker arm is provided with a cam slipper that slidingly contacts with the second cam. According to this constitution, the second cam is disposed between the intake and exhaust valve springs and slidably contacts with the cam slipper that requires

a relatively small disposition space. It is possible to avoid a large valve included angle between the intake valve and the exhaust valve and to downsize the cylinder heads. The first cam is disposed so as to avoid the position between the intake and exhaust valve springs, and therefore has no effect on the valve included angle. The first cam slidably contacts with the roller that requires a relatively large disposition space, making it possible to decrease a friction loss in the valve trains.

[0010] In addition to the constitution of the invention according to claim 3 or 4, the present invention according to claim 5 is characterized in that the engine main unit is configured to be a V type engine comprising a front bank having the cylinder axis line slanting with the front raised and a rear bank having a cylinder axis line which crosses over the cylinder axis line in a V shape when viewed from the side. According to this constitution, the engine main unit of the V-type engine mounted on a small vehicle can be positioned near the front wheel by avoiding interference between the engine main unit's front cylinder head and the front wheel. Even when the engine main unit is positioned in this manner, it is possible to prevent the small vehicle's wheel base from being elongated and the front wheel's wheel stroke from being shortened. Furthermore, the engine main unit can be disposed as low as possible to ensure a space large enough to store the other parts above the engine main unit. It is possible to lower the height of an occupant seat.

Brief Description of the Drawings

[0011] An embodiment of the present invention will be described in further detail with reference to the accompanying drawings that represent an example of the present invention.

FIG. 1 is a side view of a motorcycle;
 FIG. 2 is a partially broken side view of a power unit viewed from the same direction as in FIG. 1;
 FIG. 3 is a cross sectional view taken along the line 3-3 of FIG. 2;
 FIG. 4 is a cross sectional view taken along the line 4-4 of FIG. 3;
 FIG. 5 is a cross sectional view taken along the line 5-5 of FIG. 4 viewed from arrows;
 FIG. 6 is equivalent to FIG. 5 with rocker arms omitted;
 FIG. 7 is a cross sectional view taken along the line 7-7 of FIG. 5 viewed from arrows;
 FIG. 8 is a cross sectional view taken along the line 8-8 of FIG. 5 viewed from arrows;
 FIG. 9 is a cross sectional view taken along the line 9-9 of FIG. 4 viewed from arrows;
 FIG. 10 is a cross sectional view taken along the line 10-10 of FIG. 4 viewed from arrows; and
 FIG. 11 shows FIG. 9 viewed from arrow 11.

Detailed Description of the Invention

[0012] FIGS. 1 through 11 show an example of the present invention.

[0013] FIG. 1 illustrates a motorcycle as an example of small vehicles. In FIG. 1, a body frame 11 of the motorcycle is mounted with a power unit P disposed between a front wheel WF and a rear wheel WR. The power unit P comprises a 4-cycle 2-cylinder engine E and a transmission system T that is provided between the engine E and an axle 18 of the rear wheel.

[0014] With reference to FIGS. 2 through 4, an engine main unit 13 of the engine E is a V-type engine comprising a crankcase 14, a front bank FB, and a rear bank RB. The crankcase 14 rotatably supports a crankshaft 12 having an axis line that extends horizontally with respect to the body frame 11. The front bank FB connects to the crankcase 14 by tilting a cylinder axis line CF with the front raised. The rear bank RB connects to the crankcase 14 by tilting the cylinder axis line CR with the rear raised so as to intersect with the cylinder axis line CF in a V-shaped manner when viewed from the side. Both banks FB and RB are configured like overhead valves.

[0015] The front bank FB comprises a front cylinder block 15F, a front cylinder head 16F, and a front head cover 17F. The front cylinder block 15F is connected to the crankcase 14. The front cylinder head 16F is connected to the front cylinder block 15F. The front head cover 17F is connected to the front cylinder head 16F at a side opposite the front cylinder block 15F. The rear bank RB comprises a rear cylinder block 15R, a rear cylinder head 16R, and a rear head cover 17R. The rear cylinder block 15R is connected to the crankcase 14. The rear cylinder head 16R is connected to the rear cylinder block 15R. The rear head cover 17R is connected to the rear cylinder head 16R at a side opposite the rear cylinder block 15R.

[0016] The crankcase 14 comprises a left case half 19 and a right case half 20 connected to each other. The left case half 19 is disposed to the left of the motorcycle when it is directed to a traveling direction. The right case half 20 is disposed to the right of the motorcycle when it is directed to a traveling direction. Both case halves 19 and 20 are coupled to each other on a coupling surface 21 parallel to the cylinder axis lines CF and CR of the front and rear banks FB and RB.

[0017] One end of the crankshaft 12 goes through a left crank journal section 22 in the left case half 19 and is rotatably supported by the crank journal section 22. The other end of the crankshaft 12 goes through a right crank journal section 23 in the right case half 20 and is rotatably supported by the crank journal section 23.

[0018] The crankshaft 12 has a first crank weight 24 disposed inside the left crank journal section 22 and a second crank weight 25 disposed inside the right crank journal section 23. A connecting rod 28F connects to a piston 27F slidably fit in a cylinder bore 26F provided for the front cylinder block 15F. A connecting rod 28R con-

nects to a piston 27R slidably fit in a cylinder bore 26R provided for the rear cylinder block 15R. A large end of the connecting rod 28F and a large end of the connecting rod 28R connect between the first and second crank weights 24 and 25 and are rotatably coupled to a crank pin 29 provided for the crankshaft 12.

[0019] The rear cylinder block 15R is disposed near one end of an axis line from the front cylinder block 15F to the crankshaft 12. The connecting rod 28F to the front cylinder block 15F is disposed near the second crank weight 25. The connecting rod 28R to the rear cylinder block 15R is disposed near the first crank weight 24. In this manner, the large ends of both connecting rods 28F and 28R are connected to a crank pin 29 between the first and second crank weights 24 and 25.

[0020] A dynamo 30 is attached to one end of the crankshaft 12 protruding from the left crank journal section 22. The dynamo 30 comprises a rotor 31 and a stator 32. The rotor 31 is fixed to one end of the crankshaft 12. The stator 32 is housed in the rotor 31. The dynamo 30 is covered with a left engine cover 33 that is coupled to the left case half 19 of the crankcase 14. The stator 32 is fixed to the left engine cover 33.

[0021] There is provided a driven gear 35 around the crankshaft 12 between the left crank journal section 22 and a dynamo 30. The driven gear 35 is connected to the rotor 31 of the dynamo 30 via a one-way clutch 34. A starter motor 36 has a rotation axis line parallel to the crankshaft 12. The starter motor 36 is supported over the crankcase 14 so as to be positioned between front and rear cylinder blocks 15F and 15R. An output shaft of the starter motor 36 is provided with a drive pinion 37. There are supported integrally molded first and second intermediate gears 38 and 39 and a third intermediate gear 40 between the left case half 19 of the crankcase 14 and the left engine cover 33 so as to be rotatable around an axis line parallel to the crankshaft 12. The drive pinion 37 engages with the first intermediate gear 38 having a larger diameter than that of the drive pinion 37. The second intermediate gear 39 has a smaller diameter than that of the first intermediate gear 38 and engages with the third intermediate gear 40. The third intermediate gear 40 has a larger diameter than that of the second intermediate gear 39 and engages with the driven gear 35.

[0022] When the engine E starts, operating the starter motor 36 decelerates a driving force from the starter motor 36. The driving force is then transmitted to the crankshaft 12. After the engine E starts, the one-way clutch 34 operates to prevent the power from the crankshaft 12 from being transmitted to the starter motor 36.

[0023] A pair of integrally molded drive sprockets 44F and 44R is fixed to the other end of the crankshaft 12 protruding from the right crank journal section 23. A cam chain 46F is looped around the drive sprocket 44F to drive a valve train 45F provided for the front cylinder head 16F. A cam chain 46R is looped around the drive sprocket 44R to drive a valve train 45R provided for the

front cylinder head 16R. In this manner, a right engine cover 47 covering the other end of the crankshaft 12 is connected to the right case half 20 of the crankcase 14.

[0024] In FIG. 1, an air cleaner 48 is disposed diagonally above the engine E toward the front and is mounted on the body frame 11. A fuel tank 49 is disposed above the air cleaner 48 and is mounted on the body frame 11. The air cleaner 48 is connected to the front and rear cylinder heads 16F and 16R via independent intake pipes 50F and 50R. Exhaust pipes 51F and 51R collect exhaust gas from the front and rear cylinder heads 16F and 16R and are commonly connected to an exhaust muffler 52 disposed at the right of the rear wheel WR.

[0025] The transmission system T comprises a belt-type continuously variable transmission 53, a speed reducing gear train 54, and a chain type transfer means 55. The continuously variable transmission 53 automatically and continuously shifts power output from the crankshaft 12. The speed reducing gear train 54 decelerates output from the continuously variable transmission 53. The chain type transfer means 55 is provided between the speed reducing gear train 54 and the axle 18 of the rear wheel WR.

[0026] The transmission case 56 of the transmission system T comprises a case body 57, a right case 58, and a left case 59. The case body 57 extends longitudinally so that the front is disposed to the right of the case support section 14a and the rear is disposed to the left of the rear wheel WR. In this case, the case support section 14a is molded integrally with the left and right case halves 19 and 20 of the crankcase 14. The right case 58 is connected to the case body 57 so as to cover the right side of the front half of the case body 57. The left case 59 is connected to the case body 57 so as to cover the left side of the rear half of the case body 57. The front of the case body 57 is tightened to the case support section 14a of the crankcase 14.

[0027] A transmission chamber 60 is formed between the front half of the case body 57 and the right case 58. A gear chamber 61 is formed between the rear half of the case body 57 and the left case 59.

[0028] The continuously variable transmission 53 is contained in the transmission chamber 60 and comprises a drive pulley shaft 62, a driven pulley shaft 63, a drive pulley 64, a driven pulley 65, and an endless V belt 66. The drive pulley shaft 62 is disposed in a plane orthogonal to the axis line of the crankshaft 12 and is positioned at a distance from the crankshaft 12. The drive pulley shaft 62 has an axis line parallel to the crankshaft 12. The driven pulley shaft 63 has an axis line parallel to the drive pulley shaft 62. The drive pulley 64 is attached to the drive pulley shaft 62. The driven pulley 65 is attached to the driven pulley shaft 63. The V belt 66 is looped around the drive pulley 64 and the driven pulley 65.

[0029] The drive pulley shaft 62 is disposed to the rear of the crankshaft 12. One end of the drive pulley shaft

62 is rotatably supported by one end bearing 67 provided in the left case half 19 of the crankshaft 14. The middle of the drive pulley shaft 62 is rotatably supported by an intermediate bearing 68 provided in the right case half 20 of the crankshaft 14. The other end of the drive pulley shaft 62 is rotatably supported by other end bearing 69 provided for the right case 58 in the transmission case 56. Further, the intermediate bearing 68 is provided in the right case half 20 of the crankshaft 14. The intermediate bearing 68 is shaped to partially match a rotation locus formed by an outside periphery of the second crank weight 25 in the crankshaft 12.

[0030] A transmission gear train 70 is provided between the crankshaft 12 and the drive pulley shaft 62 outside the first crank weight 24 and inside the left crank journal section 22. Accordingly, the dynamo 30 disposed outside the left crank journal section 22 is disposed outside the transmission gear train 70.

[0031] The transmission gear train 70 comprises a drive gear 71 fixed to the crankshaft 12 and a driven gear 72 that is fixed to the drive pulley shaft 62 and engages with the drive gear 71. An auxiliary gear 73 engages with the drive gear 71 and is attached to the drive pulley shaft 62 so as to be rotatable relatively to the drive gear 72. The auxiliary gear 73 is provided to suppress a noise due to backlash between the drive gear 71 and the driven gear 72 that engage with each other. A spring (not shown) is provided between the driven gear 72 and the auxiliary gear 73 to generate a spring force to relatively rotate both gears 72 and 73.

[0032] The one end bearing 67 is provided with a bearing hole 74 to allow one end of the drive pulley shaft 62 to rotatably pass through. A ball bearing 75 is provided between an external surface of the bearing hole 74 and an internal surface of the drive pulley shaft 62. The intermediate bearing 68 is provided with a bearing hole 76 coaxially with the bearing hole 74 so as to allow a middle section of the drive pulley shaft 62 along an axial direction to rotatably pass through. A ball bearing 77 and a circular seal member 78 are provided between the external surface of the bearing hole 76 and the internal surface of the drive pulley shaft 62. The other end bearing 69 is provided with a bottomed bearing hole 79 coaxially with the bearing holes 74 and 76 so as to allow the other end of the drive pulley shaft 62 to pass through. A ball bearing 80 is provided between the external surface of the bearing hole 79 and the internal surface of the drive pulley shaft 62.

[0033] In this manner, the drive pulley shaft 62 is supported on both sides of the transmission gear train 70, thus decreasing a load on the intermediate bearing 68. It becomes possible to downsize the intermediate bearing 68 and position the drive pulley shaft 62 nearer to the second crank weight 25. Consequently, it is possible to further reduce the longitudinal length of the power unit P and further shorten the wheel base.

[0034] The drive pulley 64 comprises a drive-side fixed pulley half 84 and a drive-side moving pulley half

85. The drive-side fixed pulley half 84 is fixed to the other end of the drive pulley shaft 62. The drive-side moving pulley half 85 is slidably supported by the drive pulley shaft 62 so as to be able to approach or leave the drive-side fixed pulley half 84. The drive pulley shaft 62 is disposed so that, when viewed from the side, the drive pulley 64 partially overlaps with a rotation locus formed by outside peripheries of the first and second crank weights 24 and 25 in the crankshaft 12.

[0035] A pulley drive means 86 drives the drive-side moving pulley half 85 along an axial direction. The pulley drive means 86 is disposed at a position corresponding to the drive sprockets 44F and 44R in a direction along the axis line of the crankshaft 12. Here, the cam chains 46F and 46R are looped around the drive sprockets 44F and 44R. Further, the pulley drive means 86 is disposed between the drive-side moving pulley half 85 and the intermediate bearing 68.

[0036] A cylindrical sleeve 87 is attached to surround the drive pulley shaft 62 between the inside of the ball bearing 77 and the drive-side fixed pulley half 84. The sleeve 87 slidably supports the drive-side moving pulley half 85 along an axial direction.

[0037] The pulley drive means 86 contains a screw shaft 88, a nut 89, a driven gear 90, a drive pinion 92, and a speed reducing gear mechanism. The screw shaft 88 is cylindrically formed to surround the sleeve 87 and is fixed to the case body 57 of the transmission case 56. The nut 89 is screwed to the screw shaft 88. The driven gear 90 is molded integrally with the outside periphery of the nut 89. The drive pinion 92 is provided to the output shaft of an electric motor 91 (see FIG. 2) supported by the case body 57 in the transmission case 56. The speed reducing gear mechanism 93 is provided between the drive pinion 92 and the driven gear 90 to decelerate rotary power of the electric motor 91 and transmit the power from the drive pinion 92 to the driven gear 90.

[0038] The pulley drive means 86 reciprocates the nut 89 along the axial direction of the drive pulley shaft 62 according to operation of the electric motor 91. The nut 89 is also coupled to the drive-side moving pulley half 85 via the ball bearing 94. The drive-side moving pulley half 85 slides along the axial direction of the drive pulley shaft 62 in accordance with the reciprocation of the nut 89.

[0039] When viewed from the side, the drive pulley shaft 62 is disposed at such a position where part of the drive pulley 64 overlaps with the dynamo 30. The intermediate part of the drive pulley shaft 62 is rotatably supported by the intermediate bearing 68 provided for the crankshaft 14. Part of the intermediate bearing 68 is so shaped as to follow a rotation locus formed by the outside peripheries of the first and second crank weights 24 and 25 provided for the crankshaft 12. The pulley drive means 86 slides the drive-side fixed pulley half 84 fixed to the drive pulley shaft 62 and the drive-side moving pulley half 85 constituting the drive pulley 64 along

the drive pulley shaft 63. The pulley drive means 86 is disposed at a position corresponding to the drive sprockets 44F and 44R along the axial direction of the crankshaft 12. Accordingly, the drive pulley 64 can be positioned close to the crankshaft 12 so that part of the drive pulley 64 overlaps with the dynamo 30 when viewed from the side. As a result, it is possible to reduce the longitudinal length of the power unit P and further shorten the wheel base.

[0040] One end of the driven pulley shaft 63 rotatably passes through the case body 57 and is inserted into the gear chamber 61. A ball bearing 95 is provided between the case body 57 and the driven pulley shaft 63. The other end of the driven pulley shaft 63 is rotatably supported by the right case 58 via a ball bearing 96.

[0041] The driven pulley 65 comprises a driven-side fixed pulley half 97 and a driven-side moving pulley half 98. The driven-side fixed pulley half 97 is supported by the driven pulley shaft 63 to be capable of relative rotation by keeping a specified position along the axis line direction. The driven-side moving pulley half 98 can approach or leave the driven-side fixed pulley half 97 and is supported by the driven-side fixed pulley half 97 to be capable of sliding and relative rotation. Further, the driven-side moving pulley half 98 is supplied with a spring force toward the driven-side fixed pulley half 97.

[0042] The driven-side fixed pulley half 97 is integrally provided with a cylindrical guide section 97a that coaxially surrounds the driven pulley shaft 63 to be capable of relative rotation. The driven-side moving pulley half 98 faces toward the driven-side fixed pulley half 97 from the right case 58 in the transmission case 56 and is slidably supported by the guide section 97a. A spring retainer 99 is fixed to an end of the guide section 97a on the side of the right case 58. A spring 100 is provided between the spring retainer 99 and the driven-side moving pulley half 98 to press the driven-side moving pulley half 98 against the driven-side fixed pulley half 97.

[0043] A centrifugal clutch 101 is provided between the guide section 97a of the driven-side fixed pulley half 97. When the driven-side fixed pulley half 97 rotates around the axis line of the driven pulley shaft 63 at a revolution speed higher than a specified value, the rotary power of the driven pulley 65 is transmitted to the driven pulley shaft 63.

[0044] The gear chamber 61 contains the speed reducing gear train 54. The speed reducing gear train 54 is configured so that a rotary power from one end of the driven pulley shaft 63 is reduced and is transmitted to the output shaft 103 via an intermediate shaft 102. The intermediate shaft 102 and the output shaft 103 are rotatably supported by the case body 57 and the left case 59. One end of the output shaft 103 protrudes from the left case 59.

[0045] The chain type transfer means 55 comprises a drive sprocket 105 and a driven sprocket 106. An endless chain 107 is looped around both sprockets. The drive sprocket 105 is fixed to a drive axle 104 that is

coaxially coupled to the output shaft 103 so as to be incapable of relative rotation. The driven sprocket 106 is fixed to the axle 18 of the rear wheel WR. The chain type transfer means 55 is contained in a chain case 108 on the left of the rear wheel WR.

[0046] A cylindrical support shaft 109 surrounds a projection of the output shaft 103 from the left case 59 and is tightened to the left case 59. The left case 59 oscillatably supports a front part of the chain case 108 via a radial bearing 110. A chain case 107 rotatably supports the drive axle 104 via ball bearings 111.

[0047] The case body 57 of the transmission case 56 oscillatably supports a mobile shaft 112 coaxial with the output shaft 103 and the drive axle 104 via a radial bearing 113. An arm 114 is disposed to the right of the rear wheel WR and extends longitudinally. The front part of the arm 114 is fixed to the mobile shaft 112. In this manner, the axle 18 of the rear wheel WR is rotatably supported between the rear of the chain case 108 and the rear of the arm 114.

[0048] In the driven pulley 65 of the belt-type continuously variable transmission 53, the driven-side moving pulley half 98 faces to the driven-side fixed pulley half 97 viewed from the outside. The driven-side moving pulley half 98 approaches and leaves the driven-side fixed pulley half 97. The right case 58 forms an outside face of the transmission case 56. The rear of the right case 58 rises outward compared to the front. That is to say, the right case 58 has a lower section 58a and a higher section 58b formed thereon. The lower section 58a covers the drive pulley 64. The higher section 58b rises outside from the lower section 58a so as to cover the driven pulley 65 and continues to the rear of the lower section 58a.

[0049] Around the drive pulley shaft 62, the lower section 58a is provided with a plurality of through-holes 115 leading to the transmission chamber 60. A plurality of vanes 84a is molded integrally with the drive-side fixed pulley half 84 in the drive pulley 64 to supply air from the plurality of through-holes 115 into the transmission chamber 60. That is to say, the drive-side fixed pulley half 84 also functions as a fan.

[0050] The right case 58 of the transmission case 56 is attached with an air intake cover 116 to cover the lower section 58a. An air intake channel 117 is formed between the air intake cover 116 and the lower section 58a. The air intake channel 117 leads to each of the through-holes 115 and opens to a front end of the higher section 58b.

[0051] An arcwise air exhaust channel 118 is formed inside a front part of the higher section 58b correspondingly to an aperture end of the air intake channel 117. The air exhaust channel 118 leads to an inside of the transmission chamber 60. The air exhaust channel 118 opens downward at the rear of the air intake channel 117.

[0052] The drive-side fixed pulley half 84 rotates to supply air from the air intake channel 117 to the trans-

mission chamber 60 via the through-holes 115. The supplied air cools the continuously variable transmission 53. After the cooling, the air is exhausted from the transmission chamber 60, to the air exhaust channel 118, then to the outside of the transmission case 56.

[0053] The crankcase 14 contains a crankcase 124 and an oil reservoir 125 separated from each other by a partition 14b provided for the crankcase 14. The crankcase 124 contains a large part of the crankshaft 12 and one end of the drive pulley shaft 62. The oil reservoir 125 is disposed to the rear of the crankshaft 12. The oil reservoir 125 extends to the left of the drive pulley shaft 62 so as to be formed to continue to the inside of the left engine cover 33.

[0054] In this manner, a feed pump (not shown) supplies oil in the oil reservoir 125 to lubrication parts in the engine E. When the oil returns to the crankcase 124 after lubrication, a return pump (not shown) returns the oil to the oil reservoir 125.

[0055] As shown in FIGS. 5 through 9, the front cylinder head 16F of the front bank FB is provided with a pair of intake valves 127 against the top of the piston 27F along the axis line of the crankshaft 12 so as to be capable of being opened and closed freely. The intake valves 127 control intake gas from the intake pipe 50F to the combustion chamber 126 formed between the front cylinder block 15F and the front cylinder head 16F. A pair of exhaust valves 128 are provided parallel to the intake valves 127 so as to be capable of being opened and closed freely. The exhaust valves 128 control exhaust gas from the combustion chamber 126 to the exhaust pipe 51F. Coil-type intake valve springs 129 are provided between both intake valves 127 and the cylinder head 16F, and apply force to the intake valves 127 along a direction to close these valves. Coil-type exhaust valve spring 130 are provided between both exhaust valves 128 and the cylinder head 16F, and apply force to the exhaust valves 128 along a direction to close these valves.

[0056] The valve train 45F opens and closes both intake valves 127 and both exhaust valves 128. The valve train 45F is contained in a valve chamber 123F formed between the front cylinder head 16F and the front head cover 17F. A timing transmission system 43F halves to decelerate rotary power from the crankshaft 12. This power is applied to the valve train 45F to drive it rotatively. The valve train 45F comprises a cam shaft 131, first and second rocker shafts 132 and 133, and first and second rocker arms 134 and 135. The cam shaft 131 is rotatably supported by the front cylinder head 16F. The first and second rocker shafts 132 and 133 have axis lines parallel to the cam shaft 131 and are supported by the front cylinder head 16F. The first and second rocker shafts 132 and 133 oscillatably support the first and second rocker arms 134 and 135.

[0057] The cam shaft 131 is disposed so that its axis line approximately is positioned above the cylinder axis line CF. The cam shaft 131 is rotatably supported by the

front cylinder head 16F between the intake valve springs 129 and the exhaust valve springs 130. The front cylinder head 16F is integrally provided with a plurality of, e. g., a pair of support sections 136 and 137 axially along the cam shaft 131 at a specified interval. The support sections 136 and 137 are respectively provided with bearing holes 138 and 139 to rotatably support the cam shaft 131. In this manner, the support section 136 has a ball bearing 140 inserted between an external surface of the bearing hole 138 and an outside periphery of the cam shaft 131. The support section 137 has a ball bearing 141 inserted between an external surface of the bearing hole 139 and an outside periphery of the cam shaft 131.

[0058] Between both support sections 136 and 137, the cam shaft 131 is integrally provided with a first cam 142 and a second cam 143. The first cam 142 drives one set of intake valves 127 or exhaust valves 128. In the embodiment, the first cam 142 drives a set of intake valves 127. The second cam 143 drives the other set of intake valves 127 or exhaust valves 128. In the embodiment, the second cam 143 drives a set of exhaust valves 128. The second cam 143 is smaller than the first cam 142. The second cam 143 is disposed between a set of intake and exhaust valve springs 129 and 130 arranged at one side (the left side in FIGS. 5 and 6) along the axis line of the cam shaft 131. The first cam 142 is disposed farther from the set of intake and exhaust valve springs 129 and 130 to that side along the axis line.

[0059] Viewed from the direction along the cylinder axis line CF, the first and second rocker shafts 132 and 133 are supported by the front cylinder head 16F at a position where both rocker shafts catch the cam shaft 131 vertically. The second rocker shaft 133 is disposed below the first rocker shaft 132. A distance between the second rocker shaft 133 and the crankshaft 12 is smaller than a distance between the first rocker shaft 132 and the crankshaft 12. That is to say, the second rocker shaft 133 is nearer to the crankshaft 12 than the first rocker shaft 132 by distance ΔL .

[0060] The first rocker shaft 132 oscillatably supports a first rocker arm 134 having contact arms 134a and 134b that respectively contact with a pair of intake valves 127. The first rocker arm 134 axially supports a roller 144 via a roller bearing 145. The roller 144 rollingly contacts with the first cam 142 of the cam shaft 131. The second rocker shaft 134 oscillatably supports a second rocker arm 135 having contact arms 135a and 135b that respectively contact with a pair of intake valves 128. The second rocker arm 135 is provided with a cam slipper 146 that slidingly contacts with the second cam 143 of the cam shaft 131.

[0061] The timing transmission system 43F is contained in a cam chain chamber 148F that is formed from the crankcase 14 to the front cylinder block 15F, the front cylinder head 16F, and the front head cover 17F. The timing transmission system 43F comprises a drive sprocket 44F, a driven sprocket 149F, a cam chain 46F,

an arched chain tensioner 150F, a known tensioner lifter 151F, and a chain guide 152F. The drive sprocket 44F is fixed to the crankshaft 12. The driven sprocket 149F is fixed to one end of the cam shaft 131 protruding from the support section 136 in the cylinder head 16F. The cam chain 46F is looped around the drive sprocket 44F and the driven sprocket 149F. The chain tensioner 150F slidably contacts with the cam chain 46F to supply a given strain to a loose side of the cam chain 46F. The tensioner lifter 151F is mounted on the front cylinder block 15F to press the center of the chain tensioner 150F along a longitudinal direction with a given load. The chain guide 152F is mounted on the front cylinder block 15F so as to slidably contact with a tense side of the cam chain 46F.

[0062] The crankshaft 12 rotates in a direction indicated by an arrow 153 in FIG. 4. In the timing transmission system 43F, the cam chain 46F protrudes from the cylinder axis line CF toward the front. That is to say, the cylinder axis line CF slopes with the front raised. The loose side is formed below the cylinder axis line CF. The chain tensioner 150F and the tensioner lifter 151F are also positioned toward the front from the cylinder axis line CF.

[0063] The driven sprocket 149F is fastened to a support member 154 with a plurality of, e.g., a pair of bolts 155. Press fitting or the like is used to fix the support member 154 to one end of the cam shaft 131 protruding from the support section 136 in the front cylinder head 16F.

[0064] In FIG. 10, the valve train 45R at the rear bank RB is contained in a valve chamber 123R formed between the rear cylinder head 16R and the rear head cover 17R. The valve train 45R is configured similarly to the valve train 45F at the front bank FB and comprises the cam shaft 131, the first and second rocker shafts 132 and 133, and the first and second rocker arms 134 and 135. A timing transmission system 43R halves to decelerate rotary power from the crankshaft 12. The cam shaft 131 is rotatively driven by this rotary power and is rotatably supported by the rear cylinder head 16R. The first and second rocker shafts 132 and 133 have axis lines parallel to the cam shaft 131 and are supported by the rear cylinder head 16R. The first and second rocker arms 134 and 135 are oscillatably supported by the first and second rocker shafts 132 and 133 respectively.

[0065] Therefore, the configuration of the valve train 45R is only illustrated here by assigning the same reference numerals to the same parts or components as for the valve train 45F at the front bank FB. A detailed description is omitted for simplicity.

[0066] Paying particular attention to FIG. 4, the timing transmission system 43R is contained in a cam chain chamber 148R formed from the crankcase 14 to the rear cylinder block 15R, the rear cylinder head 16R, and the rear head cover 17R. The timing transmission system 43R comprises a drive sprocket 44R, a driven sprocket 149R, the cam chain 46R, an arched chain tensioner

150R, a known tensioner lifter 151R, and a chain guide 152R. The drive sprocket 44R is fixed to the crankshaft 12. The driven sprocket 149R is fixed to one end of the cam shaft 131. The cam chain 46R is looped around the drive sprocket 44R and the driven sprocket 149R. The chain tensioner 150R slidably contacts with the cam chain 46R to supply a given strain to a loose side of the cam chain 46R. The tensioner lifter 151R is mounted on the front cylinder block 15R to press the center of the chain tensioner 150R along a longitudinal direction with a given load. The chain guide 152R is mounted on the front cylinder block 15R so as to slidably contact with a tense side of the cam chain 46R.

[0067] The crankshaft 12 rotates in the direction indicated by the arrow 153. At this time, the cam chain 46R of the timing transmission system 43R forms the loose side toward the front from the cylinder axis line CR of the rear bank RB. That is to say, the cylinder axis line CR slopes with the rear raised. The chain tensioner 150R and the tensioner lifter 151R are also positioned toward the front from the cylinder axis line CR.

[0068] The driven sprocket 149R is fastened to a cam pulser 156 with a pair of bolts 157, for example. Press fitting or the like is used to fix the cam pulser 156 to one end of the cam shaft 131. The cam pulser 156 is provided with three protrusions 156a at intervals along the peripheral direction. The protrusions 156a are radially formed toward the outside. A compression top dead center detecting sensor 158 is attached to the rear cylinder head 16R to detect a compression top dead center of the piston 27R by detecting the protrusions 156a.

[0069] For detection of compression top dead centers, the compression top dead center is first detected for the reference cylinder, i.e., the rear bank RB in the embodiment. Then, a crank angle sensor (not shown) is used to determine a phase of the other cylinder, i.e., the front bank FB in the embodiment. Thus, the compression top dead center can be detected for the front bank FB. If the cam pulser has a single protrusion, a signal disturbed by noise makes it impossible to determine the compression top dead center for one revolution of the cam shaft 131. To solve this problem, the cam pulser 156 is provided with three protrusions 156a as mentioned above to be able to restore to the normal state through a half revolution of the cam shaft 131 (one revolution of the crankshaft 12).

[0070] In the front bank FB and the rear bank RB, ignition plugs 158 are attached to the cylinder heads 16F and 16R so that the plug tips are inserted into the combustion chamber 126. The cam shaft 131 is provided between the intake valve 127 and the exhaust valve 128. Here, let us consider a projection drawing on a plane (that shown in FIG. 9) parallel to the axis line of the cam shaft 131 including the cylinder axis lines CF and CR. On such projection drawing, the ignition plugs 158 are attached to the cylinder heads 16F and 16R at an angle from the side. In this case, the axis line of the ignition plug 158 should cross over an elongation of the

axis line of the cam shaft 131 toward the side opposite the driven sprockets 149F and 149R.

[0071] There are provided inward concave portions 159 for installing the ignition plugs 158 on the side opposite the cam chain chambers 148F and 148R with reference to the cylinder axis lines CF and CR and on an outside surface of the cylinder heads 16F and 16R toward head covers 17F and 17R. The ignition plugs 158 are screwed into installation holes 160 provided for the cylinder heads 16F and 16R so that the ignition plugs 158 are directed toward the combustion chambers 126.

[0072] Such structure for installing the ignition plugs 158 must prevent a tool for installing the ignition plugs 158 on the cylinder heads 16F and 16R from interfering with a joint between the cylinder head 16F and 16R and the head covers 17F and 17R. To join the head covers 17F and 17R from this viewpoint, the cylinder heads 16F and 16R are provided with head cover coupling surfaces 161F and 161R. The head cover coupling surfaces 161F and 161R are formed as inclined planes that slantwise cross over planes orthogonal to the cylinder axis lines CF and CR. According to this structure, a distance between the head cover coupling surface 161F or 161R and the cylinder block 15F or 15R gradually decreases along the axis line of the cam shaft 131 toward the driven sprockets 149F and 149R.

[0073] The cam shaft 131 is molded integrally with the first and second cams 142 and 143. The ball bearings 140 and 141 are provided between the cam shaft 131 and the support sections 136 and 137. With this state, the cam shaft 131 is assembled so as to press-fit outer races of the ball bearings 140 and 141 into the bearing holes 138 and 139 in the support sections 136 and 137. As shown in FIG. 11, semicircular concave portions 162F and 162R are provided on sidewalls of the cylinder heads 16F and 16R opposite to the ignition plugs 158 so that both ends of the concave portions continue to the head cover coupling surfaces 161F and 161R. The concave portions 162F and 162R enable the cam shaft 131 to be inserted and fit into the bearing holes 138 and 139.

[0074] The head covers 17F and 17R are coupled to the cylinder heads 16F and 16R through intermediation of gaskets 164 between a set of the head covers 17F and 17R and a set of the head cover coupling surfaces 161F and 161R. The head covers 17F and 17R are integrally provided with semicircular lids 163 to close the concave portions 162F and 162R when the head covers 17F and 17R are coupled to the cylinder heads 16F and 16R.

[0075] The cam shaft 131 has the first and second cams 142 and 143 of which the first cam 142 is larger than the other. When the cam shaft 131 is fit into the bearing holes 138 and 139 of the support sections 136 and 137, the first cam 142 passes through the bearing hole 138 of the support section 136. For this purpose, the bearing hole 138 is not completely circular but is partially enlarged outward to allow the higher section 142a

of the first cam 142 to pass through.

[0076] The following describes working of the embodiment. The cam shaft 131 is provided with the first and second cams 142 and 143 in the valve trains 45F and 45R of the front and rear banks FB and RB for the V-type engine E. The cam shaft 131 is supported by the cylinder heads 16F and 16R so that the axis line of the cam shaft 131 is almost positioned above the cylinder axis lines CF and CR. The second cam 143 is disposed between the intake and exhaust valve springs 129 and 130 and is so shaped to be smaller than the first cam 142. The first cam 142 is disposed farther from the position between the intake and exhaust valve springs 129 and 130 along the direction of the axis line of the cam shaft 131.

[0077] Therefore, it is possible to prevent the first and second cams 142 and 143 and the intake and exhaust valve springs 129 and 130 from interfering with each other. Further, it is possible to provide a relatively small valve included angle between the intake valve 127 and the exhaust valve 128. Moreover, the combustion chamber 126 can be compacted for a higher compression ratio. Furthermore, it is possible to compact the valve trains 45F and 45R including the cam shaft 131 and to downsize the cylinder heads 16F and 16R.

[0078] A pair of intake valves 127 and a pair of exhaust valves 128 are arranged on both sides of the cam shaft 131 along the axis line thereof. These valves are provided on the cylinder heads 16F and 16R in the front and rear banks FB and RB so as to be capable of being opened and closed freely. Therefore, the combustion chamber 126 can be compacted for a higher compression ratio in a 4-valve overhead cam engine. In addition, it is possible to compact the valve trains 45F and 45R including the cam shaft 131 and to downsize the cylinder heads 16F and 16R.

[0079] The engine main unit 13 is mounted on the body frame 11 in the rear of the front wheel WF of the motorcycle that is positioned with the axis line of the crankshaft 12 kept to be horizontal. In the front bank FB of the engine main unit 13, the first rocker arm 134 is driven by the first cam 142 and is oscillatably supported by the first rocker shaft 132 having the axis line parallel to the cam shaft 131. The second rocker arm 135 is driven by the second cam 143 and has the axis line parallel to the cam shaft 131. The second rocker arm 135 is oscillatably supported by the second rocker shaft 133 disposed below the first rocker shaft 132. A distance between the second rocker shaft 133 and the crankshaft 12 is set to be smaller than a distance between the first rocker shaft 132 and the crankshaft 12.

[0080] Though the cylinder axis line CF slopes with the front raised, the front bank FB makes it possible to minimize a distance between the crankshaft 12 and the bottom of the front end of the engine main unit 13. The engine main unit 13 can be positioned near the front wheel WF by avoiding interference with the front wheel WF, thus shortening the motorcycle's wheel base. Alter-

natively, it is possible to elongate a wheel stroke of the front wheel WF.

[0081] Since the engine E is of V type, the front cylinder head 16F can be positioned near the front wheel WF by avoiding interference with the front wheel WF. The engine main unit 13 can be disposed as low as possible to ensure a space large enough to store the other parts above the engine main unit 13. It is possible to lower the height of an occupant seat.

[0082] The first rocker arm 134 axially supports the roller 144 that rollingly contacts with the first cam 142. The second rocker arm 135 is provided with the cam slipper 146 that slidingly contacts with the second cam 143. The second cam 143 is disposed between the intake and exhaust valve springs 129 and 130 and slidably contacts with the cam slipper 146 that requires a relatively small disposition space. It is possible to avoid a large valve included angle between the intake valve 127 and the exhaust valve 128 and to downsize the cylinder heads 16F and 16R. The first cam 142 is disposed so as to avoid the position between the intake and exhaust valve springs 129 and 130, and therefore has no effect on the valve included angle. The first cam 142 slidably contacts with the roller 144 that requires a relatively large disposition space, making it possible to decrease a friction loss in the valve trains 45F and 45R.

[0083] The rear bank RB has the cylinder axis line CR slanted with the rear raised. In the rear bank RB, the timing transmission system 43R having the chain tensioner 150R is provided between the crankshaft 12 and the cam shaft 131. The transmission 53 shifts power from the crankshaft 12 and transmits it to the rear wheel WR. The transmission case 56 of the transmission 53 is extended toward the rear. The chain tensioner 150R is disposed toward the front from the cylinder axis line CR.

[0084] Accordingly, the rear cylinder block 15R is prevented from expanding toward the rear due to the disposition of the chain tensioner 150R. Even if an angle of gradient is increased for the cylinder axis line CR, the capacity of the transmission case 56 is prevented from being decreased. In addition, it is possible to prevent the rear cylinder block 15R from interfering the transmission case 56 and to lower the height of the engine E.

[0085] The V-type engine E is configured to comprise the front bank FB having the sloped cylinder axis line CF with the front raised and the rear bank RB having the sloped cylinder axis line CR with the rear raised. The V-type engine E can be relatively largely inclined to the rear to lower the height of the engine E.

[0086] The front bank FB has the front cylinder head 16F. The rear bank RB has the rear cylinder head 16R. The exhaust pipes 51F and 51R are connected to the bottom of the side wall of the front cylinder head 16F and to the rear of the side wall of the rear cylinder head 16R, respectively. It is possible to conveniently manipulate the exhaust pipe 51F of the front bank FB in a space formed below the front bank FB in the V-type en-

gine E that is relatively largely inclined to the rear. Further, it is possible to prevent the exhaust pipe 51F from protruding downward from the power unit P and to easily ensure the minimum road clearance. The rear bank RB is free from protrusion of the part related to the chain tensioner 150R, i.e., the tensioner lifter 151R from the rear bank RB to the rear. It is possible to easily lay out the exhaust pipe 151R for the rear bank RB with no consideration for preventive measures against interference with that part.

[0087] The front and rear banks FB and RB contain the valve trains 45F and 45R in which the driven sprockets 149F and 149R are fixed to one end of the cam shaft 131. The ignition plugs 158 are attached to the front and rear cylinder heads 16F and 16R. In this case, the axis line of the ignition plug 158 should cross over an elongation of the axis line of the cam shaft 131 toward the side opposite the driven sprockets 149F and 149R. The cylinder heads 16F and 16R are provided with head cover coupling surfaces 161F and 161R to join the head covers 17F and 17R. The head cover coupling surfaces 161F and 161R are formed as inclined planes that slantwise cross over planes orthogonal to the cylinder axis lines CF and CR. According to this structure, a distance between the head cover coupling surface 161F or 161R and the cylinder block 15F or 15R gradually decreases along the axis line of the cam shaft 131 toward the driven sprockets 149F and 149R.

[0088] In this manner, the head cover coupling surface 161F and 161R slope so as to approach the cylinder blocks along the axis line of the cam shaft 131 toward the driven sprockets 149F and 149R. At portions corresponding to the ignition plugs 158, the head cover coupling surfaces 161F and 161R are positioned farthest from the cylinder blocks 15F and 15R. Even if the ignition plug 158 is straight installed toward the center of the combustion chamber 126, an ignition plug tool can be prevented from interfering with the joint between the cylinder heads 16F and 16R and the head covers 17F and 17R. It is possible to not only prevent the rigidity from degrading due to expansion of the cylinder heads 16F and 16R and miniaturization of the head covers 17F and 17R, but also increase the degree of freedom for installing the ignition plugs 158.

[0089] Further, the front and rear cylinder heads 16F and 16R are integrally provided with a pair of support sections 136 and 137 respectively having the bearing holes 138 and 139 that rotatably supports the cam shaft 131. The semicircular concave portions 162F and 162R are provided on sidewalls of the cylinder heads 16F and 16R opposite to the ignition plugs 158 so that both ends of the concave portions continue to the head cover coupling surfaces 161F and 161R. The concave portions 162F and 162R enable the cam shaft 131 to be inserted and fit into the bearing holes 138 and 139.

[0090] Therefore, it is possible to insert a cutting tool from the concave portions 162F and 162R to cut out the bearing holes 138 and 139 for the support sections 136

and 137. The cylinder heads 16F and 16R can support the cam shaft 131 by ensuring excellent workability and decreasing the number of parts.

[0091] The head covers 17F and 17R are integrally provided with semicircular lids 163 to close the concave portions 162F and 162R when the head covers 17F and 17R are coupled to the cylinder heads 16F and 16R. Closing the concave portions 162F and 162R requires no other parts than the head covers 17F and 17R. It is possible to prevent the number of parts from increasing due to provision of the concave portions 162F and 162R.

[0092] While there have been described specific preferred embodiments of the present invention, it is to be distinctly understood that the present invention is not limited thereto and various changes and modifications may be made in the present invention without departing from the spirit and scope thereof.

[0093] For example, the present invention can be applied to not only motorcycles, but also the other small vehicles such as three-wheeled vehicles.

[0094] According to claim 1 of the present invention as mentioned above, it is possible to provide a relatively small valve included angle between the intake valve and the exhaust valve. Moreover, the combustion chamber can be compacted for a higher compression ratio. Furthermore, it is possible to compact the valve trains including the cam shaft and to downsize the cylinder heads.

[0095] According to claim 2 of the present invention, the combustion chamber can be compacted for a higher compression ratio in a 4-valve overhead O cam engine. In addition, it is possible to compact the valve trains including the cam shaft and to downsize the cylinder heads.

[0096] According to claim 3 of the present invention, though the cylinder axis line slopes with the front raised, it is possible to minimize a distance between the crankshaft and the bottom of the front end. The engine main unit can be positioned near the front wheel by avoiding interference with the front wheel, thus shortening the small vehicle's wheel base. Alternatively, it is possible to elongate a wheel stroke of the front wheel.

[0097] According to claim 4 of the present invention, it is possible to avoid a large valve included angle between the intake valve and the exhaust valve and to downsize the cylinder heads. Further, it is possible to decrease a friction loss in the valve trains.

[0098] Moreover, according to claim 5 of the present invention, the front cylinder head of the V-type engine main unit can be positioned near the front wheel by avoiding interference with the front wheel. It is possible to prevent the small vehicle's wheel base from being elongated and the front wheel's wheel stroke from being shortened. Furthermore, the engine main unit can be disposed as low as possible to ensure a space large enough to store the other parts above the engine main unit. It is possible to lower the height of an occupant seat.

Claims

1. An overhead cam engine, **characterized in that** cylinder heads (16F, 16R) constituting part of an engine main unit (13) are provided with an intake valve (127) and an exhaust valve (128) capable of being opened and closed freely, **in that** the intake and exhaust valves (127, 128) are supplied with forces by coil type intake and exhaust valve springs (129, 130) toward a valve closing direction, **in that** a cam shaft (131) is provided between the intake valve spring (129) and the exhaust valve spring (130) and is rotatably supported by the cylinder heads (16F, 16R), **in that** the cam shaft is provided with a first cam (142) to drive one of the intake valve (127) and the exhaust valve (128) and is provided with a second cam (143) to drive the other of the intake valve (127) and the exhaust valve (128), **in that** the cylinder heads (16F, 16R) support the cam shaft (131) with its axis line approximately disposed above cylinder axis lines (CF, CR), **in that** a second cam (143) is disposed between the intake and exhaust valve springs (129, 130) and is formed to be smaller than a first cam (142), and **in that** the first cam (142) is disposed farther from a position between the intake and exhaust valve springs (129 and 130) along the direction of the axis line of the cam shaft (131).
2. The overhead cam engine according to claim 1, **characterized in that** a pair of intake valves (127) and a pair of exhaust valves (128) are arranged on both sides of the cam shaft (131) along the axis line thereof, and **in that** these valves are provided on the cylinder heads (16F, 16R) so as to be capable of being opened and closed freely.
3. The overhead cam engine according to claim 1 or 2, **characterized in that** an engine main unit (13) including the cylinder head (16F) is mounted on a body frame (11) in the rear of a small vehicle's front wheel (WF), **in that** the vehicle is positioned by sloping the cylinder axis line (CF) with the front raised and by keeping the axis line of the crankshaft (12) horizontal, **in that** a first rocker arm (134) is driven by one of the first and second cams (142, 143) and is oscillatably supported by a first rocker shaft (132) having an axis line parallel to the cam shaft (131), **in that** a second rocker arm (135) is driven by the other of the first and second cams (142, 143) and is oscillatably supported by a second rocker shaft (133) which has an axis line parallel to the cam shaft (131) and is disposed below the first rocker shaft (132), and **in that** a distance between the second rocker shaft (133) and the crankshaft 12 is set to be smaller than a distance between the first rocker shaft (132) and the crankshaft (12).
4. The overhead cam engine according to claim 3,

characterized in that the first rocker arm (134) axially supports the roller (144) which rollingly contacts with the first cam (142), and **in that** the second rocker arm (135) is provided with a cam slipper (146) that slidingly contacts with the second cam (143). 5

5. The overhead cam engine according to claim 3 or 4, **characterized in that** the engine main unit (13) is configured to be a V type engine comprising a front bank (FB) having the cylinder axis line (CF) slanting with the front raised and a rear bank (RB) having a cylinder axis line (CR) which crosses over the cylinder axis line (CF) in a V shape when viewed from the side. 10 15

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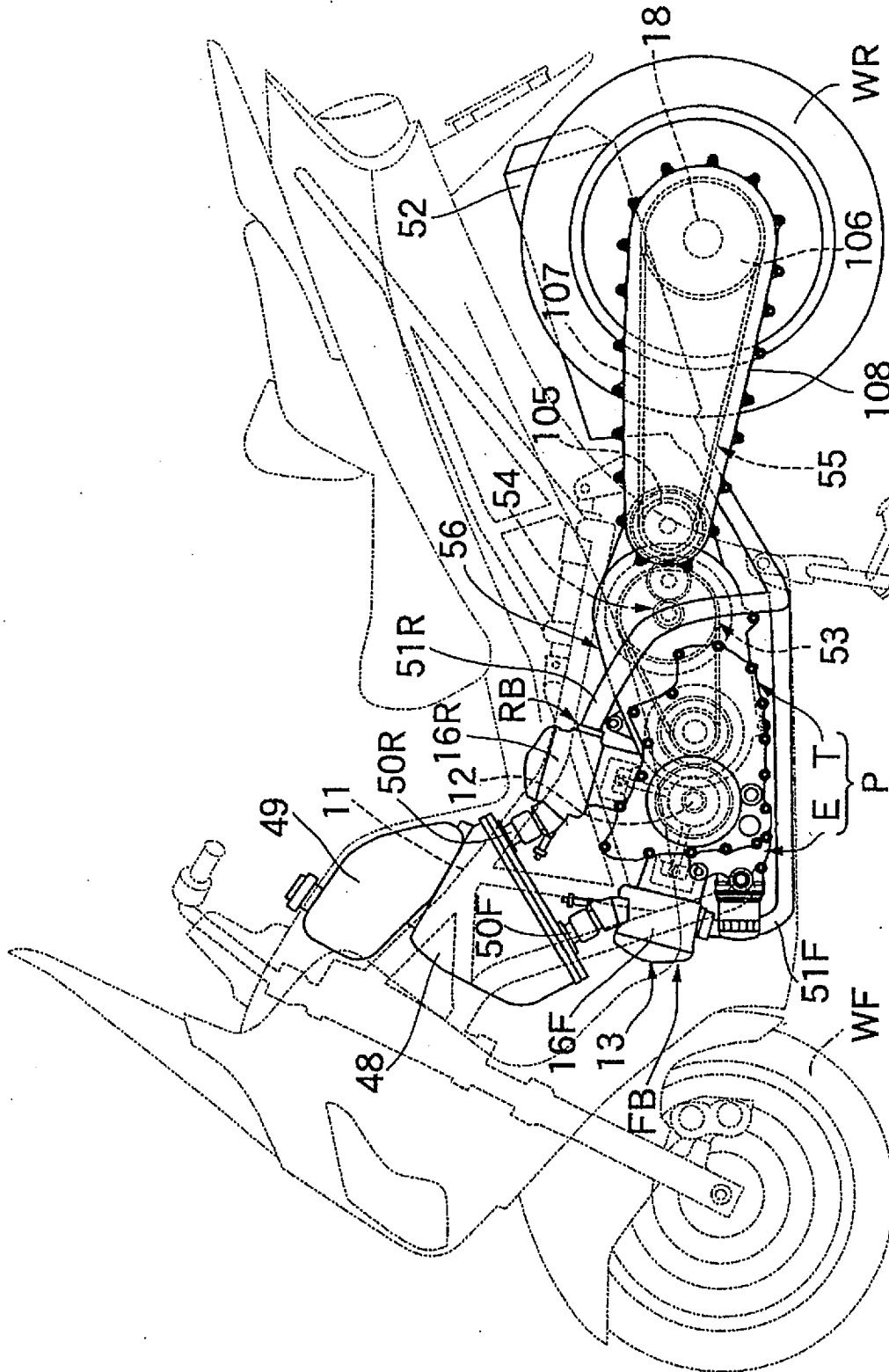


FIG. 1

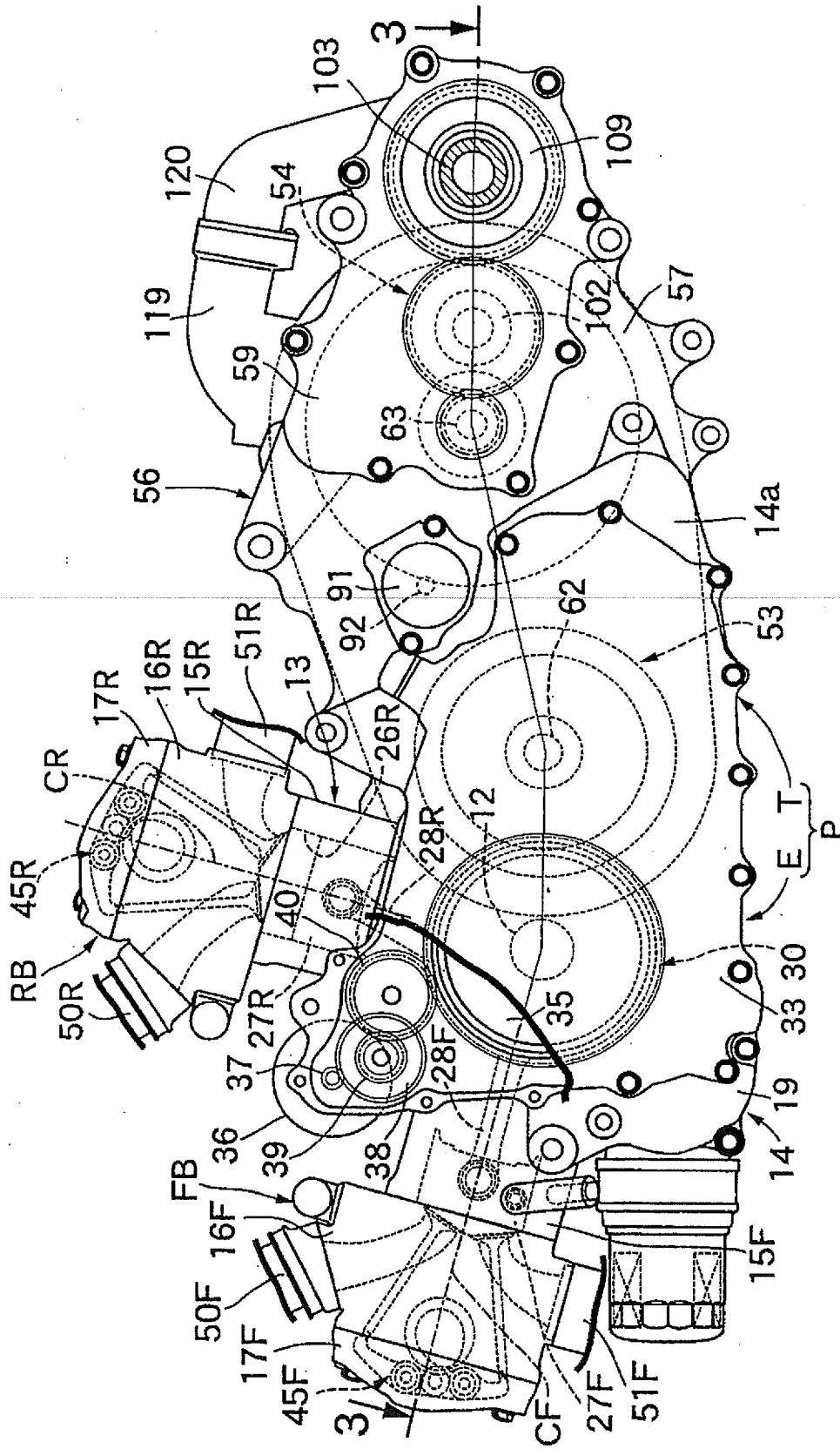


FIG. 2

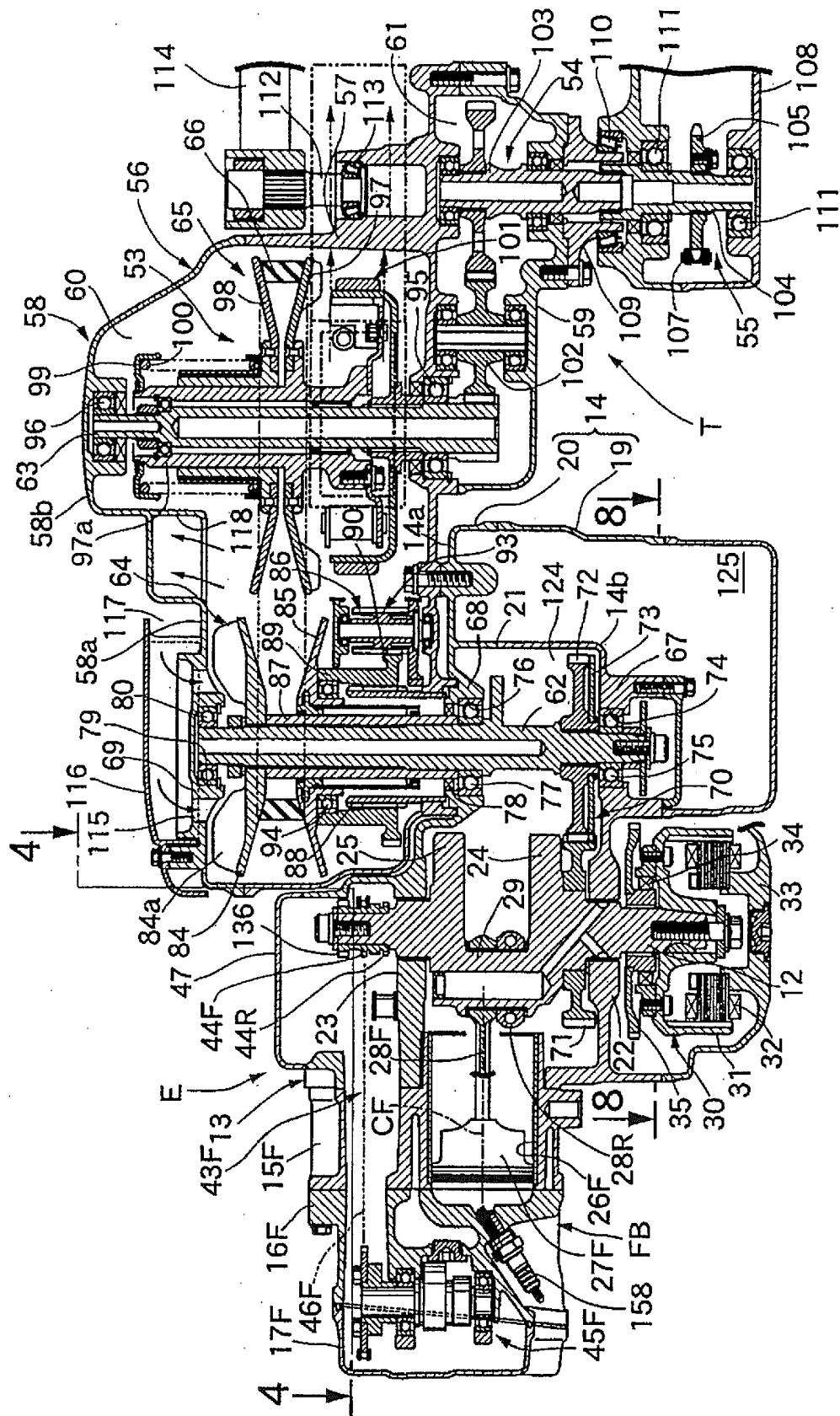


FIG. 3

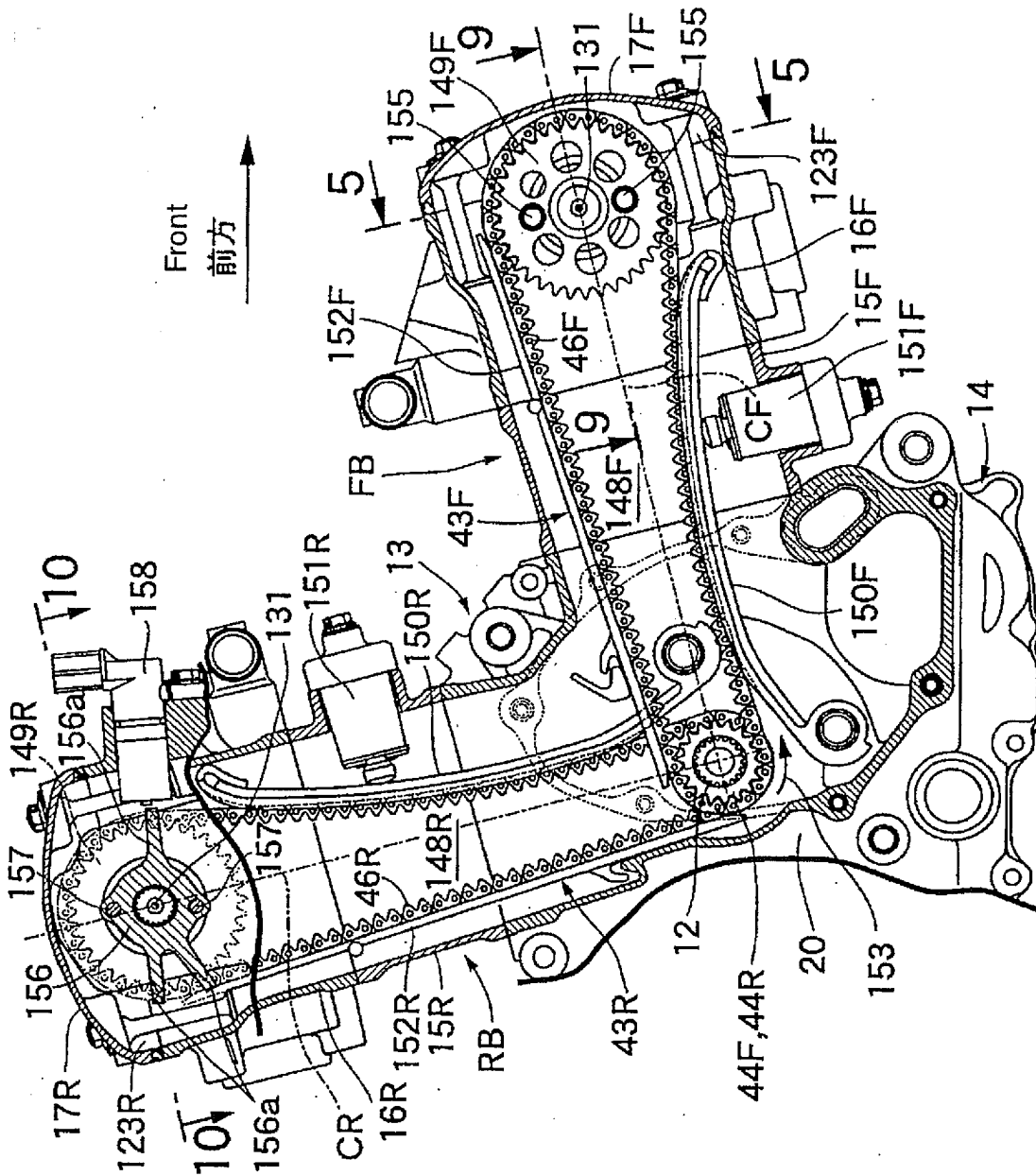


FIG. 4

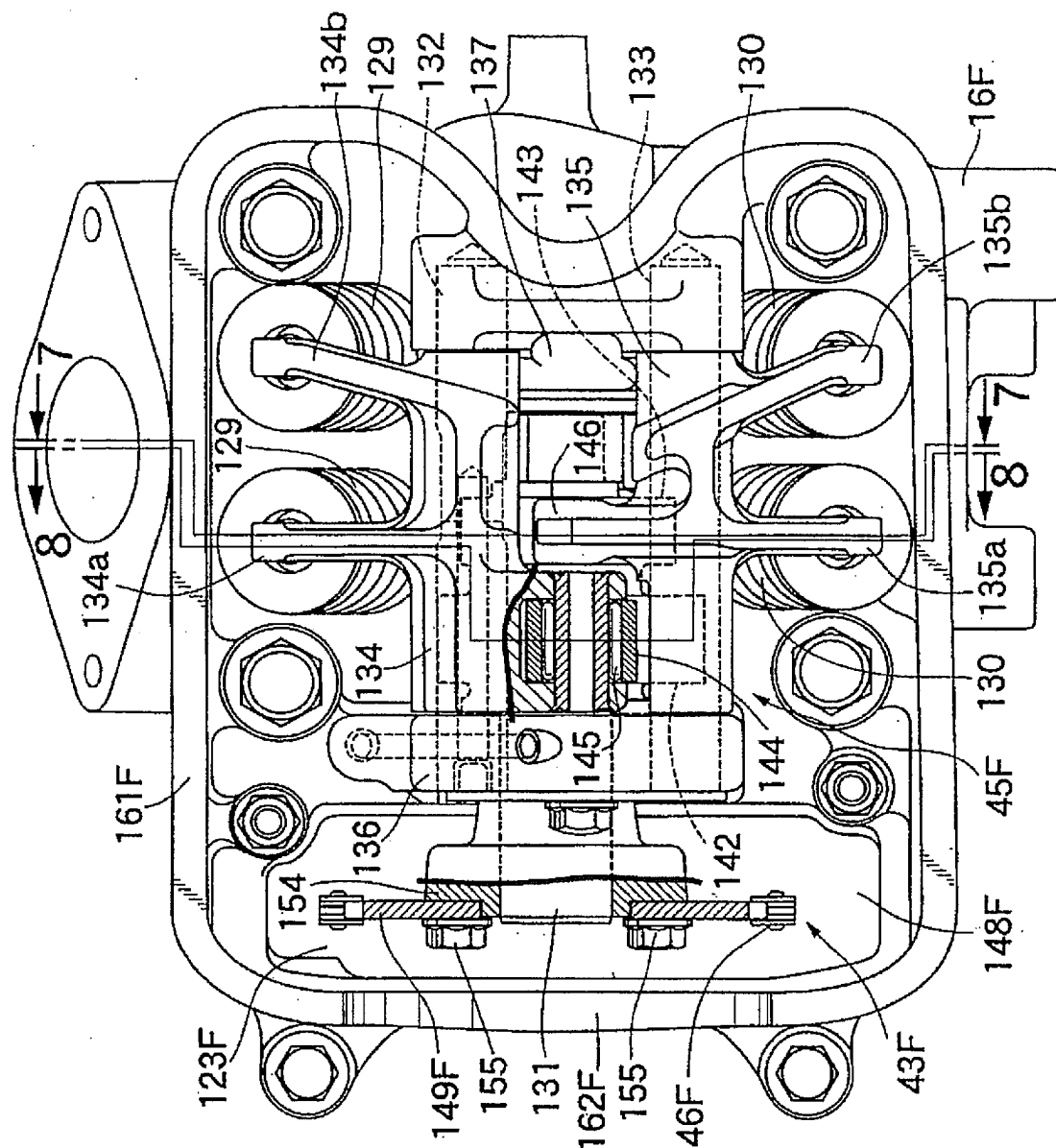


FIG. 5

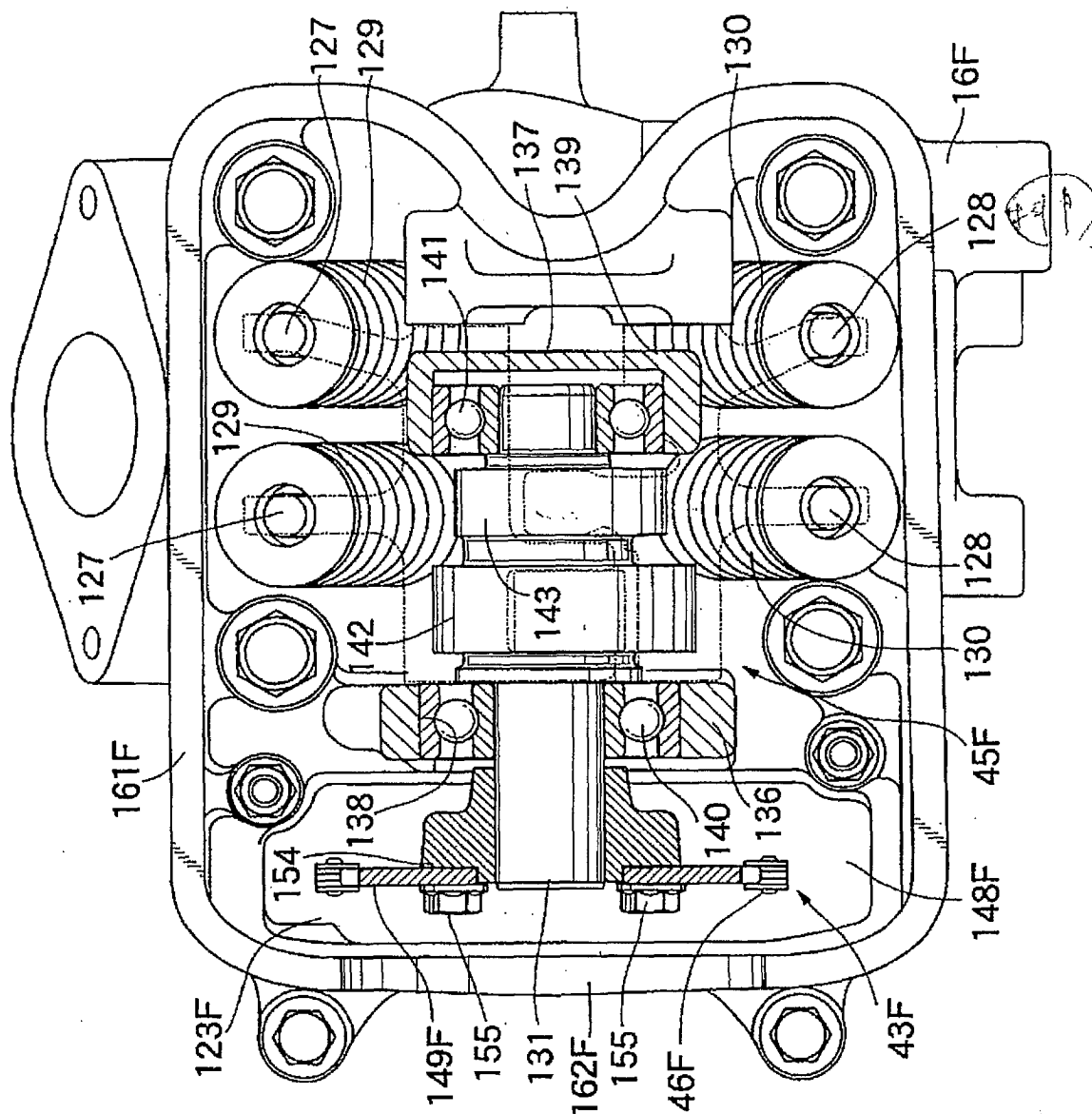


FIG. 6

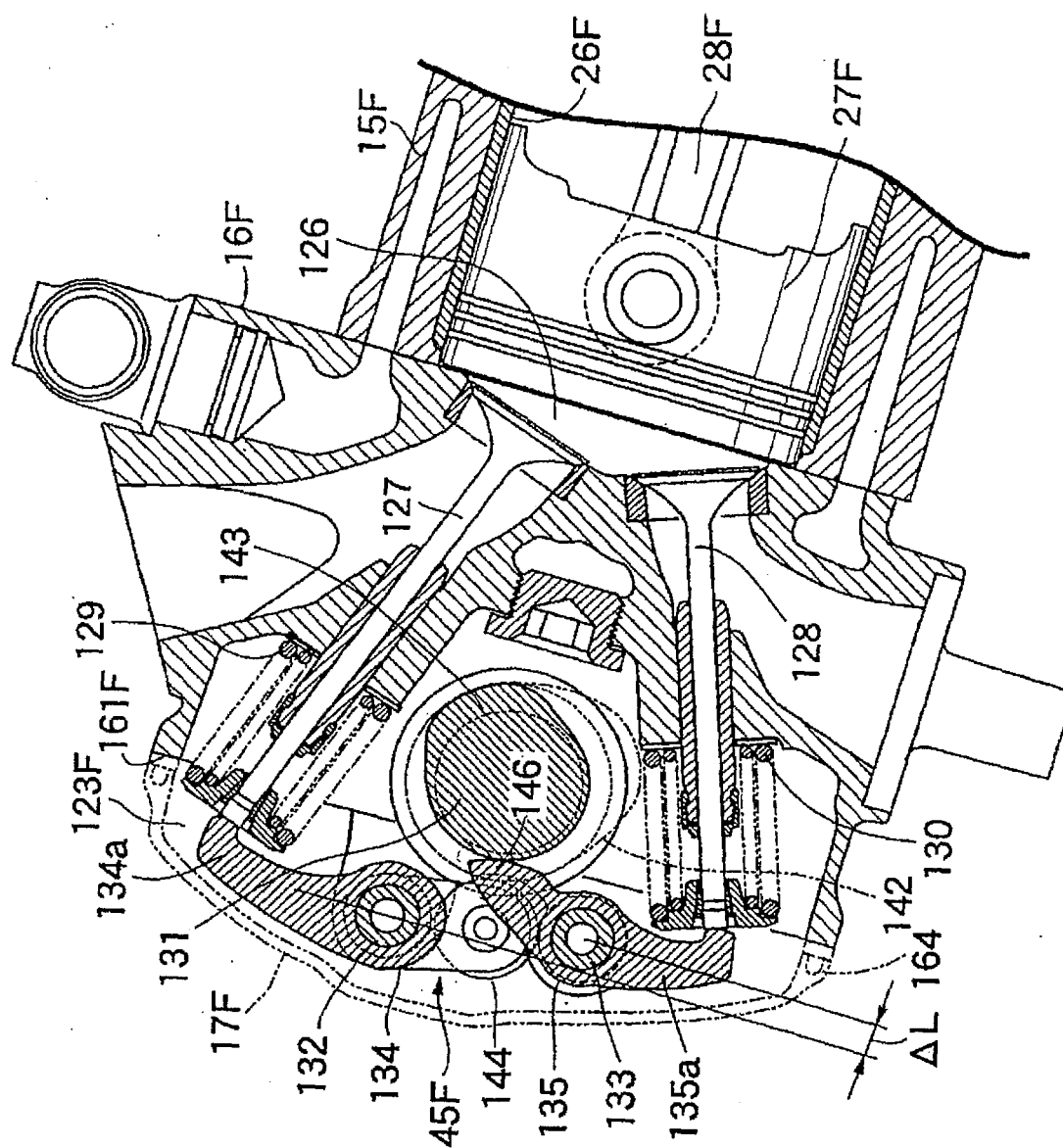


FIG. 7

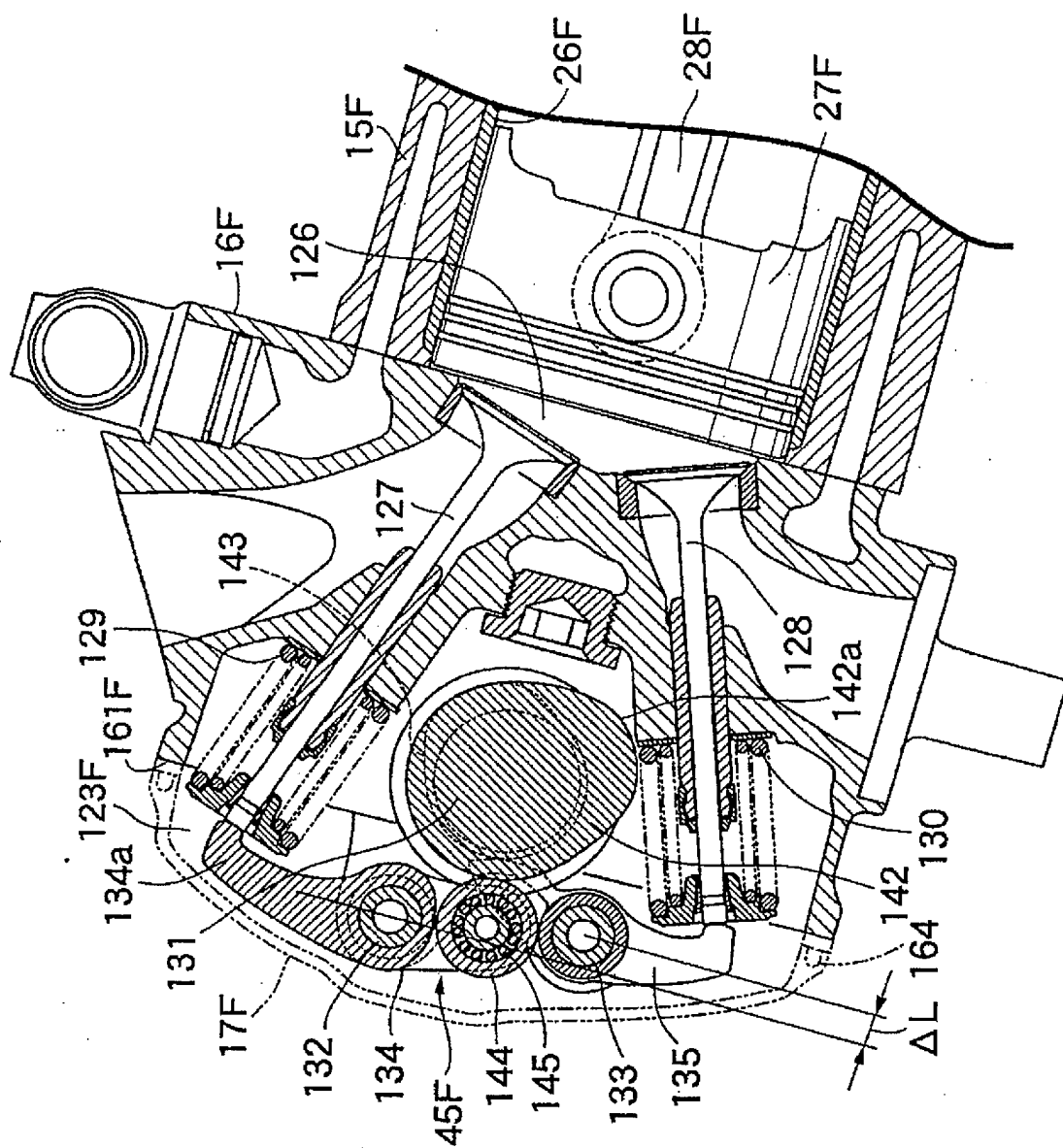


FIG. 8

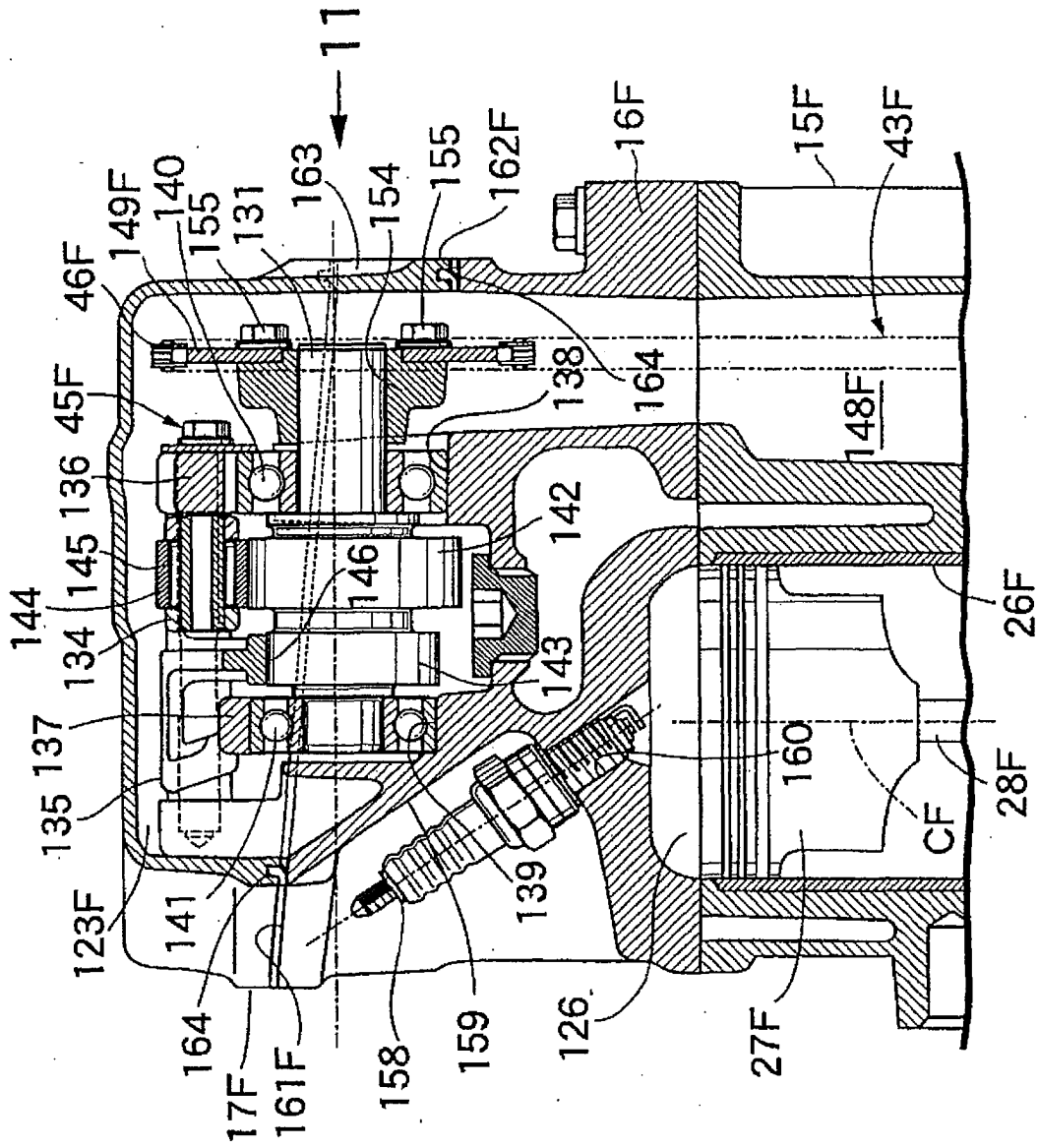


FIG. 9

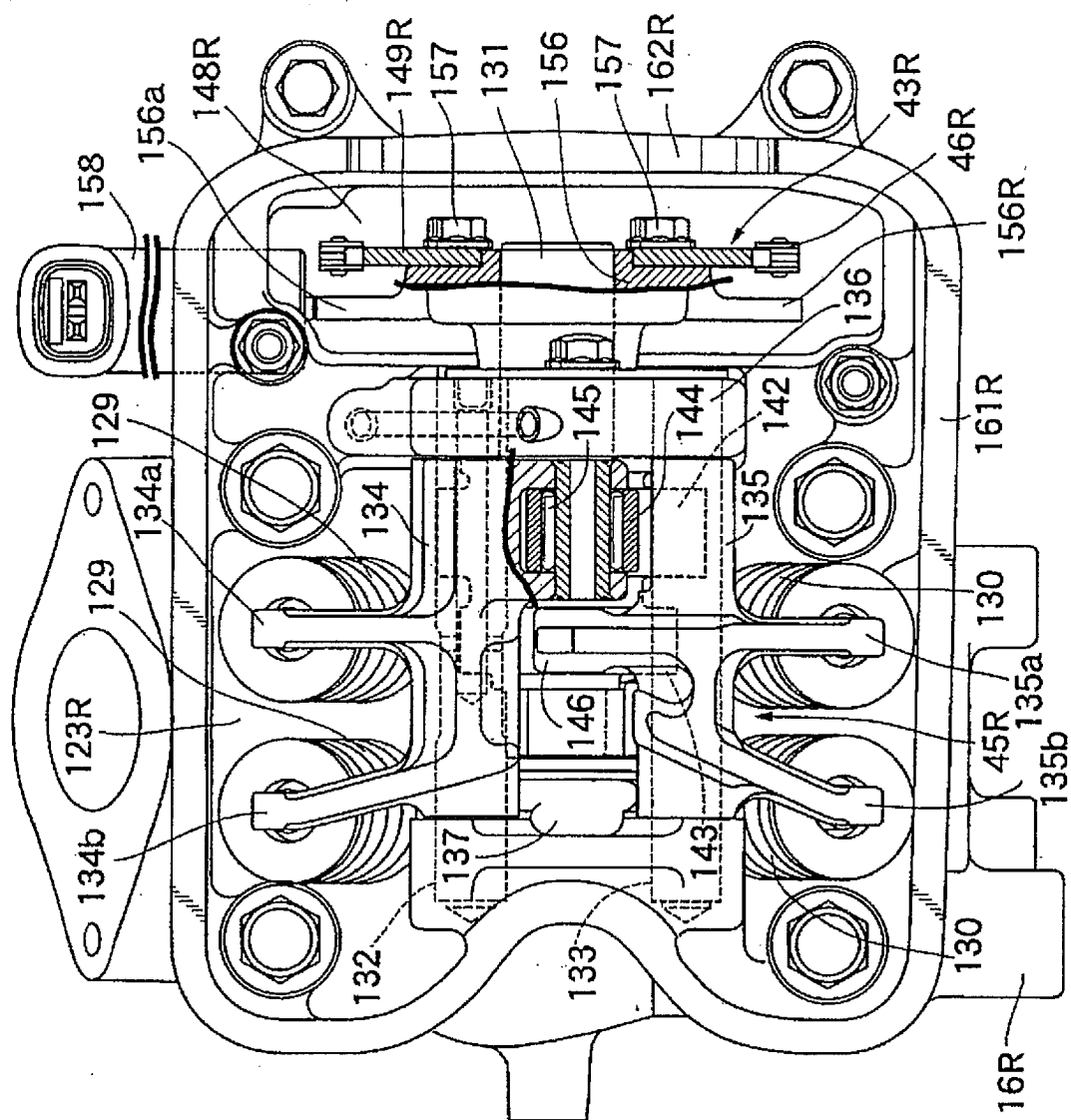


FIG. 10

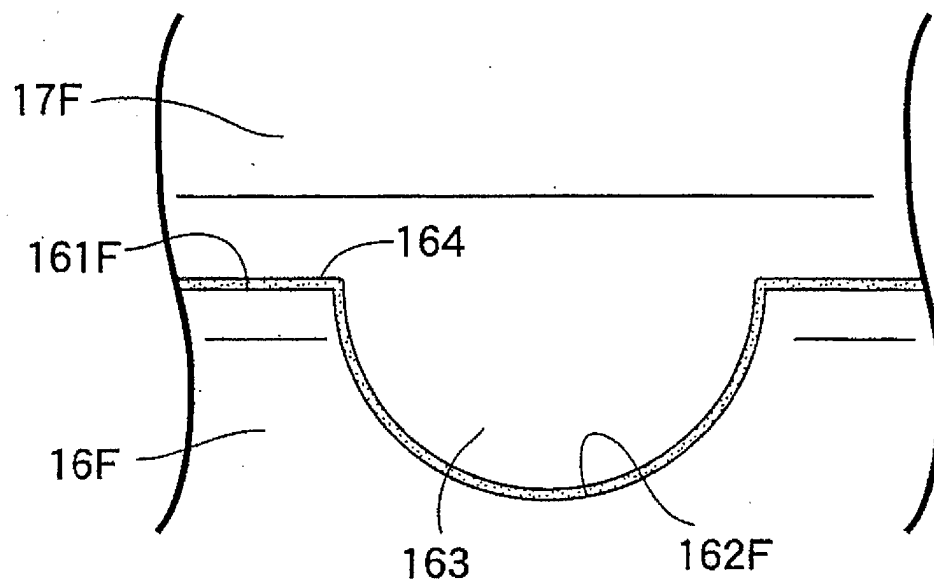


FIG. 11