(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 987 973 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.02.2016 Bulletin 2016/08

(21) Application number: **15185073.2**

(22) Date of filing: **26.02.2014**

(51) Int Cl.:
F01L 13/00 *(2006.01)* ***F01L 1/26*** *(2006.01)*
F02B 67/04 *(2006.01)* ***F02F 1/00*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **25.03.2013 JP 2013061263**
25.03.2013 JP 2013061265
25.03.2013 JP 2013061266

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
14156797.4 / 2 784 273

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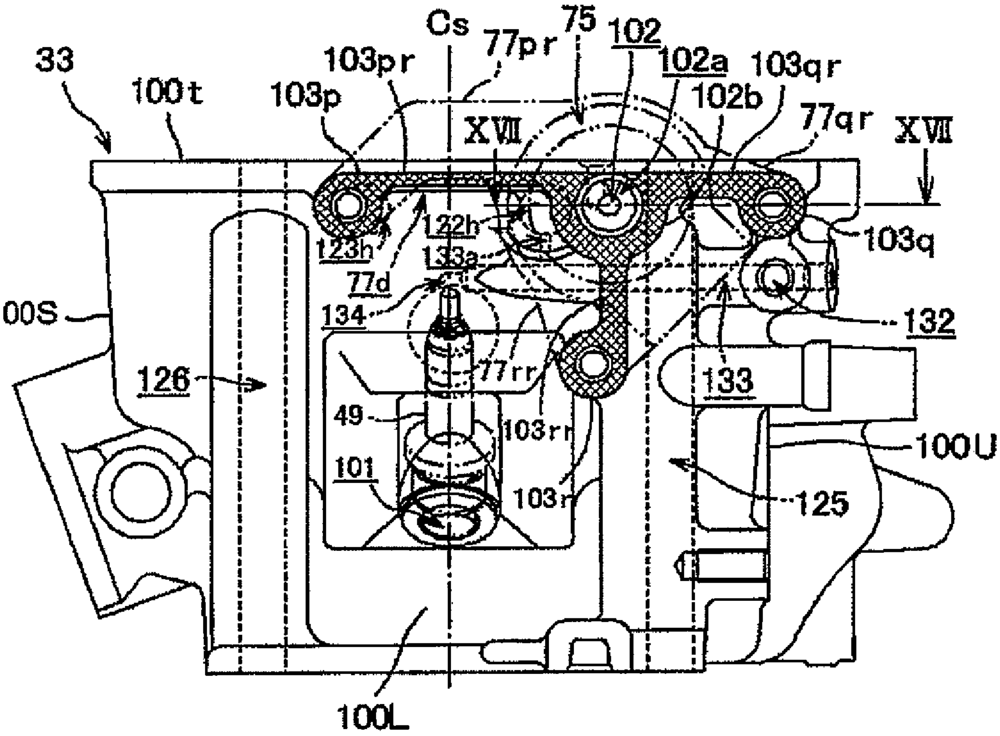
Remarks:
This application was filed on 14-09-2015 as a divisional application to the application mentioned under INID code 62.

(54) SADDLE TYPE VEHICLE

(57) There is provided a saddle type vehicle comprising, supported for rocking motion on a vehicle body frame, a power unit (20) including an OHC type internal combustion engine (30) and a belt-type continuously variable transmission (21); the OHC type internal combustion engine (30) having a cylinder axial line (Cc) tilted forward greatly and being provided therein with a plurality of rocker arms (57, 58) arrayed and supported for rocking motion in a mutually neighboring relationship on a rocker arm shaft (55) and operable in an interlocking relationship with engine valves (61, 62); a connection pin (71) fitted for movement in an axial direction of the rocker arm shaft (55) in the rocker arms (57, 58) positioned adjacent each other being provided to be movable between a connection position at which the connection pin (71) connects the rocker arms (57, 58) positioned adjacent each other to each other for integral rocking motion and a disconnection position at which the connection pin (71) disconnects the rocker arms (57, 58) from each other to allow independent rocking motion of each of the rocker arms (57, 58); a pressing force transmission member (74, 76) being provided which transmits pressing force of a pressing force generation source (75) disposed outside the OHC type internal combustion engine (30) to the connection pin (71) to move the connection pin (71) in the vehicle widthwise direction, wherein the OHC type internal combustion engine (30) has side walls (100L, 100R) directed in the vehicle widthwise direction and side walls (100U, 100S) directed in a vertical direction, the side walls together assuming a rectangular tubular shape, the pressing force generation source (75) is attached to one of the side walls (100L, 100R) directed in the vehicle widthwise direction, and the OHC type internal combustion engine (30) is a water-cooled internal combustion engine, and a water pump (150) is supported on one side wall on the opposite side to the side wall to which the pressing force generation source (75) is attached, of the side walls (100L, 100R) directed in the vehicle widthwise direction.

FIG.14


33
100t
103p
103pr
Cs
77pr
75
102
102a
103qr
102b
77qr
XVII
XVII
123h
122h
133a
77d
103q
134
132
100S
126
77rr
133
49
103rr
100U
101
103r
125
100L

Description

[Technical Field]

[0001] The present invention relates to a saddle type vehicle.

[Background Art]

[0002] For among OHC type internal combustion engines wherein a valve mechanism such as a camshaft is configured on a cylinder head, a variable valve apparatus wherein a valve timing can be changed is already known. In the variable valve apparatus of the type just described, rocker arms for converting and transmitting rotation of the camshaft into and as opening and closing motion of engine valves are provided adjacent each other. A connection pin moves in the rocker arms provided adjacent each other. The connection pin is movable between a connection position in which it connects the rocker arms to each other for integral rocking motion and a disconnection position in which it allows the rocker arms to rock independently of each other thereby to change the valve timing.

[0003] An example of a variable valve apparatus has been proposed in a prior application by the applicant same as that of the present application (refer to Japanese Patent Laid-Open No. 2012-77741; in the following also referred to as Patent Document 1). In the variable valve apparatus, a solenoid is used as a pressing force generation source for moving the connection pin. An operating portion or rod of the solenoid moves the connection pin through a push rod ((power) transmission rod or pressing force transmission member) supported for sliding movement on the cylinder head.

[0004] In the OHC type internal combustion engine disclosed in Patent Document 1, an ignition plug is provided in a projecting manner on a wall face of the cylinder head to which the solenoid is attached.

[0005] Since the ignition plug is mounted on the same wall face in such a manner that it is inserted obliquely from the head cover side, upon maintenance of the ignition plug, the ignition plug is moved to be mounted or dismounted in a direction of an axial line directed by the ignition plug in the mounted state.

[0006] In the variable valve apparatus disclosed in Patent Document 1, the operating rod of the solenoid is inserted in a sliding hole of the cylinder head configured to support the push rod (power transmission rod) for sliding motion. Further, a sandwiched inner space (space) sandwiched between the operating rod and the push rod is formed in the same sliding hole, and an oil supply hole (oil supplying hole) communicated with the sandwiched inner space is formed above the sandwiched inner space.

[0007] The variable valve apparatus has a function as an oil damper which suppresses, when the sandwiched inner space is filled with oil supplied from the oil supply hole, collision of the operating rod with the push rod by operation of the solenoid and buffers an impact and vibration by the collision.

[0008] In the variable valve apparatus disclosed in Patent Document 1, the connection pin which moves in the rocker arm is disposed at a position swollen upwardly (head cover side in the cylinder axial line direction) with respect to a rocker arm shaft between the rocker arm shaft and a roller which contacts with a cam lobe of an end portion of the rocker arm on the camshaft side. Also the transmission rod which acts upon the connection pin is disposed on an upwardly swollen portion of an upper end face of the cylinder head at a mating face position between the cylinder head and the head cover above the rocker arm shaft.

[Summary of the Invention]

[Problem to Be Solved by the Invention]

[0009] In Patent Document 1, the solenoid is positioned comparatively near to the head cover rather than the ignition plug, and the axial line directed by the ignition plug as viewed in the direction of an axial line of the cylinder overlaps with the solenoid as shown in figure 2 of Patent Document 1. Therefore, when the ignition plug is moved to be mounted or dismounted in the axial line direction directed by the ignition plug, the solenoid makes an obstacle and the maintenance operation is not easy.

[0010] Particularly, where the OHC type internal combustion engine is mounted on a saddle type vehicle in which it is not easy to assure a length of the cylinder head in the cylinder axial line direction, the ignition plug and the solenoid are likely to be positioned near to each other. This makes it further difficult to assure the maintenance space around the ignition plug.

[0011] The present invention has been made in view of such a subject as just described and provides a variable valve apparatus for an OHC type internal combustion engine which can keep a good maintenance performance of an ignition plug while miniaturization of a cylinder head is achieved. To this end, a pressing force generation source attached to a wall face of a cylinder head to which the ignition plug is attached is disposed at a position which is not far from the ignition plug and at which the pressing force generation source does not make an obstacle to a mounting and dismounting operation of the ignition plug.

[0012] Moreover, the oil supply hole of Patent Document 1 is formed at a position at which it fully faces the sandwiched inner space between the operating rod and the push rod when the solenoid is in an inactive state. Therefore, if, by the operation of the solenoid, the operating rod starts movement toward the push rod, then the oil filled in the sandwiched inner space is sandwiched and is likely to overflow from the oil supply hole and there is the possibility that the function as the oil damper degrades arising from coming off of the oil. Therefore, it is desired to utilize the function as the oil damper more effectively.

[0013] The present invention has been made in view of such a situation as described above, it is a further object of the present invention to provide a variable valve apparatus for an OHC type internal combustion engine capable of enhancing a function as an oil damper by oil to be supplied between an operating rod and a push rod.

[0014] Since the rocker arm has the upwardly swollen portion in order to dispose the connection pin in this manner, the rocker arm itself is likely to increase in size toward the head cover side in the cylinder axial line direction. Further, in order to dispose the transmission rod, it sometimes has a swollen portion which is swollen to a position above the upper end face of the cylinder head. From those, also the cylinder head and the head cover increase in size.

[0015] Further, the transmission rod serving as a pressing force transmission member is positioned on a mating face between the cylinder head and the head cover above the rocker arm shaft. Therefore, also the solenoid serving as a pressing force generation source is provided on the head cover side in the cylinder axial line direction. Consequently, there is the possibility that the cylinder head and the head cover may further increase in size in the cylinder axial line direction.

[0016] The present invention has been made in such a situation as described above, and a further object of the present invention resides in provision of a variable valve apparatus for an OHC type internal combustion engine wherein increase in size of a cylinder head and a head cover can be prevented. To this end, a connection pin and a pressing force transmission member are disposed as near as possible to a crankcase side in the cylinder axial line direction.

[Means for Solving the Problem]

[0017] The object of the present invention is achieved by the subject-matter of the independent claim. The dependent claims study further the central idea of the present invention.

[0018] In order to attain the object described above, there is provided a variable valve apparatus for an OHC type internal combustion engine which includes a crankcase (31), a cylinder block (32) and a cylinder head (33) placed in order on the crankcase (31) and fastened together by a plurality of stud bolts (180) extending through the cylinder block (32) and the cylinder head (33) in a cylinder axial line direction, a plurality of rocker arms (57, 58) arrayed and supported for rocking motion in a mutually neighboring relationship on a rocker arm shaft (55) in the inside of the cylinder head (33) and operable in an interlocking relationship with engine valves (61, 62), and a head cover (34) placed on the cylinder head (33) to cover the cylinder head (33), the variable valve apparatus including:

a connection pin (71) fitted for movement in an axial direction of the rocker arm shaft (55) in the rocker arms (57, 58) positioned adjacent each other and movable between a connection position at which the connection pin (71) connects the rocker arms (57, 58) positioned adjacent each other to each other for integral rocking motion and a disconnection position at which the connection pin (71) disconnects the rocker arms (57, 58) from each other to allow independent rocking motion of each of the rocker arms (57, 58); and

a pressing force transmission member (74, 76) configured to transmit pressing force of a pressing force generation source (75) disposed outside the cylinder head (33) to the connection pin (71) to move the connection pin (71);

the pressing force generation source (75) being attached to a wall face (100L) of the cylinder head (33) on which an ignition plug (49) is provided in a projecting manner;

an accommodation case (77, 78) which accommodates a main body of the pressing force generation source (75) therein being provided at a position at which the accommodation case (77, 78) does not overlap with an ignition plug center axial line (Cs), which is directed by the ignition plug (49), as viewed in the cylinder axial line direction.

[0019] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that the pressing force generation source (75) is positioned on the head cover (34) side with respect to the ignition plug (49).

[0020] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that

the pressing force transmission member (74, 76) is provided for sliding movement on the cylinder head (33).

[0021] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that

the pressing force generation source (75) has a plurality of attachment arm portions (77pr, 77qr, 77rr) formed around the accommodation case (77, 78) so as to extend radially along the wall face (100L) of the cylinder head (33), and

the attachment arm portions (77pr, 77qr, 77rr) are attached only to the cylinder head (33).

[0022] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that,

from among the attachment arm portions (77pr, 77qr, 77rr), the attachment arm portion (77pr) which extends in a direction overlapping with the ignition plug center axial line (Cs) as viewed in the cylinder axial line direction has a recessed portion (77d) formed thereon so as to be open toward the ignition plug (49) side in such a manner that the recessed portion (77d) crosses but keeps away from the ignition plug center axial line (Cs).

[0023] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that,
on the cylinder head (33), rib portions (103pr, 103qr, 103rr) with which the attachment arm portions (77pr, 77qr, 77rr) extending from the periphery of the accommodation case (77, 78) are abutted and attachment boss portions (103p, 103q, 103r) at end portions of the rib portions (103pr, 103qr, 103rr) are formed in a projecting manner, and the attachment arm portions (77pr, 77qr, 77rr) are attached to the attachment boss portions (103p, 103q, 103r).

[0024] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that
the accommodation case (77, 78) and the attachment arm portions (77pr, 77qr, 77rr) of the pressing force generation source (75) are made of a metal.

[0025] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that,
on the wall face (100L) to which the pressing force generation source (75) of the cylinder head (33) is attached, an oil passage (133) is formed in the proximity of the pressing force generation source (75).

[0026] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that
the OHC type internal combustion engine (30) is mounted on a vehicle body frame of a saddle type vehicle (1) in a posture in which a cylinder axial line (Cc) is tilted forward greatly to a position proximate to a horizontal position,
the pressing force generation source (75) is attached to the side wall face (100L) of the cylinder head (33) directed in the vehicle widthwise direction, and
the pressing force generation source (75) is covered on the outer sides thereof in the vehicle widthwise direction with part (6) of the vehicle body frame.

[0027] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that
a water pump (150) is attached to a side wall face (100R) of the cylinder head (33) on the opposite side to the side wall face (100L) to which the pressing force generation source (75) is attached.

[0028] The variable valve apparatus for an OHC type internal combustion engine can be further configured such that
the water pump (150) is disposed on the crankcase side with respect to the pressing force generation source (75) in the cylinder axial line direction,
an breather chamber (34b) is provided on the inner side of the head cover (34), and
an exit portion (34c) of the breather chamber (34b) is formed on an outer wall face of the head cover (34) such that an opening thereof is directed to the water pump (150) side in the vehicle widthwise direction.

[0029] There may further be provided a variable valve apparatus for an OHC type internal combustion engine which includes a crankcase (31), a cylinder block (32) and a cylinder head (33) placed in order on the crankcase (31) and fastened together by a plurality of stud bolts (180) extending through the cylinder block (32) and the cylinder head (33) in a cylinder axial line direction, a plurality of rocker arms (57, 58) arrayed and supported for rocking motion in a mutually neighboring relationship on a rocker arm shaft (55) in the inside of the cylinder head (33) and operable in an interlocking relationship with engine valves (61, 62), and a head cover (34) placed on the cylinder head (33) to cover the cylinder head (33), the variable valve apparatus including:

> a connection pin (71) fitted for movement in an axial direction of the rocker arm shaft (55) in the rocker arms (57, 58) positioned adjacent each other and movable between a connection position at which the connection pin (71) connects the rocker arms (57, 58) positioned adjacent each other to each other for integral rocking motion and a disconnection position at which the connection pin (71) disconnects the rocker arms (57, 58) from each other to allow independent rocking motion of each of the rocker arms (57, 58); and
> a push rod (74) interposed between an operating rod (76) of a pressing force generation source (75) disposed outside the cylinder head (33) and the connection pin (71) and configured to transmit pressing force of the operating rod (76) to the connection pin (71) to move the connection pin (71);
> the cylinder head (33) having a rod sliding hole (102) formed therein in which the operating rod (76) and the push rod (74) are fitted coaxially for sliding motion in a rod axial direction, the cylinder head (33) further having an oil supply hole (130) formed therein which is open at one end thereof to the inside of the cylinder head (33) and at the other end thereof to the rod sliding hole (102) and supplies oil therethrough;
> the oil supply hole (130) which supplies oil into a sandwiched inner space (80) defined by and between the operating rod (76) and the push rod (74) in the rod sliding hole (102) when the pressing force generation source (75) is in an inactive state being formed at a position offset in the rod axial direction with respect to the sandwiched inner space (80).

[0030] The variable valve apparatus for an OHC type internal combustion engine as further described above may be configured such that
the oil supply hole (130) is disposed such that only one of the push rod (74) and the operating rod (76) faces the oil supply hole (130) when the pressing force generation source (75) is in an inactive state.

[0031] The variable valve apparatus for an OHC type internal combustion engine as further described above may be configured such that
part of the sandwiched inner space (80) is communicated

with the oil supply hole (130) when the pressing force generation source (75) is in an inactive state.

[0032] The variable valve apparatus for an OHC type internal combustion engine as further described above may be configured such that
the oil supply hole (130) and the rod sliding hole (102) have such a positional relationship that center axial lines thereof cross each other at a right angle and in a spaced relationship from each other.

[0033] The variable valve apparatus for an OHC type internal combustion engine as further described above may be configured such that,
stud bolt fastening holes (115, 116, 125, 126) are formed on the cylinder head (33) such that the stud bolts (180) extend therethrough,
reinforcement plates (140, 141) abutted over an opening end face of at least two of the stud bolt fastening holes (115, 116, 125, 126) are fastened together with the cylinder head (33) by the stud bolts (180), and
part of the opening of the oil supply hole (130) on the one end side is covered with the reinforcement plates (140, 141) as viewed in the cylinder axial direction.

[0034] The variable valve apparatus for an OHC type internal combustion engine as further described above may be configured such that,
the OHC type internal combustion engine (30) is mounted on a saddle type vehicle (1) in a posture in which a cylinder axial line (Cc) thereof is tilted forward greatly to a position proximate to a horizontal position, and
a nut (181) is screwed with the stud bolts (180) which is positioned above the oil supply hole (130) and is tightened such that an angular portion thereof is directed downwardly.

[0035] The variable valve apparatus for an OHC type internal combustion engine as further described above may be configured such that
the oil supply hole (130) is disposed such that the sandwiched inner space (80) when the pressing force generation source (75) is in an inactive state is placed at a position at which the sandwiched inner space (80) does not face the oil supply hole (130).

[0036] There may also be provided a variable valve apparatus for an OHC type internal combustion engine which includes a crankcase (31), a cylinder block (32) and a cylinder head (33) placed in order on the crankcase (31) and fastened together by a plurality of stud bolts (180) extending through the cylinder block (32) and the cylinder head (33) in a cylinder axial line direction, a plurality of rocker arms (57, 58) arrayed and supported for rocking motion in a mutually neighboring relationship on a rocker arm shaft (55) in the inside of the cylinder head (33) and operable in an interlocking relationship with engine valves (61, 62), and a head cover (34) placed on the cylinder head (33) to cover the cylinder head (33), the variable valve apparatus including:

a connection pin (71) fitted for movement in an axial direction of the rocker arm shaft (55) in the rocker arms (57, 58) positioned adjacent each other and movable between a connection position at which the connection pin (71) connects the rocker arms (57, 58) positioned adjacent each other to each other for integral rocking motion and a disconnection position at which the connection pin (71) disconnects the rocker arms (57, 58) from each other to allow independent rocking motion of each of the rocker arms (57, 58); and

a pressing force transmission member (74, 76) configured to transmit pressing force of a pressing force generation source (75) disposed outside the cylinder head (33) to the connection pin (71) to move the connection pin (71);

the connection pin (71) being disposed between rocker arm shaft insertion holes (57h, 58h) in which the rocker arm shaft (55) for the rocker arms (57, 58) is inserted and action side end portions (57vv, 58vv) which act on the engine valves (61, 62);

the cylinder head (33) having a plurality of stud bolt fastening holes (115, 116, 125, 126) formed therein through which the stud bolts (180) extend and rocker arm shaft supporting holes (112h, 122h) formed therein which support the rocker arm shaft (55), the cylinder head (33) further having a pressing force transmission member sliding hole (102) formed therein in which the pressing force transmission member (74, 76) is inserted for sliding movement, the pressing force transmission member sliding hole (102) being provided at a position at which the pressing force transmission member sliding hole (102) overlaps with the rocker arm shaft supporting hole (122h) in the cylinder axial line direction between the stud bolt fastening hole (125) located nearest to the rocker arm shaft supporting hole (122h) and the rocker arm shaft supporting hole (122h).

[0037] The variable valve apparatus for an OHC type internal combustion engine as also described above may be configured such that
adjustment screws (57t, 58t) for adjusting an abutting position with the engine valves (61, 62) are screwed in the action side end portions (57vv, 58vv) of the rocker arms (57, 58), and
an axial line (Cp) of the connection pin (71) is disposed between head side end portions (57tt, 58tt) of the adjustment screws (57t, 58t) and an axial line (Cr) of the rocker arm shaft insertion holes (57h, 58h) in the cylinder axial line direction.

[0038] The variable valve apparatus for an OHC type internal combustion engine as also described above may be configured such that
the connection pin (71) and the pressing force transmission member (74, 76) are provided on the crankcase (31) side with respect to the mating face (100t) between the cylinder head (33) and the head cover (34).

[0039] The variable valve apparatus for an OHC type internal combustion engine as also described above may be configured such that

the pressing force transmission member (74, 76) neighbor with one of the stud bolts (180).

[0040] The variable valve apparatus for an OHC type internal combustion engine as also described above may be configured such that,

an axial line (Cd) of the pressing force transmission member (74, 76) is positioned on the crankcase (31) side with respect to the axial line (Cp) of the connection pin (71).

[0041] The variable valve apparatus for an OHC type internal combustion engine as also described above may be configured such that,

the axial line (Cd) of the pressing force transmission member (74, 76) is positioned on the rocker arm shaft (55) side with respect to the axial line (Cp) of the connection pin (71).

[0042] The variable valve apparatus for an OHC type internal combustion engine as also described above may be configured such that

the pressing force generation source (75) is fixedly secured only to the cylinder head (33).

[Effects of the Invention]

[0043] With the variable valve apparatus for an OHC type internal combustion engine as described above, the pressing force generation source (75) is attached to the wall face (100L) of the cylinder head (33) on which the ignition plug (49) is provided in a projecting manner. Further, the accommodation case (77, 78) which accommodates the main body of the pressing force generation source (75) therein is provided at the position at which the accommodation case (77, 78) does not overlap with the ignition plug center axial line (Cs), which is directed by the ignition plug (49), as viewed in the cylinder axial line direction. Therefore, the pressing force generation source (75) can be disposed at the position at which it does not make an obstacle when the ignition plug (49) is moved to be mounted or dismounted in the axial line direction of the ignition plug center axial line (Cs) directed by the ignition plug (49) without disposing the pressing force generation source (75) away from the ignition plug (49). Therefore, while miniaturization of the cylinder head (33) is achieved, the maintenance performance of the ignition plug (49) can be maintained favorably.

[0044] With the variable valve apparatus for an OHC type internal combustion engine as described above, the pressing force generation source (75) is positioned on the head cover (34) side with respect to the ignition plug (49). Therefore, the maintenance space around the ignition plug (49) can be assured readily.

[0045] With the variable valve apparatus for an OHC type internal combustion engine as described above, the pressing force transmission member (74, 76) is provided for sliding movement on the cylinder head (33). Therefore, swelling of the pressing force generation source (75), which provides pressing force to the pressing force transmission member (74, 76), to the head cover (34) side can be suppressed. Further, increase in size of the cylinder head (33) and peripheral elements in the cylinder axial line direction can be prevented.

[0046] Consequently, the variable valve apparatus can be made suitable particularly for a saddle type vehicle for which miniaturization of the cylinder head (33) and peripheral elements is demanded.

[0047] With the variable valve apparatus for an OHC type internal combustion engine as described above, the pressing force generation source (75) has the plural attachment arm portions (77pr, 77qr, 77rr) formed around the accommodation case (77, 78) so as to extend radially along the wall face (100L) of the cylinder head (33). Further, the attachment arm portions (77pr, 77qr, 77rr) are attached only to the cylinder head (33). Therefore, it is possible to raise the rigidity of the cylinder head (33) and further suppress swelling of the pressing force generation source (75) to the head cover (34) side.

[0048] Further, the electromagnetic solenoid (75) is attached only to the cylinder head (33) but not to the head cover (34). Therefore, upon maintenance of the valve system in the cylinder head (33), the head cover (34) can be removed without removing the pressing force generation source (75). Consequently, maintenance operation of the valve system can be carried out readily.

[0049] With the variable valve apparatus for an OHC type internal combustion engine as described above, from among the attachment arm portions (77pr, 77qr, 77rr), the attachment arm portion (77pr) which extends in the direction overlapping with the ignition plug center axial line (Cs) as viewed in the cylinder axial line direction has the recessed portion (77d) formed thereon so as to be open toward the ignition plug (49) side in such a manner that the recessed portion (77d) crosses but keeps away from the ignition plug center axial line (Cs). Therefore, when the ignition plug (49) is moved in the direction of the ignition plug center axial line (Cs) to mount or dismount the ignition plug (49), the attachment arm portion (77pr) does not make an obstacle thanks to the recessed portion (77d). Consequently, a good maintenance performance of the ignition plug (49) can be maintained favorably.

[0050] With the variable valve apparatus for an OHC type internal combustion engine as described above, on the cylinder head (33), the rib portions (103pr, 103qr, 103rr) with which the attachment arm portions (77pr, 77qr, 77rr) extending from the periphery of the accommodation case (77, 78) are abutted and the attachment boss portions (103p, 103q, 103r) at the end portions of the rib portions (103pr, 103qr, 103rr) are formed in a projecting manner, and the attachment arm portions (77pr, 77qr, 77rr) are attached to the attachment boss portions (103p, 103q, 103r). Therefore, the pressing force generation source (75) is retained stably on the cylinder head (33) by the rib portions (103pr, 103qr, 103rr) and the attachment boss portions (103p, 103q, 103r).

[0051] Further, the attachment arm portions (77pr, 77qr, 77rr) of the pressing force generation source (75) are abutted with and attached to the rib portions (103pr, 103qr, 103rr) and the attachment boss portions (103p, 103q, 103r). Therefore, the rib portions (103pr, 103qr, 103rr) and the attachment boss portions (103p, 103q, 103r) can be maintained in a high rigidity state. Consequently, the pressing force generation source (75) can be supported further firmly.

[0052] With the variable valve apparatus for an OHC type internal combustion engine as described above, the accommodation case (77, 78) and the attachment arm portions (77pr, 77qr, 77rr) of the pressing force generation source (75) are made of a metal. Therefore, heat generated in the accommodation case (77, 78) for the pressing force generation source (75) can be transmitted from the attachment arm portions (77pr, 77qr, 77rr) to the rib portions (103pr, 103qr, 103rr). Consequently, the heat radiation efficiency of the pressing force generation source (75) can be improved.

[0053] Further, the rib portions (103pr, 103qr, 103rr) and the attachment boss portions (103p, 103q, 103r) are formed in a projecting manner on the wall face (100L) of the cylinder head (33). Therefore, those portions of the attachment arm portions (77pr, 77qr, 77rr) abutted by the rib portions (103pr, 103qr, 103rr) and attachment boss portions (103p, 103q, 103r) which protrude from the abutting face cooperate with the cylinder head wall face (100L) to form the space therebetween. As running wind enters the space, the attachment arm portions (77pr, 77qr, 77rr) can be cooled, and consequently, the cooling effect can be raised.

[0054] With the variable valve apparatus for an OHC type internal combustion engine as described above, on the wall face (100L) to which the pressing force generation source (75) of the cylinder head (33) is attached, the oil passage (133) is formed in the proximity of the pressing force generation source (75). Therefore, the pressing force generation source (75) can be cooled effectively by oil flowing in the oil passage (133).

[0055] With the variable valve apparatus for an OHC type internal combustion engine as described above, the OHC type internal combustion engine (30) is mounted on the vehicle body frame of the saddle type vehicle (1) in a posture in which the cylinder axial line (Cc) is tilted forward greatly to the position proximate to the horizontal position. Further, the pressing force generation source (75) is attached to the side wall face (100L) of the cylinder head (33) directed in the vehicle widthwise direction, and the pressing force generation source (75) is covered on the outer sides thereof in the vehicle widthwise direction with part (6) of the vehicle body frame. Therefore, the pressing force generation source (75) is disposed between the cylinder head (33) and the vehicle body frame (6). Consequently, the pressing force generation source (75) can be protected effectively from an external factor by the cylinder head (33) and the vehicle body frame (6).

[0056] With the variable valve apparatus for an OHC type internal combustion engine as described above, the water pump (150) is attached to the side wall face (100R) of the cylinder head (33) on the opposite side to the side wall face (100L) to which the pressing force generation source (75) is attached. Therefore, the pressing force generation source (75) and the water pump (150) which are heavy articles are attached in a distributed manner on the opposite side wall faces (100L, 100R) directed in the vehicle widthwise direction of the cylinder head (33) so that they do not interfere with each other. Consequently, the weight balance around the cylinder head (33) can be improved. Further, also where both of the pressing force generation source (75) and the water pump (150) are attached to the cylinder head (33), the maintenance performance of the ignition plug (49) can be assured favorably.

[0057] With the variable valve apparatus for an OHC type internal combustion engine as described above, the breather chamber (34b) is provided on the inner side of the head cover (34). Further, the exit portion (34c) of the breather chamber (34b) is formed on the outer wall face of the head cover (34) such that the opening thereof is directed to the water pump (150) side in the vehicle widthwise direction. Therefore, the breather hose (146) connected to the exit portion (34c) of the breather chamber (34b) of the head cover (34) and extending to the water pump (150) side does not interfere with the pressing force generation source (75) on the opposite side. Also it can be avoided readily for the breather hose (146) to interfere with the water pump (150) provided on the crankcase (31) side with respect to the pressing force generation source (75).

[0058] With the variable valve apparatus for an OHC type internal combustion engine as further described above, the oil supply hole (130) which supplies oil into the sandwiched inner space (80) defined by and between the operating rod (76) and the push rod (74) in the rod sliding hole (102) when the pressing force generation source (75) is in an inactive state is formed at the position offset in the rod axial direction with respect to the sandwiched inner space (80). Therefore, when the pressing force generation source (75) is in an inactive state, the sandwiched inner space (80) at the position at which the oil supply hole (130) is offset in the axial direction can be made similar to a closed space. Further, at an initial stage when the pressing force generation source (75) is rendered operative to start movement of the operating rod (76), the oil supplied into the sandwiched inner space (80) having a state close to a closed space is less likely to flow out from the oil supply hole (130). Therefore, the oil in the sandwiched inner space (80) can enhance the damper function as an oil damper.

[0059] Further, together with the movement of the operating rod (76), also the sandwiched inner space (80) moves and the offset from the oil supply hole (130) decreases. Therefore, the oil in the sandwiched inner space (80) gradually flows out from the oil supply hole (130).

[0060] Accordingly, even if the operating rod (76) is abutted with the push rod (74) soon, since also the push rod (74) is moving upon such abutment, an impact by the abutment can be suppressed to a very low level.

[0061] Moreover, with the variable valve apparatus for an OHC type internal combustion engine as further described above, the oil supply hole (130) is disposed such that only one of the push rod (74) and the operating rod (76) faces the oil supply hole (130) when the pressing force generation source (75) is in an inactive state. Therefore, a communication port on the boundary between the oil supply hole (130) and the rod sliding hole (102) is partly or fully closed with the push rod (74) or the operating rod (76). Consequently, the sandwiched inner space (80) formed between the operating rod (76) and the push rod (74) in the rod sliding hole (102) can be made similar to a closed space further. Therefore, flowing out of oil in the sandwiched inner space (80) at an initial stage when the pressing force generation source (75) is rendered operative can be suppressed to further enhance the oil damper function.

[0062] With the variable valve apparatus for an OHC type internal combustion engine as further described above, part of the sandwiched inner space (80) is communicated with the oil supply hole (130) when the pressing force generation source (75) is in an inactive state. Therefore, when the pressing force generating source (75) is in an inactive state, oil can be supplied from the oil supply hole (130) into the sandwiched inner space (80) to fill the sandwiched inner space (80). Further, since the connection port which communicates the sandwiched inner space (80) and the oil supply hole (130) with each other therethrough is narrow, the sandwiched inner space (80) can be kept in a state proximate to that of a closed space. Consequently, flowing out of oil in the sandwiched inner space (80) at an initial stage when the pressing force generation source (75) is rendered operative can be suppressed to assure a high oil damper function.

[0063] With the variable valve apparatus for an OHC type internal combustion engine as further described above, the oil supply hole (130) and the rod sliding hole (102) have such a positional relationship that the center axial lines thereof cross each other at a right angle and in a spaced relationship from each other. Therefore, the communication port on the boundary between the oil supply hole (130) and the rod sliding hold (102) is formed narrower. Further, the oil supply hole (130) is offset not only in the axial direction but also in a perpendicular direction to the axial direction with respect to the sandwiched inner space (80). Therefore, while the pressing force generation source (75) is rendered operative to start movement of the operating rod (76) until the end of the operating rod (76) passes the oil supply hole (130), the sandwiched inner space (80) can be kept in a state proximate to that of a closed state. Consequently, flowing out of the oil in the sandwiched inner space (80) can be suppressed further to assure a high oil damper function.

[0064] With the variable valve apparatus for an OHC type internal combustion engine as further described above, the reinforcement plates (140, 141) abutted over the opening end face of at least two of the stud bolt fastening holes (115, 116, 125, 126) are fastened together with the cylinder head (33) by the stud bolts (180). Therefore, the rigidity of the cylinder head (33) can be kept high. Further, part of the opening of the oil supply hole (130) is covered with the reinforcement plates (140, 141) as viewed in the cylinder axial direction. Therefore, flowing out of the oil in the sandwiched inner space (80) when the pressing force generation source (75) operates is suppressed, and consequently, the oil damper function can be maintained high more and more.

[0065] With the variable valve apparatus for an OHC type internal combustion engine as further described above, the OHC type internal combustion engine (30) is mounted on the saddle type vehicle (1) in the posture in which the cylinder axial line (Cc) thereof is tilted forward greatly to a position proximate to a horizontal position. Further, the nut (181) is screwed with the stud bolts (180) which is positioned above the oil supply hole (130) and is tightened such that the angular portion thereof is directed downwardly. Therefore, oil sticking to the nut (181) flows downwardly from the angular portion. Therefore, the oil is guided to and enters the oil supply hole (130) readily.

[0066] With the variable valve apparatus for an OHC type internal combustion engine as further described above, the oil supply hole (130) is disposed such that the sandwiched inner space (80) when the pressing force generation source (75) is in an inactive state is placed at the position at which the sandwiched inner space (80) does not face the oil supply hole (130). Therefore, the sandwiched inner space (80) when the pressing force generation source (75) is in an inactive state is a closed space. Further, flowing out of the oil in the sandwiched inner space (80) at an initial stage when the pressing force generation source (75) is rendered operative is very little. Consequently, the high oil damper function can be operated effectively.

[0067] Further, when the state of the pressing force generation source (75) changes over from an active state to an inactive state, the push rod (74) is retracted together with the operating rod (76). Thereupon, the sandwiched inner space (80) between the push rod (74) and the operating rod (76) is expanded while passing the oil supply hole (130). Consequently, the oil can be sucked from the oil supply hole (130) into the sandwiched inner space (80) to fill the sandwiched inner space (80) with the oil readily.

[0068] With the variable valve apparatus for an OHC type internal combustion engine as also described above, the connection pin (71) is disposed between the rocker arm shaft insertion holes (57h, 58h) for the rocker arms (57, 58) and the action side end portions (57vv, 58vv) which act on the engine valves (61, 62). Therefore, the connection pin (71) can be provided not at a position swollen by a great amount to the head cover (34) side from the rocker arm shaft (55) but at a position nearer to the rocker arm shaft (55) in the cylinder axial line direction on the crankcase (31) side. Therefore, there is no necessity to make the rocker arms (57, 58) themselves swell to the head cover (34) side to increase the size of them. In addition, increase in size of the cylinder head (33) and the head cover (34) can be avoided.

[0069] Further, the pressing force transmission member sliding hole (102) is formed on the cylinder head (33) at the position at which it overlaps with the rocker arm shaft supporting hole (122h) in the cylinder axial line direction between the stud bolt fastening hole (125) and the rocker arm shaft supporting hole (122h). Therefore, the pressing force transmission member (74, 76) can be disposed compactly making use of the space between the stud bolt fastening hole (125) and the rocker arm shaft supporting hole (122h). Further, the pressing force transmission member (74, 76) is provided at the position at which it overlaps with the rocker arm shaft (55) in the cylinder axial line direction. Therefore, the cylinder head (33) can be miniaturized in the cylinder axial line direction, and increase in size of the cylinder head (33) and the head cover (34) can be avoided more and more.

[0070] Specifically, as an OHC type internal combustion engine to be incorporated in a saddle type vehicle in which it is difficult to assure a space, the OHC type internal combustion engine of the present invention which avoids increase in size of the cylinder head and associated elements can be suitably applied.

[0071] With the variable valve apparatus for an OHC type internal combustion engine as also described above, the adjustment screws (57t, 58t) for adjusting the abutting position with the engine valves (61, 62) are screwed in the action side end portions (57vv, 58vv) of the rocker arms (57, 58). Further, the axial line (Cp) of the connection pin (71) is disposed between the head side end portions (57tt, 58tt) of the adjustment screws (57t, 58t) and the axial line (Cr) of the rocker arm shaft insertion holes (57h, 58h) in the cylinder axial line direction. Therefore, the rocker arm shaft (55), connection pin 71 and adjustment screws (57t, 58t) can be juxtaposed on a substantially straight line. Consequently, the valve side arm portions (57v, 58v) of the rocker arms (57, 58) from the rocker arm shaft insertion holes (57h, 58h) to the action side end portions (57vv, 58vv) which act on the engine valves (61, 62) can be formed in a substantially liner shape. Therefore, the rocker arms (57, 58) can be miniaturized in a high space efficiency.

[0072] Further, the portions of the rocker arms (57, 58) in which the connection pin (71) is fitted for movement are formed with a thickness increased by an amount by which the connection pin (71) is fitted and supported. Therefore, the rigidity of the valve side arm portions (57v, 58v) from the rocker arm shaft insertion holes (57h, 58h) to the action side end portions (57vv, 58vv) which act on the engine valves (61, 62) can be raised.

[0073] With the variable valve apparatus for an OHC type internal combustion engine as also described above, the connection pin (71) and the pressing force transmission member (74, 76) are provided on the crankcase (31) side with respect to the mating face (100t) between the cylinder head (33) and the head cover (34). Therefore, when the rocker arm shaft (55), connection pin (71) and adjustment screws (57t, 58t) are juxtaposed on a straight line, the adjustment screws (57t, 58t) are positioned in the proximity of the mating face (100t) between the cylinder head (33) and the head cover (34). Consequently, an adjustment operation of the adjustment screws (57t, 58t) can be carried out readily.

[0074] Especially, the connection pin (71) and the pressing force transmission members (74, 76) are positioned on the crankcase (31) side with respect to the head side end portions (57tt, 58tt) of the adjustment screws (57t, 58t). Therefore, an adjustment operation by the adjustment screws (57t, 58t) can be carried out more readily.

[0075] With the variable valve apparatus for an OHC type internal combustion engine as also described above, the pressing force transmission member (74, 76) neighbor with one of the stud bolts (180). Therefore, the stud bolt fastening hole (125) and the pressing force transmission member sliding hole (102) of the cylinder head (33) can be positioned as near as possible to the rocker arm shaft supporting hole (122h). Consequently, miniaturization of the cylinder head (33) can be anticipated.

[0076] With the variable valve apparatus for an OHC type internal combustion engine as also described above, the axial line (Cd) of the pressing force transmission member (74, 76) is positioned on the crankcase (31) side with respect to the axial line (Cp) of the connection pin (71). Therefore, the pressing force generation source (75) which presses the pressing force transmission member (74, 76) can be disposed near to the crankcase (31) side. Consequently, the swelling amount of the pressing force generation source (75) to the head cover (34) side in the cylinder axial line direction can be reduced.

[0077] With the variable valve apparatus for an OHC type internal combustion engine as also described above, the axial line (Cd) of the pressing force transmission member (74, 76) is positioned on the rocker arm shaft (55) side with respect to the axial line (Cp) of the connection pin (71). Therefore, a configuration wherein, while the pressing force transmission member (74, 76) avoids interference with the stud bolts (180), it presses the connection pin (71) efficiently can be implemented.

[0078] With the variable valve apparatus for an OHC type internal combustion engine as also described above, the pressing force generation source (75) is fixedly secured only to the cylinder head (33). Therefore, the shape of the mating face between the cylinder head (33) and the head cover (34) can be simplified. Besides, since the necessity to fix the pressing force generation source (75) to the head cover (34) side is eliminated, also simplification of the head cover (34) can be achieved.

[Brief Description of the Drawings]

[0079]

FIG. 1 is a general side elevational view of a scooter type motorcycle according to an embodiment of the present invention.

FIG. 2 is a view as viewed in a direction indicated by an arrow mark II of FIG. 1.

FIG. 3 is a general left side elevational view of a power unit.

FIG. 4 is a right side elevational view of the power unit with part of an internal combustion engine omitted.

FIG. 5 is a sectional view of the internal combustion engine (sectional view taken along line V-V of FIG. 3).

FIG. 6 is a vertical sectional view of a cylinder head and peripheral elements of the same.

FIG. 7 is a view of a cylinder head and a valve mechanism as viewed in a direction of an axial line of a cylinder from a head cover side with the head cover removed.

FIG. 8 is a sectional view taken along line VIII-VIII of FIGS. 6 and 7.

FIG. 9 is a sectional view taken along line IX-IX of FIGS. 6 and 7.

FIG. 10 is a partial sectional view of the cylinder head and a variable valve apparatus when an electromagnetic solenoid is inactive (sectional view taken along line X-X of FIG. 6).

FIG. 11 is a partial sectional view of the electromagnetic solenoid in an active state.

FIG. 12 is a partial sectional view of the cylinder head and the variable valve apparatus when the electromagnetic solenoid is inactive in a different example.

FIG. 13 is a top plan view of the cylinder head.

FIG. 14 is a left side elevational view of the cylinder head itself (view as viewed in a direction indicated by an arrow mark XIV of FIG. 13).

FIG. 15 is a right side elevational view of the cylinder head itself (view as viewed in a direction indicated by an arrow mark XV of FIG. 13).

FIG. 16 is a sectional view taken along line XVI-XVI of FIG. 13.

FIG. 17 is a sectional view taken along line XVII-XVII of FIG. 14.

FIG. 18 is a sectional view taken along line XVIII-XVIII of FIGS. 13 and 17.

[Mode for Carrying Out the Invention]

[0080] In the following, an embodiment according to the present invention is described with reference to the drawings.

[0081] FIG. 1 is a side elevational view of a scooter type motorcycle 1 which is a saddle type vehicle according to an embodiment to which the present invention is applied.

[0082] In the present specification, the forward, rearward, leftward and rightward directions are determined with reference the vehicle of the motorcycle 1.

[0083] A vehicle body front section 1f and a vehicle body rear section 1r are connected to each other by a low floor section 1c. In a vehicle body frame which configures a skeleton of a vehicle body, a down tube 3 extends downwardly from a head pipe 2 of the vehicle body front section 1f. A pair of floor pipes 4 branching to the left and the right at a lower end of the down tube 3 are curved horizontally and extend rearwardly below the floor section 1c. The floor pipes 4 are bent obliquely upwardly at a rear location of the floor section 1c and rise and extend rearwardly. A pair of left and right main pipes 5 are supported at a front portion thereof by rear ends of the floor pipes 4 and extend obliquely upwardly rearwardly. The left and right main pipes 5 are connected at rear ends thereof to each other.

[0084] A connection pipe 6 is fixedly secured at the opposite end portions thereof to and provided in a projecting manner at rear portions of the floor pipes 4 which are erected obliquely upwardly. The connection pipe 6 is bent in a channel shape in a forward direction.

[0085] The main pipes 5 are fixedly secured at an end thereof to left and right side portions of the connection pipe 6 to connect the main pipes 5, floor pipes 4 and connection pipe 6 to each other to assemble them firmly (refer to FIG. 2).

[0086] An accommodation box 8 and a fuel tank 9 are supported forwardly and backwardly by the main pipes 5, and a seat 10 is disposed above them.

[0087] On the vehicle body front section 1f, a handlebar 11 is supported for pivotal motion on the head pipe 2 and provided at an upper location. A front fork 12 extends downwardly, and a front wheel 13 is supported for rotation at a lower end of the front fork 12.

[0088] Brackets 7 are provided in a downwardly projecting manner at the rear upwardly extending portions of the floor pipes 4. A power unit 20 is connected to and supported for rocking motion on the brackets 7 through a link member 16.

[0089] The power unit 20 is, at a front portion thereof, a single cylinder four-stroke water-cooled OHC type internal combustion engine 30 and has a posture in which a cylinder axial line of a cylinder is tilted forward greatly to a position substantially proximate to a horizontal position. A hanger bracket 18 projects forwardly from a lower end of a crankcase 31 of the internal combustion engine 30 and is connected at an end portion thereof to the link member 16 through a pivot shaft 19.

[0090] The power unit 20 includes a belt-type continuously variable transmission 21 extending rearwardly from the internal combustion engine 30. A reduction mechanism 22 is provided at a rear portion of the belt-type continuously variable transmission 21. A rear wheel 14 is provided on a rear wheel axle 14a which is an output power shaft of the reduction mechanism 22.

[0091] A bracket 20b is provided uprightly at a rear portion of the power unit 20 at which the reduction mechanism 22 is provided. A bracket 5b is provided in a projecting manner at a rear portion of the main pipes 5. A rear cushion 15 is interposed between the bracket 20b and the bracket 5b.

[0092] Referring to FIG. 3 which is a side elevational view of the power unit 20, the internal combustion engine 30 includes a cylinder block 32, a cylinder head 33 and a head cover 34 placed in order substantially in front of the crankcase 31 and is tilted forward greatly. At an upper portion of the power unit 20, an intake pipe 23 extends from an upper portion of the cylinder head 33, which is tilted forward greatly, of the internal combustion engine 30 and is bent rearwardly. A throttle body 25 is positioned above the cylinder block 32 and connected to the intake pipe 23. An air cleaner 27 is connected to the throttle body 25 through a connection pipe 26 and positioned above the belt-type continuously variable transmission 21.

[0093] It is to be noted that an injector 24 is mounted on the intake pipe 23 and injects fuel toward an intake port.

[0094] Meanwhile, an exhaust pipe 28 extends downwardly from a lower portion of the cylinder head 33 and is bent rearwardly. Further, the exhaust pipe 28 extends rearwardly in a rightwardly displaced state until it is connected to a muffler (not shown) on the right side of the rear wheel 14.

[0095] The vehicle body front section 1f is covered from the front and the rear with a front cover 29a and a leg shield 29b, respectively, and is covered at a lower portion from the front to the left and right sides thereof with a front lower cover 29c. The floor section 1c is covered with a side cover 29d and the vehicle body rear section 1r is covered from the left and right sides with a body cover 29e.

[0096] FIG. 5 is a sectional view of the internal combustion engine 30 of the front half of the power unit 20 (sectional view taken along line V-V of FIG. 3).

[0097] The internal combustion engine 30 includes a piston 36 which moves back and forth in a cylinder liner 38 of the cylinder block 32, and a crankshaft 35. The piston 36 and a crankpin 35a of the crankshaft 35 are connected to each other by a connecting rod 37.

[0098] The crankcase 31 is configured from leftwardly and rightwardly split left crankcase 31L and right crankcase 31R united together. The right crankcase 31R forms a half body of the crankcase section. Meanwhile, the left crankcase 31L forms, at a front portion thereof, a half body of the crankcase section and is swollen rearwardly so that it serves also as a transmission case in which the belt-type continuously variable transmission 21 elongated forwardly and backwardly is accommodated.

[0099] The left crankcase (transmission case) 31L is covered at a forwardly and backwardly elongated left side open face thereof with a transmission case cover 40 and has the belt-type continuously variable transmission 21 accommodated therein.

[0100] In the crankcase formed from the front portion of the left crankcase 31L and the right crankcase 31R united together, the crankshaft 35 is supported for rotation by left and right main bearings 39. The crankshaft 35 has left and right extensions extending in a horizontal direction to the left and the right. A centrifugal weight 41 of the belt-type continuously variable transmission 21 and a driving pulley 42a are provided on the left extension of the crankshaft 35.

[0101] Referring to FIG. 3, the belt-type continuously variable transmission 21 includes a V belt 42c extending between and around the driving pulley 42a and a driven pulley 42b provided on an input shaft 22a of the reduction mechanism 22 to transmit power. The transmission ratio of the belt-type continuously variable transmission 21 is automatically changed by a change in winding diameter of the V belt 42c on the driving pulley 42a by the centrifugal weight 41 and a simultaneous change in winding diameter on the driven pulley 42b thereby to vary the speed continuously. It is to be noted that the centrifugal weight 41 moves in response to the rotational speed of the engine.

[0102] A cam chain driving sprocket wheel 43 and so forth are mounted on the right extension of the crankshaft 35. An AC generator 44 is provided at a right end portion of the right extension.

[0103] A plurality of radiator fans 45 are formed on a right side face of an outer rotor 44r of the AC generator 44.

[0104] An outer periphery of the radiator fans 45 is generally surrounded by a shroud 46. A radiator 47 is supported on the shroud 46 closely on the right side of a radiator fan 45. The radiator 47 is covered with a radiator cover 48 with a louver.

[0105] The present internal combustion engine 30 adopts a four-valve system of the SOHC type. The cylinder block 32 and the cylinder head 33 are fastened to the crankcase 31 by four stud bolts 180 extending therethrough in a cylinder axial line Cc (center axis of the cylinder bore) direction. A valve mechanism 50 is provided in the cylinder head 33 (refer to FIGS. 5 and 6).

[0106] It is to be noted that the head cover 34 is placed on and covers a mating face 100t of the cylinder head 33 with an elastic seal member 185 interposed therebetween in such a manner as to cover the valve mechanism 50.

[0107] A cam chain 51 extends between and around a camshaft 54 and the crankshaft 35 and carries out power transmission to the valve mechanism 50 in the head cover 34. A cam chain chamber 52 for the cam chain 51 is provided in a communicating relationship with the right crankcase 31R, cylinder block 32 and cylinder head 33 (refer to FIG. 5).

[0108] In particular, a driven cam chain sprocket wheel 53 is fitted on a right end of the camshaft 54 directed in the leftward and rightward horizontal direction, and the driving cam chain sprocket wheel 43 is fitted on the crankshaft 35. The cam chain 51 extends through the inside of the cam chain chamber 52 between and around the driven cam chain sprocket wheel 53 and the driving cam chain sprocket wheel 43.

[0109] Meanwhile, an ignition plug 49 is inserted in the cylinder head 33 from the opposite side (left side) to the cam chain chamber 52 toward a combustion chamber 90 (refer to FIGS. 2 and 5).

[0110] Referring to FIGS. 6 and 10, two left and right first and second intake ports 91 and 92 extend upwardly from the combustion chamber 90 which the top face of the piston 36 of the cylinder head 33, which is tilted forward greatly, faces. The first and second intake ports 91 and 92 intermediately merge with each other into a single upstream side intake port 93. The upstream side intake port 93 is connected to the intake pipe 23.

[0111] On the other hand, two left and right first and second exhaust ports 95 and 96 extend downwardly from the combustion chamber 90. The first and second exhaust ports 95 and 96 intermediately merge with each other into a single downstream side exhaust port 97. The downstream side exhaust port 97 is connected to the exhaust pipe 28.

[0112] Cylindrical valve guides 61g and 62g are fitted integrally with curved outer wall portions of the first and second intake ports 91 and 92 of the cylinder head 33, respectively. A first intake valve 61 and a second intake valve 62 are supported for sliding movement on the valve guides 61g and 62g and open and close openings of the first and second intake ports 91 and 92 which face the combustion chamber 90, respectively.

[0113] Meanwhile, valve guides 63g and 64g are fitted integrally with curved outer wall portions of the first and second exhaust ports 95 and 96 of the cylinder head 33, respectively. A first exhaust valve 63 and a second exhaust valve 64 are supported for sliding movement on the valve guides 63g and 64g and open and close openings of the first and second exhaust ports 95 and 96 which face the combustion chamber 90, respectively.

[0114] The first and second intake valves 61 and 62 and the first and second exhaust valves 63 and 64 are biased upwardly by valve springs 61s, 62s and 63s, 64s, respectively, so that they close the openings which face the combustion chamber 90.

[0115] The valve mechanism 50 has the cylinder axial line Cc tilted forward greatly to a position proximate to a horizontal position. Therefore, the first and second intake valves 61 and 62 which open and close the openings of the first and second intake ports 91 and 92 which face the combustion chamber 90, respectively, are disposed above the camshaft 54. Meanwhile, the first and second exhaust valves 63 and 64 which open and close the openings of the first and second exhaust ports 95 and 96 which face the combustion chamber 90, respectively, are disposed below the camshaft 54.

[0116] As shown in FIG. 6, an intake rocker arm shaft 55 and an exhaust rocker arm shaft 56 are disposed at obliquely upper and lower positions in front of the camshaft 54, respectively.

[0117] Referring to FIGS. 6 and 7, a first intake rocker arm 57 and a second intake rocker arm 58 are supported in a leftwardly and rightwardly adjacent relationship to each other for rocking motion on the intake rocker arm shaft 55 on the upper side. Meanwhile, an exhaust rocker arm 59 is supported for rocking motion on the exhaust rocker arm shaft 56 on the lower side.

[0118] The first intake rocker arm 57 has a cam side arm portion 57c extending downwardly from a pivotally supporting portion 57a thereof and a roller 57r supported for rotation at a lower end of the cam side arm portion 57c. The first intake rocker arm 57 rolling contacts at the roller 57r thereof with a first intake cam lobe 54i of the camshaft 54. The first intake rocker arm 57 further has a valve side arm portion 57v extending upwardly from the pivotally supporting portion 57a thereof and an adjustment screw 57t screwed at an action end 57vv which is an upper end portion of the valve side arm portion 57v. The first intake rocker arm 57 contacts at the adjustment screw 57t thereof with an upper end of a valve stem of the first intake valve 61 which is biased upwardly by the valve spring 61s.

[0119] The second intake rocker arm 58 has a cam side arm portion 58c extending downwardly from a portion thereof offset to the left side from a pivotally supporting portion 58a along the first intake rocker arm 57. The second intake rocker arm 58 further has a slipper 58s formed at a lower portion of the cam side arm portion 58c. The second intake rocker arm 58 sliding contacts at the slipper 58s thereof with a second intake cam lobe 54ii of the camshaft 54. The second intake rocker arm 58 further has a valve side arm portion 58v extending upwardly from the pivotally supporting portion 58a thereof and an adjustment screw 58t screwed at an action end portion 58vv which is an upper end portion of the valve side arm portion 58v. The second intake rocker arm 58 contacts at the adjustment screw 58t thereof with an upper end of a valve stem of the second intake valve 62 which is biased upwardly by the valve spring 62s.

[0120] The exhaust rocker arm 59 supported for rocking motion on the exhaust rocker arm shaft 56 on the lower side has a cylindrical pivotally supporting portion 59a positioned below the first intake rocker arm 57 and the second intake rocker arm 58. The exhaust rocker arm 59 further has a cam side arm portion 59c extending upwardly from a portion thereof offset to the right side of the pivotally supporting portion 59a and a roller 59r supported for rotation at an upper end of the cam side arm portion 59c. The exhaust rocker arm 59 rolling contacts at the roller 59r thereof with an exhaust cam lobe 54e of the camshaft 54. The exhaust rocker arm 59 further has valve side arm portions 59v and 59vv extending downwardly from the opposite left and right sides of the pivotally supporting portion 59a thereof and adjustment screws 59t and 59tt screwed at lower ends of the valve side arm portions 59v and 59vv, respectively. The exhaust rocker arm 59 contacts at the adjustment screws 59t and 59tt thereof with an upper end of a valve stem of the first and second exhaust valves 63 and 64 which are biased upwardly by the valve springs 63s and 64s, respectively.

[0121] Referring to FIG. 8, the first intake cam lobe 54i of the camshaft 54 moves, by a cam profile thereof, the roller 57r of the first intake rocker arm 57 forwardly at a predetermined rotational angle of the camshaft 54 to rock the first intake rocker arm 57. Consequently, the adjustment screw 57t at the other end of the first intake rocker arm 57 pushes the first intake valve 61 against the valve spring 61s to open the opening of the first intake port 91, which faces the combustion chamber 90, at a predetermined timing.

[0122] Similarly, the exhaust cam lobe 54e moves, by a cam profile thereof, the roller 59r of the exhaust rocker arm 59 forwardly at a predetermined rotational angle of the camshaft 54 to rock the exhaust rocker arm 59. Consequently, the adjustment screws 59t and 59tt at the other end of the exhaust rocker arm 59 push the exhaust valves 63 and 64 against the valve springs 63s and 64s to open the openings of the first and second exhaust ports 95 and 96 which face the combustion chamber 90 at a predetermined timing, respectively.

[0123] However, if the second intake cam lobe 54ii has an outer peripheral face of a substantially cylindrical shape and the slipper 58s at the one end of the second intake rocker arm 58 is in sliding contact with the second intake cam lobe 54ii, then the second intake rocker arm 58 is little rocked. Consequently, the second intake valve 62 is placed in a closed inactive state in which the opening of the second intake port 92 which faces the combustion chamber 90 remains closed.

[0124] However, in order to prevent occurrence of stagnation of fuel in the closed inactive state of the valve, the second intake cam lobe 54ii has a very small cam protrusion at a rotational angle thereof same as that of the first intake cam lobe 54i so that the second intake valve 62 is opened a little.

[0125] Accordingly, the closed inactive state of the valves in the present embodiment is not a fully closed rest state of the valve but involves a very small amount of opening of the valve.

[0126] It is to be noted that the second intake valve 62 is placed in a closed inactive state except when it is driven to open and close at timings same as those of the first intake valve 61 when the second intake rocker arm 58 is connected for integral rocking motion to the first intake rocker arm 57 by a variable valve apparatus 70.

[0127] In the following, the variable valve apparatus 70 is described with reference to FIG. 10.

[0128] It is to be noted that FIG. 10 is a partial sectional view of the cylinder head 33 and the variable valve apparatus 70 as viewed in a direction of the cylinder axial line from the head cover side, and the leftward and rightward relationship of them is reverse to that when the figure is viewed.

[0129] Referring to FIG. 10, the first intake rocker arm 57 and the second intake rocker arm 58 extend through rocker arm shaft insertion holes 57h and 58h formed in the intake rocker arm shaft 55 and are supported adjacent each other in the leftward and rightward direction for rocking motion on the intake rocker arm shaft 55. The first intake rocker arm 57 and the second intake rocker arm 58 have the valve side arm portions 57v and 58v and a first guide hole 57gh and a second guide hole 58gh, respectively. The valve side arm portions 57v and 58v extend upwardly from the pivotally supporting portions 57a and 58a thereof. The first guide hole 57gh and the second guide hole 58gh are perforated in parallel to the intake rocker arm shaft 55 in the valve side arm portions 57v and 58v, respectively. The first guide hole 57gh and the second guide hole 58gh are formed as circular holes of an equal diameter and connected in a leftwardly and rightwardly contiguous state to and coaxially with each other when the first intake valve 61 and the second intake valve 62 are in the closed state, respectively.

[0130] It is to be noted that the first guide hole 57gh and the second guide hole 58gh have bottom walls 57g and 58g formed on the opposite sides to the faces thereof which communicate with each other and the bottom wall 57g of the first guide hole 57gh has a circular hole at the center thereof.

[0131] A connection pin 71 is fitted for sliding movement in the leftward and rightward axial direction in the first guide hole 57gh. In the second guide hole 58gh, a disconnection piston 72 of a bottomed cylindrical shape is fitted for sliding movement in the leftward and rightward axial direction with a spring 73 interposed between the disconnection piston 72 and the bottom wall 58g.

[0132] The connection pin 71 is configured from a cylindrical main body 71a fitted fully in the first guide hole 57gh and a rod portion 71b projecting from the center of a left end face of the cylindrical main body 71a and extending through the hollow hole of the bottom wall 57g. When the first guide hole 57gh and the second guide hole 58gh are positioned contiguously in the leftward and rightward direction to and coaxially with each other, the cylindrical main body 71a of the connection pin 71 can move into the second guide hole 58gh until it spans both of the first and second guide holes 57gh and 58gh.

[0133] When the first intake valve 61 (and the second intake valve 62) is in a closed state and the first guide hole 57gh and the second guide hole 58gh are coaxial with and contiguous in the leftward and rightward direction to each other, if no external force is applied to the rod portion 71b of the connection pin 71, then the disconnection piston 72 biased by the spring 73 urges the connection pin 71 leftwardly (rightwardly in FIG. 10) as seen in FIG. 10. Consequently, the cylindrical main body 71a is fitted fully in the first guide hole 57gh and the right end face of the cylindrical main body 71a with which the disconnection piston 72 contacts is placed in flush with the right opening end face of the first guide hole 57gh. Therefore, the first intake rocker arm 57 and the second intake rocker arm 58 can rock independently of each other.

[0134] However, if external force is applied to the rod portion 71b of the connection pin 71 to push the connection pin 71 rightwardly (leftwardly in FIG. 11) as seen in FIG. 11, then the connection pin 71 pushes the disconnection piston 72 against the biasing force of the spring 73. Consequently, the cylindrical main body 71a of the connection pin 71 advances and fitted into the second guide hole 58gh. Therefore, the cylindrical main body 71a of the connection pin 71 is positioned so as to span both of the first guide hole 57gh and the second guide hole 58gh. As a result, the first intake rocker arm 57 and the second intake rocker arm 58 are connected to each other by the connection pin 71 and rock integrally with each other.

[0135] Then, if the external force to the connection pin 71 disappears, then the disconnection piston 72 urges the connection pin 71 leftwardly by the biasing force of the spring 73 so that the connection pin 71 is placed into the first guide hole 57gh thereby to cancel the connection.

[0136] In this manner, the first intake rocker arm 57 and the second intake rocker arm 58 are connected to each other by advancement (movement in the rightward direction) of the connection pin 71 and rock integrally with each other. On the other hand, the connection between the first intake rocker arm 57 and the second intake rocker arm 58 is canceled by retraction (movement in the leftward direction) of the connection pin 71.

[0137] Referring to FIG. 6 (and FIG. 10), the axial line Cp of the connection pin 71 is disposed between head side end portions 57tt and 58tt of the adjustment screws 57t and 58t and the axial line Cr of the rocker arm shaft insertion holes 57h and 58h in the cylinder axial line direction.

[0138] The cylinder head 33 tilted forward greatly includes a rectangular tubular outer peripheral wall 100 configured from four wall portions including a left side wall 100L, a right side wall 100R, an upper wall 100U and a lower wall 100S. The rod portion 71b of the connection pin 71 projects leftwardly (in FIG. 10, rightwardly), and the left side wall 100L of the outer peripheral wall 100 has a rod sliding hole 102 perforated at a portion thereof to which the rod portion 71b is opposed in such a manner as to extend leftwardly and rightwardly therethrough. A push rod 74 is inserted for sliding movement in the rod sliding hole 102.

[0139] The push rod 74 has a disk portion 74a provided at a right end thereof and having an increased diameter. The push rod 74 is fitted in the rod sliding hole 102 of the left side wall 100L from the right side (in FIG. 10, the left side) while the disk portion 74a at the right end thereof remains in the inside of the cylinder head 33. The push rod 74 has a left end positioned in the inside of the rod sliding hole 102.

[0140] A right side face of the disk portion 74a at the right end of the push rod 74 is opposed to the rod portion 71b projecting rightwardly of the connection pin 71 fitted in the first guide hole 57gh of the first intake rocker arm 57.

[0141] While the connection pin 71 rocks together with the first intake rocker arm 57, the disk portion 74a of the push rod 74 always has an area sufficient for the same to always oppose to the rod portion 71b of the connection pin 71 which rocks within a range within which the connection pin 71 can rock.

[0142] An electromagnetic solenoid 75 is attached from the outer side to the left side wall 100L of the cylinder head 33 and serves as a pressing force generation source for driving the variable valve apparatus 70.

[0143] It is to be noted that the pressing force generation source can be configured applying a hydraulic cylinder in addition to the electromagnetic solenoid 75.

[0144] As shown in FIGS. 10 and 11, an operating rod 76 projects rightwardly from the electromagnetic solenoid 75 and is inserted from the left side into the rod sliding hole 102 in which the push rod 74 is inserted from the right side. The left end of the push rod 74 and the right end of the operating rod 76 are opposed to each other in the inside of the rod sliding hole 102.

[0145] Referring to FIG. 6 (and FIG. 10), the axial line Cd of the pressing force transmission members of the push rod 74 and the operating rod 76 inserted in the rod sliding hole 102 is always positioned on the crankcase 31 side and on the intake rocker arm shaft 55 side with respect to the axial line Cp of the connection pin 71 which is fitted for rocking motion in the first guide hole 57gh of the first intake rocker arm 57.

[0146] FIG. 10 is a partial sectional view of the electromagnetic solenoid 75 in an inactive state. In the disconnection state in which the connection pin 71 is urged leftwardly through the disconnection piston 72 by the biasing force of the spring 73 to accommodate the cylindrical main body 71a fully in the first guide hole 57gh, the push rod 74 assumes a leftwardly retracted position in which it contacts with the rod portion 71b of the connection pin 71. In the rod sliding hole 102, a sandwiched inner space 80 of a suitable width is formed in a sandwiched relationship between the push rod 74 and the operating rod 76 when the electromagnetic solenoid 75 is in an inactive state.

[0147] FIG. 11 is a partial sectional view of the electromagnetic solenoid 75 in an active state. By operation of the electromagnetic solenoid 75, the operating rod 76 projecting rightwardly urges the connection pin 71 rightwardly (in FIG. 11, leftwardly) together with the disconnection piston 72 against the biasing force of the spring 73. Consequently, the cylindrical main body 71a of the connection pin 71 spans both of the first guide hole 57gh and the second guide hole 58gh to place the first intake rocker arm 57 and the second intake rocker arm 58 in a connection state.

[0148] The cylinder head 33 is a cast part configured from a nonmagnetic member made of an aluminum alloy. The structure of the cylinder head 33 is described in detail with reference to FIGS. 13 to 18.

[0149] An opening of the upstream side intake port 93 is formed on the upper wall 100U of the cylinder head 33, and an opening end is formed on the lower wall 100S such that it projects a little to the outside of the downstream side exhaust port 97.

[0150] Further, the ignition plug 49 is mounted on the left side wall 100L of the cylinder head 33, and the electromagnetic solenoid 75 is attached to the left side wall 100L as described hereinabove (refer to FIGS. 3 and 8).

[0151] Therefore, an ignition plug mounting hole 101 is formed at a central recessed portion of the left side wall 100L of the cylinder head 33 such that the ignition plug 49 is mounted obliquely as shown in FIG. 14. Further, the rod sliding hole 102 in which the operating rod 76 of the electromagnetic solenoid 75 and the push rod 74 are inserted is perforated at a position of the cylinder head 33 displaced a little to the upper wall 100U side from the center in the proximity of the mating face 100t of the cylinder head 33 with the head cover 34.

[0152] A rod boss portion 102b is formed at an outer side opening portion of the rod sliding hole 102 and has an increased inner diameter portion 102a formed thereon such that the inner diameter of the rod sliding hole 102 increases over two stages (refer to FIG. 17).

[0153] Referring to FIG. 14, an attachment boss portion 103p is formed on the left side wall 100L of the cylinder head 33 and has an attachment hole at a position thereof displaced to the lower wall 100S side from the center in the proximity of the mating face 100t. Further, a rib portion 103pr is formed so as to extend along the mating face 100t from the rod boss portion 102b toward the attachment boss portion 103p.

[0154] The rod boss portion 102b is located on the upper wall 100U side with respect to the ignition plug mounting hole 101, and the attachment boss portion 103p is located on the lower wall 100S side with respect to the ignition plug mounting hole 101. The rib portion 103pr which connects the rod boss portion 102b and the attachment boss portion 103p to each other is formed across the central ignition plug mounting hole 101 on the mating face 100t side.

[0155] An attachment boss portion 103q and a rib portion 103qr are formed on the opposite side to the attachment boss portion 103p with respect to the rod boss portion 102b. An attachment boss portion 103r is formed at a rather spaced position from the rod boss portion 102b on the opposite side to the mating face 100t. A rib portion 103rr is formed so as to extend from the rod boss portion 102b toward the attachment boss portion 103r.

[0156] In particular, two rib portions 103pr and 103qr extend from the rod boss portion 102b to the opposite sides to each other along the mating face 100t, and one rib portion 103rr extends in a direction perpendicular to the rib portions 103pr and 103qr. The attachment boss portions 103p, 103q and 103r are formed at end portions of the rib portions 103pr and 103qr and the rib portion 103rr, respectively.

[0157] The three attachment boss portions 103p, 103q and 103r and the three rib portions 103pr, 103qr and 103rr described above are swollen from an outer wall face of the left side wall 100L such that end faces thereof form an attachment face (portion indicated by lattice hatching lines in FIG. 14) of a continuous same plane.

[0158] Meanwhile, as shown in FIG. 10, the electromagnetic solenoid 75 includes a fixed core 75s and a movable core 75d fixedly secured integrally to an end portion of the operating rod 76 which extends through the fixed core 75s. The electromagnetic solenoid 75 includes a solenoid main body which includes the movable core 75d around which a coil 75c is provided circumferentially. The solenoid main body is accommodated in accommodation cases 77 and 78 formed as two divisional members.

[0159] A spring 79 is interposed between the fixed core 75s and the movable core 75d.

[0160] The accommodation cases 77 and 78 are made of a metal having a high thermal conductivity.

[0161] The accommodation case 77 is configured from a cylindrical portion 77a which covers the periphery of the coil 75c, a bottom wall portion 77b for the cylindrical portion 77a, and three attachment arm portions 77pr, 77qr and 77rr extending radially from the bottom wall portion 77b. Attachment boss portions 77p, 77q and 77r having attachment holes are formed at end portions of the attachment arm portions 77pr, 77qr and 77rr, respectively (refer to FIGS. 3 and 14).

[0162] A rod boss portion 77bb is provided at the center of the bottom wall portion 77b and projects inwardly and outwardly. The rod boss portion 77bb supports the operating rod 76 for pivotal motion and for sliding movement. The portion of the rod boss portion 77bb which projects to the inner side configures the fixed core 75s.

[0163] The accommodation case 78 has a bottomed cylindrical shape and is fitted on the opening end of the cylindrical portion 77a of the accommodation case 77 such that it covers the movable core 75d.

[0164] It is to be noted that an elastic member 78r is pasted to the bottom face of the accommodation case 78 of the bottomed cylindrical shape in an opposing relationship to the movable core 75d.

[0165] The three attachment arm portions 77pr, 77qr and 77rr and the three attachment boss portions 77p, 77q and 77r extending radially from the bottom wall portion 77b of the accommodation case 77 correspond to the three rib portions 103pr, 103qr and 103rr and the three attachment boss portions 103p, 103q and 103r of the left side wall 100L of the cylinder head 33, respectively, and are opposed to each other. Thus, the attachment boss portions 77p, 77q and 77r and the attachment arm portions 77pr, 77qr and 77rr are abutted with the attachment face which is the same continuous face formed by the attachment boss portions 103p, 103q and 103r and the rib portions 103pr, 103qr and 103rr. Then, the attachment boss portions of them are fastened to each other by bolts 104p, 104q and 104r to attach the electromagnetic solenoid 75 to the left side wall 100L of the cylinder head 33 (refer to FIGS. 3 and 14).

[0166] Thereupon, the rod boss portion 77bb formed in a projecting manner at the center of the bottom wall portion 77b of the accommodation case 77 is inserted into the increased inner diameter portion 102a of the rod sliding hole 102 of the cylinder head 33 with a seal member 83 and an O-snap ring 84 interposed therebetween (refer to FIG. 10).

[0167] The bottom wall portion 77b and the attachment arm portions 77pr and 77qr of the accommodation case 77 of the electromagnetic solenoid 75 protrude to the head cover 34 side from a mating face 104h of the cylinder head 33 with the head cover 34 as indicated by an alternate long and two short dashes line in FIG. 14(refer to FIGS. 8 and 14).

[0168] However, the electromagnetic solenoid 75 is attached only to the cylinder head 33.

[0169] Referring to FIG. 14, the electromagnetic solenoid 75 attached to the cylinder head 33 in this manner is provided at a position which is on the head cover 34 side with respect to the ignition plug 49 and does not overlap with the ignition plug center axial line Cs directed by the ignition plug 49 as viewed in the cylinder axial line direction shown in FIG. 7.

[0170] The accommodation case 77 has an attachment arm portion 77qr which is abutted with the rib portion 103pr formed across the ignition plug mounting hole 101 at the center of the cylinder head 33 on the mating face 100t. The attachment arm portion 77qr has a recessed portion 77d formed thereon and open toward the ignition plug 49 side such that it extends across and keeps away from the ignition plug center axial line Cs directed by the ignition plug 49 mounted in the ignition plug mounting hole 101 between the attachment boss portion 103p and the attachment arm portion 77rr (refer to FIGS. 3, 8 and 14).

[0171] When the power unit 20 is incorporated in the scooter type motorcycle 1, the electromagnetic solenoid 75 attached to the left side wall 100L of the cylinder head 33 of the internal combustion engine 30 is covered, on the outer side (left side) in the vehicle widthwise direction and the front side thereof, in a surrounding manner with the connection pipe 6 of the vehicle body frame.

[0172] The present OHC type internal combustion engine 30 is a water-cooled internal combustion engine, and a water pump 150 is attached to the right side wall 100R of the cylinder head 33 on the opposite side to the left side wall 100L to which the electromagnetic solenoid 75 is attached.

[0173] A circular hole 105 of a large diameter is formed in the right side wall 100R of the cylinder head 33 (refer to FIG. 15). A water pump body 151 of a cylindrical shape of the water pump 150 is fitted watertight in and supported by the circular hole 105 (refer to FIG. 8).

[0174] Referring to FIG. 8, the water pump body 151 of the water pump 150 is configured from a long cylindrical portion 151a and a short cylindrical portion 151b. The long cylindrical portion 151a is elongated in an axial direction of a pump driving shaft 153 and supports the pump driving shaft 153 for rotation through a bearing 155. The short cylindrical portion 151b is expanded in a diametrical direction and short in the axial direction. The short cylindrical portion 151b is extended in a diametrical direction at one opening end thereof so that it accommodates part of the impeller 154 fitted on the pump driving shaft 153. The long cylindrical portion 151a is fitted in and secured to the circular hole 105 of the right side wall 100R of the cylinder head 33 with an O-snap ring 156 interposed therebetween such that the pump driving shaft 153 is disposed coaxially with the camshaft 54. The pump driving shaft 153 is fitted and directly coupled, at a left end thereof, in and to a fitting hole perforated on a right end face of the camshaft 54.

[0175] A water pump cover 152 covers a right opening of the short cylindrical portion 151b of the water pump body 151 and cooperates with the short cylindrical portion 151b to accommodate the impeller 154 therebetween. The water pump cover 152 is superposed on the opening end face of the short cylindrical portion 151b.

[0176] Four bolt holes are formed on an outer circumference of the short cylindrical portion 151b of the water pump body 151. Also on the water pump cover 152, four bolt holes are formed corresponding to the bolt holes of the water pump body 151 (refer to FIGS. 4 and 15).

[0177] Three attachment boss portions 106 having a female threaded hole are formed on the right side wall 100R of the cylinder head 33 and around the circular hole 105. Bolt holes at the three corresponding locations of the water pump body 151 and the water pump cover 152 are abutted with the three attachment boss portions 106 of the cylinder head 33 and fastened together individually by the bolts 157a to attach the water pump 150 to the right side wall 100R of the cylinder head 33.

[0178] It is to be noted that the bolt holes at the remaining one location of the water pump body 151 and the water pump cover 152 project to the head cover 34 side from the mating face 100t of the cylinder head 33 with the head cover 34. The cylinder head 33 and the head cover 34 are fastened together by bolts 157b (refer to FIG. 8).

[0179] Referring to FIG. 4, to the water pump cover 152, a water suction tube portion 152a extends from the intake port swollen on the right side of the pump driving shaft 153 along the right side face of the cylinder head 33 toward the cylinder block 32 side. Further, the discharge port directed in a tangential direction from the outer periphery of the impeller 154 is extended such that a water discharge tube portion 152b extends to the water pump cover 152. Furthermore, an air vent tube portion 152C is provided in an upwardly projecting manner at an upper portion of the outer periphery of the impeller 154.

[0180] A water outlet opening 107 of a water jacket 33w in the cylinder head 33 is formed in the right side wall 100R of the cylinder head 33. Further, two working holes 108 and 109 are perforated in the right side wall 100R along the mating face 100t with the head cover 34 around the circular hole 105.

[0181] The working holes 108 and 109 are located coaxially with the intake rocker arm shaft 55 and the exhaust rocker arm shaft 56.

[0182] Referring to FIG. 4, the water suction tube portion 152a of the water pump 150 extending to the cylinder block 32 side is connected to a thermostat 160.

[0183] A branch connection pipe 161 is provided in a projecting manner at the water outlet opening 107 of the cylinder head 33. The main pipe of the branch connection pipe 161 is connected to an upstream side radiator tank 47a of the radiator 47 through a radiator inlet hose 162 while the branch pipe of the branch connection pipe 161 is connected to the thermostat 160 through a bypass hose 164.

[0184] A downstream side radiator tank 47b of the radiator 47 and the thermostat 160 are connected to each other by a radiator outlet hose 163.

[0185] A water discharge hose 165 connects a water inlet opening of the water jacket in the cylinder block 32 and the water discharge tube portion 152b of the water pump 150 to each other.

[0186] It is to be noted that the air vent tube portion 152c provided in an upwardly projecting manner on the water pump 150 is connected to the upper branch connection pipe 161 through an air vent pipe 166.

[0187] Upon warming up while the internal combustion engine 30 does not yet heat up, the thermostat 160 closes up the path of water flowing in from the radiator 47 but opens the water path bypassing from the cylinder head 33 so that warming up is accelerated through the path of water which does not pass the radiator 47. Then, when the warming up comes to an end and normal operation is entered, the thermostat 160 closes up the water path for bypassing from the cylinder head 33 but opens the water path flowing in from the radiator 47. Consequently, cooling water cooled by the radiator 47 is circulated from the cylinder block 32 in the cylinder head 33 to cool the cylinder block 32 and the cylinder head 33.

[0188] The cylinder head 33 has an inner wall 110 formed in parallel to the right side wall 100R on the inner side of the outer peripheral wall 100 (refer to FIGS. 9 and 13). The inner wall 110 cooperates with the right side wall 100R to configure the cam chain chamber 52 therebetween.

[0189] A bearing circular hole 111 is formed coaxially with the circular hole 105 in the inner wall 110 and has a diameter substantially equal to that of the circular hole 105 formed in the right side wall 100R. Also an intake rocker arm shaft supporting portion 112 and an exhaust rocker arm shaft supporting portion 113 are formed on the inner wall 110. The intake rocker arm shaft supporting portion 112 and the exhaust rocker arm shaft supporting portion 113 have an intake rocker arm shaft supporting hole 112h and an exhaust rocker arm shaft supporting hole 113h having an equal diameter to that of and disposed coaxially with the working holes 108 and 109 formed in the right side wall 100R, respectively.

[0190] The working holes 108 and 109 for perforating the rocker arm shaft supporting holes 112h and 113h are closed up from the outside with plug members 65 and 66, respectively (refer to FIGS. 7 and 9).

[0191] When the water pump 150 is attached to the right side wall 100R of the cylinder head 33, the short cylindrical portion 151b of the water pump body 151 is positioned closely to and covers the plug members 65 and 66 from the outside (refer to FIGS. 4 and 7).

[0192] Accordingly, coming off of the plug members 65 and 66 is prevented by the water pump 150 attached to the cylinder head 33.

[0193] Stud bolt fastening holes 115 and 116 are perforated on the opposite outer sides of the intake rocker arm shaft supporting portion 112 and the exhaust rocker arm shaft supporting portion 113 of the inner wall 110, respectively, such that they extend through the inner wall 110 in the cylinder axial line direction (refer to FIGS. 13 and 16).

[0194] The stud bolts 180 are fitted in the stud bolt fastening holes 115 and 116.

[0195] The left side wall 100L is recessed to the inner side from the mating face 100t with the head cover 34 and is opposed to the inner wall 110. A bearing circular hole 121 of a diameter smaller than that of the bearing circular hole 111 of the inner wall 110 is formed coaxially with the bearing circular hole 111. An intake rocker arm shaft supporting portion 122 and an exhaust rocker arm shaft supporting portion 123 are formed in the left side wall 100L. The intake rocker arm shaft supporting portion 122 and the exhaust rocker arm shaft supporting portion 123 have an intake rocker arm shaft supporting hole 122h and an exhaust rocker arm shaft supporting hole 123h, respectively. The intake rocker arm shaft supporting hole 122h and the exhaust rocker arm shaft supporting hole 123h have a diameter equal to and are disposed coaxially in an opposing relationship to the intake rocker arm shaft supporting hole 112h and the exhaust rocker arm shaft supporting hole 113h of the inner wall 110, respectively.

[0196] The intake rocker arm shaft supporting portion 122 and the exhaust rocker arm shaft supporting portion 123 have stud bolt fastening holes 125 and 126 perforated therein at a position rather offset leftwardly on the outer sides thereof and extending in the cylinder axial direction through them (refer to FIGS. 13 and 14).

[0197] The stud bolts 180 are inserted in the stud bolt fastening holes 125 and 126.

[0198] The rod sliding hole 102 is formed between the intake rocker arm shaft supporting hole 122h of the left side wall 100L and the stud bolt fastening hole 125 in the proximity of the intake rocker arm shaft supporting hole 122h. Particularly, the rod sliding hole 102 is formed at a position overlapping with the intake rocker arm shaft supporting hole 122h in the cylinder axial line direction (refer to FIGS. 13, 17 and 18).

[0199] The rod sliding hole 102 overlaps with a nut 181 as viewed in the cylinder axial line direction and is provided in the proximity of the stud bolt fastening hole 125.

[0200] Further, an oil supply hole 130 is perforated in the cylinder axial line direction toward the rod sliding hole 102 in the proximity of the stud bolt fastening hole 125 and is open to the end face of the left side wall 100L on the head cover 34 side.

[0201] The oil supply hole 130 and the rod sliding hole 102 have such a positional relationship that the center axial lines thereof are spaced away from each other and cross perpendicularly with each other.

[0202] Accordingly, the oil supply hole 130 communicates the inner side space of the cylinder head 33 and the rod sliding hole 102 with each other.

[0203] The camshaft 54 is supported for rotation in the bearing circular hole 111 and the bearing circular hole 121 provided coaxially with each other in the inner wall 110 and the left side wall 100L which are opposed to each other.

[0204] Referring to FIG. 8, the camshaft 54 is fitted at a left end thereof for rotation in the bearing circular hole 121 and at a right side portion thereof for rotation in the bearing circular hole 111 through a bearing 82.

[0205] It is to be noted that the camshaft 54 projects into the cam chain chamber 52 on the right side with respect to the bearing 82 and has the driven cam chain sprocket wheel 53 fitted at a right end thereof.

[0206] Further, a decompression mechanism 85 is incorporated between the bearing 82 and the exhaust cam lobe 54e of the camshaft 54 on the left side of the bearing 82 utilizing the exhaust cam lobe 54e.

[0207] The intake rocker arm shaft 55 is fitted at the opposite ends thereof in the intake rocker arm shaft supporting hole 112h and the intake rocker arm shaft supporting hole 122h, which are coaxial with each other, of the inner wall 110 and the left side wall 100L which are opposed to each other such that the intake rocker arm shaft 55 is supported in the supporting holes 112h and 122h, respectively (refer to FIGS. 7 and 9). Further, the exhaust rocker arm shaft 56 is fitted at the opposite ends thereof in the exhaust rocker arm shaft supporting hole 113h and the exhaust rocker arm shaft supporting hole 123h, which are coaxial with each other, of the inner wall 110 and the left side wall 100L such that the exhaust rocker arm shaft 56 is supported in the holes 113h and 123h, respectively (refer to FIGS. 7 and 8).

[0208] All of the intake rocker arm shaft supporting portion 112, exhaust rocker arm shaft supporting portion 113 and opening end portions of the stud bolt fastening holes 115 and 116 of the inner wall 110 and the intake rocker arm shaft supporting portion 122, exhaust rocker arm shaft supporting portion 123 and opening end portions of the stud bolt fastening holes 125 and 126 of the left side wall 100L have an end face

[0209] (portions indicated by lattice hatching lines in FIG. 13) lying on the same plane with a mating face 104t of the cylinder head 33 with the head cover 34.

[0210] Referring to FIG. 13, a pin insertion hole 112p of a small diameter is formed so as to extend in the cylinder axial line direction through a portion of the intake rocker arm shaft supporting portion 112 of the inner wall 110 from an end face thereof to the intake rocker arm shaft supporting hole 112h.

[0211] In the intake rocker arm shaft 55 fitted in the intake rocker arm shaft supporting hole 112h, a pin insertion hole 55p is perforated such that it extends through the intake rocker arm shaft 55 along the axial center in a diametrical direction in a corresponding relationship to the pin insertion hole 112p. The pin insertion holes 112p and 55p are formed coaxially in the intake rocker arm shaft supporting portion 112 and the intake rocker arm shaft 55, respectively. A pin member 142 is inserted in the pin insertion holes 112p and 55p from the head cover 34 side to secure the intake rocker arm shaft 55 to the intake rocker arm shaft supporting portion 112 (refer to FIG. 9).

[0212] A pin insertion hole 123p of a small diameter is formed so as to extend in the cylinder axial direction through a portion of the exhaust rocker arm shaft supporting portion 123 of the left side wall 100L from an end face thereof to the exhaust rocker arm shaft supporting hole 123h.

[0213] A pin insertion hole 56p is perforated so as to extend through the exhaust rocker arm shaft 56, which is inserted in the exhaust rocker arm shaft supporting hole 123h, along the axial center in a diametrical direction in a corresponding relationship to the pin insertion hole 123p. A pin member 143 is inserted from the head cover 34 side into the pin insertion holes 123p and 56p formed coaxially in both of the exhaust rocker arm shaft supporting portion 123 and the exhaust rocker arm shaft 56 to secure the exhaust rocker arm shaft 56 to the exhaust rocker arm shaft supporting portion 123 (refer to FIG. 8).

[0214] It is to be noted that a working hole 127 is formed so as to extend in the cylinder axial line direction through a portion of the intake rocker arm shaft supporting portion 122 of the left side wall 100L from an end face thereof to the intake rocker arm shaft supporting hole 122h.

[0215] A reinforcement plate 140 bridges the opening end portions of the stud bolt fastening holes 115 and 116 of the inner wall 110 (refer to FIG. 7).

[0216] The reinforcement plate 140 abuts with end faces of the opening end portions of the stud bolt fastening holes 115 and 116 and end faces of the intake rocker arm shaft supporting portion 112 and the exhaust rocker arm shaft supporting portion 113. The opposite end portions of the reinforcement plate 140 are fastened together with the cylinder head 33 by the stud bolts 180.

[0217] The reinforcement plate 140 is bent and extends, at a central portion of a side edge between the opposite end portions thereof on the cam chain chamber 52 side (left side), to the bearing circular hole 111 side to form a bent plate portion 140b (refer to FIGS. 8 and 9).

[0218] As shown in FIG. 6, the bent plate portion 140b has a width substantially equal to the distance between the center axes of the intake rocker arm shaft supporting hole 112h and the exhaust rocker arm shaft supporting hole 113h. The bent plate portion 140b partially blocks the openings of the intake rocker arm shaft supporting hole 112h and the exhaust rocker arm shaft supporting hole 113h. Meanwhile, an end portion of the bent plate portion 140b which is recessed arcuately partially blocks the opening of the bearing circular hole 111.

[0219] Accordingly, as shown in FIGS. 6 and 8, the reinforcement plate 140 prevents, by the bent plate portion 140b thereof, the outer race of the bearing 82, which supports the camshaft 54 for rotation, from coming off from the bearing circular hole 111 thereby to restrict the camshaft 54 from moving in the axial direction.

[0220] Simultaneously, as shown in FIGS. 6 and 9, the bent plate portion 140b of the reinforcement plate 140 prevents the intake rocker arm shaft 55 and the exhaust rocker arm shaft 56 from coming off from the intake rocker arm shaft supporting hole 112h and the exhaust rocker arm shaft supporting hole 113h, respectively. Consequently, the intake rocker arm shaft 55 and the exhaust rocker arm shaft 56 are restricted from moving in the axial direction.

[0221] Further, the reinforcement plate 140 has a pin insertion hole 140p perforated at a position of the cylinder head 33 corresponding to the pin insertion hole 112p formed in the intake rocker arm shaft supporting portion 112. The pin insertion hole 140p is perforated coaxially with the pin insertion hole 112p.

[0222] On the other hand, a reinforcement plate 141 bridges the opening end portions of the stud bolt fastening holes 125 and 126 of the left side wall 100L.

[0223] The reinforcement plate 141 is abutted with end faces of the opening end portions of the stud bolt fastening holes 125 and 126 and end faces of the intake rocker arm shaft supporting portion 122 and the exhaust rocker arm shaft supporting portion 123. The opposite end portions of the reinforcement plate 141 are fastened together with the cylinder head 33 by the stud bolts 180.

[0224] The reinforcement plate 141 has a recessed portion 141p formed so as to keep away from the pin insertion hole 123p of the exhaust rocker arm shaft supporting portion 123 (refer to FIG. 7).

[0225] Further, the reinforcement plate 141 closes up the working hole 127 of the intake rocker arm shaft supporting portion 122 and partly covers the opening of the oil supply hole 130 as shown in FIG. 7.

[0226] The reinforcement plate 140 which bridges the opening end portions of the stud bolt fastening holes 115 and 116 of the inner wall 110 is fastened at the opposite ends thereof together with the cylinder head 33 by the stud bolts 180 and bridges the opening end portions of the stud bolt fastening holes 125 and 126 of the left side wall 100L. However, since the reinforcement plate 140 is fastened at the opposite ends thereof together with the cylinder head 33 by the stud bolts 180, the cylinder head 33 can be maintained in a high rigidity state.

[0227] It is to be noted that the pin member 142 fitted in the pin insertion holes 112p and 55p of both of the intake rocker arm shaft supporting portion 112 and the intake rocker arm shaft 55 extends through the pin insertion hole 140p of the reinforcement plate 140 such that end portions thereof are projected (refer to FIG. 9).

[0228] Further, the pin member 143 fitted in the pin insertion holes 123p and 56p of both of the exhaust rocker arm shaft supporting portion 123 and the exhaust rocker arm shaft 56 extends through the recessed portion 141p of the reinforcement plate 141 such that end portions thereof are projected (refer to FIG. 9).

[0229] The head cover 34 is swollen by a great amount at a central portion thereof to form a swollen portion 34a and has an internal space formed so as to be recessed to the inner side from the swollen portion 34a. The internal space of the head cover 34 is partitioned by a breather plate 145 attached to the head cover 34 from the inner side to form a breather chamber 34b.

[0230] The breather plate 145 is provided so as to extend in parallel to the mating face 100t of the cylinder head 33 on the head cover 34 side with a predetermined distance left therebetween.

[0231] As shown in FIG. 9, end portions of the pin members 142 and 143 extending through and projecting from the reinforcement plates 140 and 141 are positioned closely to the breather plate 145 with a small gap left therebetween.

[0232] Accordingly, the amount of movement of the pin members 142 and 143 fitted in the pin insertion holes 112p and 123p of the intake rocker arm shaft supporting portion 112 and the exhaust rocker arm shaft supporting portion 123 is restricted by the breather plate 145 attached to the head cover 34. Consequently, the pin members 142 and 143 are prevented from coming off from the pin insertion holes 112p and 123p, respectively.

[0233] Referring to FIG. 2 which shows a view of the power unit 20 incorporated in the vehicle as viewed in front elevation, an exit portion 34c of the breather chamber 34b of the head cover 34 is formed at an upper portion of the swollen portion 34a such that the opening thereof is directed to the right side (water pump 150 side). A breather hose 146 is connected at an end portion thereof to the exit portion 34c, extends toward the water pump 150 side and is curved so as to be directed rearwardly. Further, the breather hose 146 is connected to the clean side of the air cleaner 27.

[0234] Accordingly, the breather hose 146 does not interfere with the electromagnetic solenoid 75 attached to the left side wall 100L of the cylinder head 33.

[0235] Now, a lubricating system in the cylinder head 33 and the valve mechanism 50 is described.

[0236] The stud bolt fastening hole 115 of the cylinder head 33 is utilized as a path of oil supplied from the cylinder block 32 side. Referring to FIGS. 7 and 13, an oil passage 131 is formed from an intermediate portion of the stud bolt fastening hole 115 toward the upper wall 100U. The oil passage 131 is bent at an end portion thereof and communicated with an oil passage 132 which extends toward the left side wall 100L in the upper wall 100U. The oil passage 132 is bent at an end portion thereof and is communicated with an oil passage 133 which extends toward the bearing circular hole 121 in the left side wall 100L.

[0237] In the cylinder head 33 tilted forward to a position near to a horizontal position, the oil passage 132 perforated horizontally in the upper wall 100U is positioned at an uppermost location. Injection holes 132a and 132b are formed in a branching manner at two locations of the oil passage 132 above and corresponding to the first intake rocker arm 57 and the second intake rocker arm 58, respectively (refer to FIGS. 6 and 13).

[0238] Oil injected from the injection holes 132a and 132b is dispersed to end portions of the valve side arm portions 57v and 58v and the adjustment screws 57t and 58t of the first intake rocker arm 57 and the second intake rocker arm 58, respectively (refer to FIGS. 6 and 10).

[0239] The oil passage 133 in the left side wall 100L is perforated in the proximity of the electromagnetic solenoid 75 attached to the left side wall 100L and extends through the stud bolt fastening hole 125. Further, the oil passage 133 passes in a crossing relationship with the intake rocker arm shaft supporting hole 122h with a distance left therebetween. The oil passage 133 is communicated at an end portion thereof with an oil inlet passage 134 which is formed so as to extend leftwardly of the bearing circular hole 121 shown in FIG. 8 (refer to FIGS. 13 and 14).

[0240] It is to be noted that the stud bolt fastening hole 125 is structured such that it is closed at the top and the bottom thereof.

[0241] An oil branch passage 133a connects the oil passage 133 and the intake rocker arm shaft supporting hole 122h which crosses with the oil passage 133 to each other (refer to FIGS. 9 and 18).

[0242] Referring to FIG. 8, the camshaft 54 has a shaft hole 54a which is open at a left end thereof which faces the oil inlet passage 134 and has extraction oil passages 54b, 54c and 54d perforated therein in a diametrical direction from the shaft hole 54a.

[0243] Accordingly, oil introduced into the shaft hole 54a of the camshaft 54 from the oil passage 133 through the oil inlet passage 134 rubricates the bearing portions by communicating extraction oil passage 54b on the left side with the bearing circular hole 121 of the left side wall 100L. Meanwhile, the extraction oil passage 54c at the center is open to an outer peripheral face of the second intake cam lobe 54ii so that the oil lubricates the slidably contacting portion of the second intake cam lobe 54ii with the slipper 58s of the second intake rocker arm 58. Further, the extraction oil passage 54d on the right side is open toward the decompression mechanism 85 so that the oil lubricates the decompression mechanism 85.

[0244] Referring to FIG. 9, the intake rocker arm shaft 55 fitted in and supported by the intake rocker arm shaft supporting hole 122h has a shaft hole 55a open at a left end thereof. An introduction oil passage 55b is formed at a portion of the intake rocker arm shaft 55 on the left side of the shaft hole 55a such that it extends through the shaft hole 55a coaxially with the oil branch passage 133a. Oil diverted from the oil passage 133 to the oil branch passage 133a is introduced into the shaft hole 55a from the introduction oil passage 55b of the intake rocker arm shaft 55. Further, an extraction oil passage 55c is formed in the intake rocker arm shaft 55 in the proximity of the right end of the shaft hole 55a from the shaft hole 55a toward the second guide hole 58gh of the second intake rocker arm 58 (refer to FIG. 10).

[0245] Referring to FIG. 10, an introduction oil passage 58d is formed in the second intake rocker arm 58 such that it communicates the extraction oil passage 55c and the right end side of the second guide hole 58gh with each other.

[0246] An adjustment oil passage 58e is formed in the valve side arm portion 58v of the second intake rocker arm 58 such that it extends upwardly outwardly from the right end side of the second guide hole 58gh.

[0247] Accordingly, oil introduced into the second guide hole 58gh from the shaft hole 55a of the second intake rocker arm 58 through the extraction oil passage 55c and the introduction oil passage 58d lubricates the disconnection piston 72 for sliding movement. Then, the oil is discharged from the adjustment oil passage 58e upon sliding movement of the disconnection piston 72 and then adjusted.

[0248] It is to be noted that the valve side arm portion 57v of the first intake rocker arm 57 has an introduction oil passage 57d perforated therein so as to extend upwardly outwardly from the first guide hole 57gh. The valve side arm portion 57v further has an oil passage 57e perforated on the opposite side to and coaxially with the introduction oil passage 57d.

[0249] Oil dispersed to an upper end portion of the valve side arm portion 57v of the first intake rocker arm 57 flows along the surface of the valve side arm portion 57v into the introduction oil passage 57d and lubricates the disconnection piston 72 for sliding movement. Further, the first intake rocker arm 57 is lubricated for rocking motion by the oil passing through the oil passage 57e.

[0250] The oil supply hole 130 communicates the rod sliding hole 102 in which the operating rod 76 of the electromagnetic solenoid 75 and the push rod 74 of the variable valve apparatus 70 are inserted and the inner side space of the cylinder head 33 with each other. The oil supply hole 130 is positioned below an outer periphery of an annular opening end face 125t of the stud bolt fastening hole 125 as viewed in the cylinder axial line direction shown in FIG. 13 of the cylinder head 33 which is tilted forward to a posture close to the horizontal posture. An oil guide groove 135 is formed between the mating face 100t of the cylinder head 33, which is formed on the left side along the outer periphery of the opening end face 125t, and the opening end face 125t.

[0251] The oil guide groove 135 introduces oil injected from the oil passage 132 in the upper wall 100U of the cylinder head 33 through the injection hole 132a and so forth and sticking to the wall face of the cylinder head 33 on the upper wall 100U side into the oil supply hole 130.

[0252] A rib 136 is provided which extends leftwardly horizontally from a position at which it contacts with a lower edge of the oil supply hole 130 below the oil guide groove 135 to the mating face 100t. Also oil staying above the rib 136 is admitted into the oil supply hole 130.

[0253] Further, as shown in FIG. 7, the stud bolts 180 extend through the stud bolt fastening holes 125 and fasten the reinforcement plate 141 together with the cylinder head 33, and the hexagonal nuts 181 are screwed with the stud bolts 180. The hexagonal nuts 181 are fastened such that one angular portion thereof is specifically directed downwardly in comparison with the other angular portions. Consequently, oil sticking to the hexagonal nuts 181 is guided by the downwardly directed angular portions and flows downwardly along the surface of the reinforcement plate 141 from the angular portions and then flows round to a side edge of the reinforcement plate 141. Therefore, the oil is easily admitted into the oil supply hole 130.

[0254] In the present variable valve apparatus 70, when the electromagnetic solenoid 75 is in an inactive state (state in which the first and second intake rocker arms 57 and 58 are not connected to each other by the connection pin 71 and can rock independently of each other), the sandwiched inner space 80 defined by and between the operating rod 76 and the push rod 74 in the rod sliding hole 102 is positioned as illustrated in FIG. 10. In this position of the sandwiched inner space 80, the oil supply hole 130 for supplying oil into the sandwiched inner space 80 is offset to the push rod 74 side (right side) such that a left end portion of the push rod 74 faces the oil supply hole 130 while the operating rod 76 is positioned so as not to face the oil supply hole 130. Consequently, the sandwiched inner space 80 has such a positional relationship that part thereof communicates with the oil supply hole 130.

[0255] The oil supply hole 130 has such a positional relationship that it is directed in the cylinder axial line direction and has a center axial line spaced away from and crossing perpendicularly with that of the rod sliding hole 102. The area of the communication port on the boundary between the oil supply hole 130 and the rod sliding hole 102 is small in comparison with that where the center axial lines of them cross perpendicularly with each other. In addition, when the electromagnetic solenoid 75 is in an inactive state, the oil supply hole 130 is offset to the push rod 74 side with respect to the sandwiched inner space 80. Consequently, the communication port on the boundary between the oil supply hole 130 and the rod sliding hole 102 is partly closed by the push rod 74. Therefore, the sandwiched inner space 80 assumes a state close to that of a closed space.

[0256] In FIG. 10, oil supplied from the oil supply hole 130 to the sandwiched inner space 80 when the electromagnetic solenoid 75 is in an inactive state is indicated by scattered points.

[0257] As seen in FIG. 10, the sandwiched inner space 80 is communicated only partly with the oil supply hole 130 but is in a state close to a state of a closed space.

[0258] Further, as shown in FIG. 7, the reinforcement plate 141 which bridges the opening end portions of the stud bolt fastening holes 125 and 126 of the left side wall 100L of the cylinder head 33 covers approximately one half of the opening of the oil supply hole 130 as viewed in the cylinder axial line direction. Therefore, flowing out of oil in the sandwiched inner space 80 from the oil supply hole 130 is inhibited.

[0259] In this manner, when the electromagnetic solenoid 75 is in an inactive state, the sandwiched inner space 80 filled with oil supplied from the oil supply hole 130 is in a state close to that of a closed space, and oil is inhibited from flowing out from the oil supply hole 130. Therefore, at an initial stage when the electromagnetic solenoid 75 is operated to project the operating rod 76, flowing out of oil in the sandwiched inner space 80 from the oil supply hole 130 is inhibited. Consequently, the damper function of the operating rod 76 as an oil damper which pushes the push rod 74 through the oil in the sandwiched inner space 80 can be raised, and an impact or vibration by collision can be damped.

[0260] As the operating rod 76 moves rightwardly by operation of the electromagnetic solenoid 75, also the push rod 74 moves rightwardly through the oil in the sandwiched inner space 80.

[0261] Since also the sandwiched inner space 80 moves rightwardly together with the movement of the push rod 74, the offset amount of the oil supply hole 130 offset rightwardly with respect to the sandwiched inner space 80 decreases. Consequently, while the oil in the sandwiched inner space 80 gradually flows out from the oil supply hole 130, the sandwiched inner space 80 becomes smaller and the operating rod 76 approaches the push rod 74 until it is finally abutted with the push rod 74.

[0262] Accordingly, since the operating rod 76 is abutted with the push rod 74 in such a manner as to catch up the push rod 74 in a state in which the push rod 74 is moving rightwardly, the impact upon abutment can be suppressed very low.

[0263] An operation state of the electromagnetic solenoid 75 when the operating rod 76 ends the rightward movement is illustrated in FIG. 11.

[0264] The push rod 74 and the connection pin 71 move rightwardly together with the operating rod 76 and the connection pin 71 connects the first and second intake rocker arms 57 and 58 to each other so that they rock integrally with each other. The right end of the operating rod 76 abuts with the left end of the push rod 74 to eliminate the sandwiched inner space 80, and the abutting portion is positioned in contact with the right side of the oil supply hole 130.

[0265] If the electromagnetic solenoid 75 changes over from an active state to an inactive state, then the operating rod 76 moves leftwardly all at once by the spring 79 of the electromagnetic solenoid 75. Following the leftward movement of the operating rod 76, the push rod 74 is moved leftwardly by the spring 73 through the connection pin 71 and the piston 72.

[0266] When the leftward movement of the push rod 74 and the operating rod 76 stops, the sandwiched inner space 80 is formed again. Therefore, when the operating rod 76 stops, the sandwiched inner space 80 communicating with the oil supply hole 130 can be filled with oil.

[0267] FIG. 12 illustrates an example wherein the positional relationship between the sandwiched inner space 80 and the oil supply hole 130 when the electromagnetic solenoid 75 is in an inactive state is changed.

[0268] When the electromagnetic solenoid 75 is inactive, the oil supply hole 130 is offset by a great amount to the push rod 74 side (right side) with respect to the sandwiched inner space 80. Thus, the push rod 74 completely closes up the communication port on the boundary between the oil supply hole 130 and the rod sliding hole 102.

[0269] In other words, when the electromagnetic solenoid 75 is in an inactive state, the sandwiched inner space 80 is a closed space.

[0270] Accordingly, at an initial stage when the electromagnetic solenoid 75 operates, oil in the sandwiched inner space 80 little flows out, and the damper function as an oil damper is maintained. Thus, an impact or vibration by collision can be damped efficiently.

[0271] As the operating rod 76 moves rightwardly upon operation of the electromagnetic solenoid 75, also the sandwiched inner space 80 moves and is brought into communication with the oil supply hole 130. Therefore, while the oil in the sandwiched inner space 80 gradually flows out through the oil supply hole 130, the sandwiched inner space 80 becomes smaller and the operating rod 76 approaches the push rod 74 until it is finally abutted with the push rod 74.

[0272] Accordingly, since the operating rod 76 is abutted with the push rod 74 in such a manner as to catch up the push rod 74 in a state in which the push rod 74 is moving rightwardly, the impact upon abutment can be suppressed very low.

[0273] An operation state of the electromagnetic solenoid 75 when the operating rod 76 ends the movement is indicated by an alternate long and two short dashes line in FIG. 12.

[0274] The abutting portion of the right end of the operating rod 76 with the left end of the push rod 74 faces the oil supply hole 130. A configuration may be adopted wherein, when the electromagnetic solenoid 75 changes over from an active state into an inactive state, the push rod 74 decreases in speed and stops more quickly than the operating rod 76. In this instance, the operating rod 76 moves at a higher speed than the push rod 74, whereupon the sandwiched inner space 80 between the left end of the push rod 74 and the right end of the operating rod 76 gradually becomes larger. When the sandwiched inner space 80 communicates with the oil supply hole 130, oil can be sucked into the sandwiched inner space 80 through the oil supply hole 130. As a result, when the operating rod 76 stops, the sandwiched inner space 80 is filled with the oil.

[0275] In the variable valve apparatus 70 of the present OHC type internal combustion engine 30, the accommodation cases 77 and 78 which accommodate the main body of the electromagnetic solenoid 75 serving as a pressing force generation source attached to the wall face of the left side wall 100L on which the ignition plug 49 of the cylinder head 33 is provided in a projecting manner are provided at a position at which they do not overlap with the ignition plug center axial line Cs directed by the ignition plug 49 as viewed in the cylinder axial line direction as shown in FIGS. 7 and 14. Therefore, the electromagnetic solenoid 75 can be disposed at a position at which it does not make an obstacle when the ignition plug 49 is moved to be mounted or dismounted in the axial line direction of the ignition plug center axial line Cs directed by the ignition plug 49 without disposing the electromagnetic solenoid 75 away from the ignition plug 49. Therefore, while miniaturization of the cylinder head 33 is achieved, the maintenance performance of the ignition plug 49 can be maintained favorably.

[0276] Since the electromagnetic solenoid 75 is positioned on the head cover 34 side with respect to the ignition plug 49 as shown in FIGS. 3 and 14, the maintenance space around the ignition plug 49 can be assured readily.

[0277] Since the push rod 74 and the operating rod 76 which are pressing force transmission members are provided for sliding movement on the cylinder head 33 as shown in FIG. 10, swelling of the electromagnetic solenoid 75, which provides pressing force to the push rod 74 and the operating rod 76, to the head cover 34 side can be suppressed. Consequently, increase in size of the cylinder head 33 and peripheral elements in the cylinder axial line direction can be prevented.

[0278] Therefore, the variable valve apparatus 70 can be made suitable particularly for the scooter type motorcycle 1 which is a saddle type vehicle and for which miniaturization of the cylinder head 33 and peripheral elements is demanded.

[0279] As shown in FIGS. 3 and 14, in the electromagnetic solenoid 75, the plurality of attachment arm portions 77pr, 77qr and 77rr are formed around the accommodation cases 77 and 78 so as to extend radially along the wall face of the left side wall 100L of the cylinder head 33. The attachment arm portions 77pr, 77qr and 77rr are attached only to the cylinder head 33. Therefore, it is possible to raise the rigidity of the cylinder head 33 and further suppress swelling of the electromagnetic solenoid 75 to the head cover 34 side.

[0280] Further, the electromagnetic solenoid 75 is attached only to the cylinder head 33 but not to the head cover 34. Therefore, upon maintenance of the valve system in the cylinder head 33, the head cover 34 can be removed without removing the electromagnetic solenoid 75. Consequently, maintenance operation of the valve system can be carried out readily.

[0281] Referring to FIGS. 3 and 14, from among the attachment arm portions 77pr, 77qr and 77rr of the electromagnetic solenoid 75, the attachment arm portion 77pr which extends in a direction overlapping with the ignition plug center axial line Cs as viewed in the cylinder axial line direction has the recessed portion 77d formed therein. The recessed portion 77d is open toward the ignition plug 49 side in such a manner as to cross but keep away from the ignition plug center axial line Cs. Therefore, when the ignition plug 49 is moved in a direction of the ignition plug center axial line Cs to be mounted or dismounted, the attachment arm portion 77pr does not make an obstacle thanks to the recessed portion 77d. Consequently, a good maintenance performance of the ignition plug 49 can be maintained favorably.

[0282] As shown in FIG. 14, the rib portions 103pr, 103qr and 103rr with which the attachment arm portions 77pr, 77qr and 77rr extending from the periphery of the accommodation cases 77 and 78 are abutted and the attachment boss portions 103p, 103q and 103r at the end portions of the rib portions 103pr, 103qr and 103rr are formed in a projecting manner on the cylinder head 33. Therefore, the electromagnetic solenoid 75 is retained stably on the cylinder head 33 by the rib portions 103pr, 103qr and 103rr and the attachment boss portions 103p, 103q and 103r.

[0283] Further, the attachment arm portions 77pr, 77qr and 77rr of the electromagnetic solenoid 75 are abutted with and attached to the rib portions 103pr, 103qr and 103rr and the attachment boss portions 103p, 103q and 103r. Therefore, the rib portions 103pr, 103qr and 103rr and the attachment boss portions 103p, 103q and 103r can be maintained in a high rigidity state. Consequently, the electromagnetic solenoid 75 can be supported further firmly.

[0284] The accommodation cases 77 and 78 and the attachment arm portions 77pr, 77qr and 77rr of the electromagnetic solenoid 75 are made of a metal. Therefore, heat generated in the accommodation cases 77 and 78 for the electromagnetic solenoid 75 can be transmitted from the attachment arm portions 77pr, 77qr and 77rr to the rib portions 103pr, 103qr and 103rr. Therefore, the heat radiation efficiency of the electromagnetic solenoid 75 can be improved.

[0285] Further, the rib portions 103pr, 103qr and 103rr and the attachment boss portions 103p, 103q and 103r are formed in a projecting manner on the wall face of the left side wall 100L of the cylinder head 33. Therefore, those portions of the attachment arm portions 77pr, 77qr and 77rr abutted by the rib portions 103pr, 103qr and 103rr and attachment boss portions 103p, 103q and 103r which protrude from the abutting face cooperate with the wall face of the left side wall 100L of the cylinder head 33 to form a space therebetween (refer to FIG. 8). As running wind enters the space, the attachment arm portions 77pr, 77qr and 77rr can be cooled, and consequently, the cooling effect can be raised.

[0286] As shown in FIGS. 10 and 14, the oil passage 133 is formed in the left side wall 100L, to which the electromagnetic solenoid 75 of the cylinder head 33 is attached, in the neighborhood of the electromagnetic solenoid 75. Therefore, the electromagnetic solenoid 75 can be cooled effectively by oil flowing in the oil passage 133.

[0287] The present OHC type internal combustion engine 30 is incorporated in the vehicle body frame of the scooter type motorcycle 1, which is a saddle type vehicle, in a posture in which the cylinder axial line Cc is tilted forward greatly to a position proximate to a horizontal position. Further, the electromagnetic solenoid 75 which is a pressing force generation source is attached to the wall face of the left side wall 100L of the cylinder head 33 which is directed in the vehicle widthwise direction. Furthermore, the outer side of the electromagnetic solenoid 75 in the vehicle widthwise direction is covered with the connection pipe 6 which is part of the vehicle body frame. Therefore, the electromagnetic solenoid 75 is disposed between the cylinder head 33 and the connection pipe 6. Consequently, the electromagnetic solenoid 75 can be protected effectively from an external factor by the cylinder head 33 and the connection pipe 6.

[0288] As shown in FIG. 2, the water pump 150 is attached to the wall face of the right side wall 100R on the opposite side to the wall face of the left side wall 100L to which the electromagnetic solenoid 75 of the cylinder head 33 is attached. Therefore, the electromagnetic solenoid 75 and the water pump 150 which are heavy articles are attached in a distributed manner on the opposite side wall faces directed in the vehicle widthwise direction of the cylinder head 33 so that they do not interfere with each other. Consequently, the weight balance around the cylinder head 33 can be improved. Further, also where both of the electromagnetic solenoid 75 and the water pump 150 are attached to the cylinder head 33, the maintenance performance of the ignition plug 49 can be assured favorably by attaching the ignition plug 49 in such a manner as illustrated in FIG. 3 to the left side wall 100L to which the electromagnetic solenoid 75 is attached.

[0289] As shown in FIG. 2, the breather chamber 34b is provided on the inner side of the head cover 34, and the exit portion 34c of the breather chamber 34b is formed on the outer wall face of the head cover 34 such that the opening thereof is directed to the water pump 150 side in the vehicle widthwise direction. Therefore, the breather hose 146 connected to the exit portion 34c of the breather chamber 34b of the head cover 34 and extending to the water pump 150 side does not interfere with the electromagnetic solenoid 75 on the opposite side. Also it can be avoided readily for the breather hose 146 to interfere with the water pump 150 provided on the crankcase 31 side with respect to the electromagnetic solenoid 75.

[0290] In the embodiment described above, the oil supply hole 130 with respect to the sandwiched inner space 80 when the electromagnetic solenoid 75 is in an inactive state is offset to the push rod 74 side (right side). However, the oil supply hole 130 with respect to the sandwiched inner space 80 may be offset alternatively to the operating rod 76 side (left side).

[0291] However, it is necessary to employ a configuration in which, when the electromagnetic solenoid 75 is in an inactive state, the oil supply hole 130 is in a communicated state with the sandwiched inner space 80 and oil is supplied into the sandwiched inner space 80.

[0292] In such a configuration as just described, when the electromagnetic solenoid 75 is in an inactive state, the right end portion of the operating rod 76 closes part of the communication hole on the boundary between the oil supply hole 130 and the rod sliding hole 102. Therefore, the sandwiched inner space 80 is in a state proximate to that of a closed space.

[0293] Accordingly, at an initial stage when the electromagnetic solenoid 75 is rendered operative to project the operating rod 76, flowing out of the oil in the sandwiched inner space 80 from the oil supply hole 130 is suppressed. Therefore, the damper function as an oil damper for pressing the push rod 74 through the oil in the sandwiched inner space 80 by the operating rod 76 can be enhanced, and an impact and vibration by collision can be buffered.

[0294] In the variable valve apparatus 70 for the present OHC type internal combustion engine 30, the connection pin 71 is disposed between the rocker arm shaft insertion holes 57h and 58h for the first and second rocker arms 57 and 58 and the action side end portions 57vv and 58vv which act on the first and second intake valves 61 and 62 as shown in FIG. 6. Therefore, the connection pin 71 can be provided not at a position swollen by a great amount to the head cover 34 side from the intake rocker arm shaft 55 but at a position nearer to the intake rocker arm shaft 55 in the cylinder axial line direction on the crankcase 31 side. Therefore, there is no necessity to make the first and second intake rocker arms 57 and 58 themselves swell to the head cover 34 side to increase the size of them. In addition, increase in size of the cylinder head 33 and the head cover 34 can be avoided.

[0295] Further, the rod sliding hole 102 which is a pressing force transmission member sliding hole is formed on the cylinder head 33 at the position at which it overlaps with the intake rocker arm shaft supporting hole 122h in the cylinder axial line direction between the stud bolt fastening hole 125 and the rocker arm shaft supporting hole 122h as shown in FIG. 10. Therefore, the push rod 74 and the operating rod 76 which are pressing force transmission members can be disposed compactly making use of the space between the stud bolt fastening hole 125 and the intake rocker arm shaft supporting hole 122h. Further, the push rod 74 and the operating rod 76 which are pressing force transmission members are provided at the position at which they overlap with the intake rocker arm shaft 55 in the cylinder axial line direction. Therefore, the cylinder head 33 can be miniaturized in the cylinder axial line direction, and increase in size of the cylinder head 33 and the head cover 34 can be avoided more and more.

[0296] Specifically, as the OHC type internal combustion engine 30 to be incorporated in the present scooter type motorcycle 1 which is a saddle type vehicle in which it is difficult to assure a space, the OHC type internal combustion engine of the present invention which avoids increase in size of the cylinder head 33 and associated elements can be suitably applied.

[0297] It is to be noted that, while, in the present embodiment, the push rod 74 and the operating rod 76 as pressing force transmission members are formed as separate members, also it is possible in the present invention to apply them as a single rod.

[0298] Further, the adjustment screws 57t and 58t for adjusting the abutting position with the first and second intake valves 61 and 62 are screwed in the action side end portions 57vv and 58vv of the first and second intake rocker arms 57 and 58 as shown in FIG. 6. Further, the axial line Cp of the connection pin 71 is disposed between the head side end portions 57tt and 58tt of the adjustment screws 57t and 58t and the axial line Cr of the rocker arm shaft insertion holes 57h and 58h in the cylinder axial line direction. Therefore, the intake rocker arm shaft 55, connection pin 71 and adjustment screws 57t and 58t can be juxtaposed on a substantially straight line. Consequently, the valve side arm portions 57v and 58v of the first and second intake rocker arms 57 and 58 from the rocker arm shaft insertion holes 57h and 58h to the action side end portions 57vv and 58vv which act on the first and second intake valves 61 and 62 can be formed in a substantially liner shape. Therefore, the first and second intake rocker arms 57 and 58 can be miniaturized in a high space efficiency.

[0299] Further, the portions of the first and second intake rocker arms 57 and 58 in which the connection pin 71 is fitted for movement are formed with a thickness increased by an amount by which the connection pin 71 is fitted and supported. Therefore, the rigidity of the valve side arm portions 57v and 58v from the rocker arm shaft insertion holes 57h and 58h to the action side end portions 57vv and 58vv which act on the first and second intake valves 61 and 62 can be raised.

[0300] The connection pin 71 and the push rod 74 and operating rod 76 which are pressing force transmission members are provided on the crankcase 31 side with respect to the mating face 100t between the cylinder head 33 and the head cover 34 as shown in FIG. 6. Therefore, the intake rocker arm shaft 55, connection pin 71 and adjustment screws 57t and 58t are juxtaposed on a straight line, and the adjustment screws 57t and 58t are positioned in the proximity of the mating face 100t between the cylinder head 33 and the head cover 34. Consequently, an adjustment operation of the adjustment screws 57t and 58t can be carried out readily.

[0301] Especially, the connection pin 71, push rod 74 and operating rod 76 are positioned on the crankcase 31 side with respect to the head side end portions 57tt and 58tt of the adjustment screws 57t and 58t. Therefore, an adjustment operation by the adjustment screws 57t and 58t can be carried out more readily.

[0302] The push rod 74 and the operating rod 76 neighbor with the stud bolts 180 as shown in FIGS. 6 and 7. Therefore, the stud bolt fastening hole 125 and the rod sliding hole 102 which is a pressing force transmission member sliding hole 102 of the cylinder head 33 can be positioned as near as possible to the intake rocker arm shaft supporting hole 122h. Consequently, miniaturization of the cylinder head 33 can be anticipated.

[0303] The axial line Cd of the push rod 74 and the operating rod 76 is positioned on the crankcase 31 side with respect to the axial line Cp of the connection pin 71 as shown in FIG. 6. Therefore, the electromagnetic solenoid 75 which presses the push rod 74 and the operating rod 76 can be disposed near to the crankcase 31 side. Consequently, the swelling amount of the electromagnetic solenoid 75 to the head cover 34 side in the cylinder axial line direction can be reduced.

[0304] Further, the axial line Cd of the push rod 74 and the operating rod 76 is positioned on the intake rocker arm shaft 55 side with respect to the axial line Cp of the connection pin 71 as shown in FIG. 6. Therefore, a configuration wherein, while the push rod 74 and the operating rod 76 avoid interference with the stud bolts 180, they press the connection pin 71 efficiently can be implemented.

[0305] The electromagnetic solenoid 75 is fixedly secured only to the cylinder head 33 as shown in FIGS. 3 and 14. Therefore, the shape of the mating face between the cylinder head 33 and the head cover 34 can be simplified. Besides, since the necessity to fix the electromagnetic solenoid 75 to the head cover 34 side is eliminated, also simplification of the head cover 34 can be achieved.

[0306] Further, upon maintenance of the valve system in the cylinder head 33, the head cover 34 can be removed without removing the electromagnetic solenoid 75. Therefore, the maintenance operation of the valve system can be facilitated.

[0307] A variable valve apparatus for an OHC type internal combustion engine is provided and which includes a crankcase (31), a cylinder block (32) and a cylinder head (33) placed in order on the crankcase (31) and fastened together by a plurality of stud bolts (180) extending through the cylinder block (32) and the cylinder head (33) in a cylinder axial line direction, a plurality of rocker arms (57, 58) arrayed and supported for rocking motion in a mutually neighboring relationship on a rocker arm shaft (55) in the inside of the cylinder head (33) and operable in an interlocking relationship with engine valves (61, 62), and a head cover (34) placed on the cylinder head (33) to cover the cylinder head (33). The variable valve apparatus comprises: a connection pin (71) fitted for movement in an axial direction of the rocker arm shaft (55) in the rocker arms (57, 58) positioned adjacent each other and movable between a connection position at which the connection pin (71) connects the rocker arms (57, 58) positioned adjacent each other to each other for integral rocking motion and a disconnection position at which the connection pin (71) disconnects the rocker arms (57, 58) from each other to allow independent rocking motion of each of the rocker arms (57, 58); and a pressing force transmission member (74, 76) configured to transmit pressing force of a pressing force generation source (75) disposed outside the cylinder head (33) to the connection pin (71) to move the connection pin (71). The pressing force generation source (75) being attached to a wall face (100L) of the cylinder head (33) on which an ignition plug (49) is provided in a projecting manner. An accommodation case (77, 78) which accommodates a main body of the pressing force generation source (75) therein being provided at a position at which the accommodation case (77, 78) does not overlap with an ignition plug center axial line (Cs), which is directed by the ignition plug (49), as viewed in the cylinder axial line direction.

[0308] The pressing force generation source (75) can be positioned on the head cover (34) side with respect to the ignition plug (49).

[0309] The pressing force transmission member (74, 76) can be provided for sliding movement on the cylinder head (33).

[0310] The pressing force generation source (75) can have a plurality of attachment arm portions (77pr, 77qr, 77rr) formed around the accommodation case (77, 78) so as to extend radially along the wall face (100L) of the cylinder head (33), and the attachment arm portions (77pr, 77qr, 77rr) can be attached only to the cylinder head (33).

[0311] From among the attachment arm portions (77pr, 77qr, 77rr), the attachment arm portion (77pr) which extends in a direction overlapping with the ignition plug center axial line (Cs) as viewed in the cylinder axial line direction can have a recessed portion (77d) formed thereon so as to be open toward the ignition plug (49) side in such a manner that the recessed portion (77d) crosses but keeps away from the ignition plug center axial line (Cs).

[0312] On the cylinder head (33), rib portions (103pr, 103qr, 103rr) with which the attachment arm portions (77pr, 77qr, 77rr) extending from the periphery of the accommodation case (77, 78) can be abutted and attachment boss portions (103p, 103q, 103r) at end portions of the rib portions (103pr, 103qr, 103rr) can be formed in a projecting manner, and the attachment arm portions (77pr, 77qr, 77rr) can be attached to the attachment boss portions (103p, 103q, 103r).

[0313] The accommodation case (77, 78) and the attachment arm portions (77pr, 77qr, 77rr) of the pressing force generation source (75) can be made of a metal.

[0314] On the wall face (100L) to which the pressing force generation source (75) of the cylinder head (33) is attached, an oil passage (133) can be formed in the proximity of the pressing force generation source (75).

[0315] The OHC type internal combustion engine (30) can be mounted on a vehicle body frame of a saddle type vehicle (1) in a posture in which a cylinder axial line (Cc) is tilted forward greatly to a position proximate to a horizontal position. The pressing force generation source (75) can be attached to the side wall face (100L) of the cylinder head (33) directed in the vehicle widthwise direction. The pressing force generation source (75) can be covered on the outer sides thereof in the vehicle widthwise direction with part (6) of the vehicle body frame.

[0316] A water pump (150) can be attached to a side wall face (100R) of the cylinder head (33) on the opposite side to the side wall face (100L) to which the pressing force generation source (75) is attached.

[0317] The water pump (150) can be disposed on the crankcase side with respect to the pressing force generation source (75) in the cylinder axial line direction. A breather chamber (34b) can be provided on the inner side of the head cover (34). An exit portion (34c) of the breather chamber (34b) can be formed on an outer wall face of the head cover (34) such that an opening thereof is directed to the water pump (150) side in the vehicle widthwise direction.

[Description of Reference Symbols]

[0318] 1 ... Scooter type motorcycle, 4 ... Floor pipe, 5 ... Main pipe, 6 ... Connection pipe, 20 ... Power unit, 30 ... Internal combustion engine, 31 ... Crankcase, 32 ... Cylinder block, 33 ... Cylinder head, 34 ... Head cover, 34b ... Breather chamber, 49 ... Ignition plug, 50 ... Valve mechanism, 54 ... Camshaft, 55 ... Intake rocker arm shaft, 56 ... Exhaust rocker arm shaft, 57 ... First intake rocker arm, 57t ... Adjustment screw, 57h ... Rocker arm shaft insertion hole, 58 ... Second intake rocker arm, 58t ... Adjustment screw, 58h ... Rocker arm shaft insertion hole, 59 ... Exhaust rocker arm, 61 ... First intake valve, 62 ... Second intake valve, 63 ... First exhaust valve, 64 ... Second exhaust valve, 70 ... Variable valve apparatus, 71 ... Connection pin, 72 ... Disconnection piston, 74 ... Push rod, 75 ... Electromagnetic solenoid, 76 ... Operating rod, 77 ... Accommodation case, 77a ... Cylindrical portion, 77b ... Bottom wall portion, 77p, 77q, 77r ... Attachment boss portion, 77pr, 77qr, 77rr ... Attachment arm portion, 77d ... Recessed portion, 80 ... Sandwiched inner space, 100 ... Outer peripheral wall, 100L ... Left side wall, 100R ... Right side wall, 101 ... Ignition plug mounting hole, 102 ... Rod sliding hole, 103p, 103q, 103r ... Attachment boss portion, 103pr, 103qr, 103rr ... Rib portion, 104p, 104q, 104r ... Bolt, 110 ... Inner wall, 112 ... Intake rocker arm shaft supporting portion, 112h ... Intake rocker arm shaft supporting hole, 113 ... Exhaust rocker arm shaft supporting portion, 113h ... Exhaust rocker arm shaft supporting hole, 115, 116 ... Stud bolt fastening hole, 122 ... Intake rocker arm shaft supporting portion, 122h ... Intake rocker arm shaft supporting hole, 125, 126 ... Stud bolt fastening hole, 130 ... Oil supply hole, 131, 132, 133 ... Oil passage, 135 ... Oil guide groove, 136 ... Rib, 140, 141 ... Reinforcement plate, 146 ... Breather hose, 150 ... Water pump, 180 ... Stud bolt, 181 ... Hexagonal nut.

Claims

1. A saddle type vehicle comprising, supported for rocking motion on a vehicle body frame, a power unit (20) including an OHC type internal combustion engine (30) and a belt-type continuously variable transmission (21);
the OHC type internal combustion engine (30) having a cylinder axial line (Cc) tilted forward greatly and being provided therein with a plurality of rocker arms (57, 58) arrayed and supported for rocking motion in a mutually neighboring relationship on a rocker arm shaft (55) and operable in an interlocking relationship with engine valves (61, 62);
a connection pin (71) fitted for movement in an axial direction of the rocker arm shaft (55) in the rocker arms (57, 58) positioned adjacent each other being provided to be movable between a connection position at which the connection pin (71) connects the rocker arms (57, 58) positioned adjacent each other to each other for integral rocking motion and a disconnection position at which the connection pin (71) disconnects the rocker arms (57, 58) from each other to allow independent rocking motion of each of the rocker arms (57, 58);
a pressing force transmission member (74, 76) being provided which transmits pressing force of a pressing force generation source (75) disposed outside the OHC type internal combustion engine (30) to the connection pin (71) to move the connection pin (71) in the vehicle widthwise direction,
wherein the OHC type internal combustion engine (30) has side walls (100L, 100R) directed in the vehicle widthwise direction and side walls (100U, 100S) directed in a vertical direction, the side walls together assuming a rectangular tubular shape,
the pressing force generation source (75) is attached to one of the side walls (100L, 100R) directed in the vehicle widthwise direction, and
the OHC type internal combustion engine (30) is a water-cooled internal combustion engine, and a water pump (150) is supported on one side wall on the opposite side to the side wall to which the pressing force generation source (75) is attached, of the side walls (100L, 100R) directed in the vehicle widthwise direction.

2. The saddle type vehicle according to claim 1, comprising a camshaft (54) configured to drive the rocker arms (57, 58),
wherein the OHC type internal combustion engine (30) is provided therein with a cam chain chamber (52) through which a cam chain (51) extending between and around the camshaft (54) and a crankshaft (35) passes, and
the cam chain chamber (52) is formed between one side wall on the opposite side to the side wall to which the pressing force generation source (75) is at-

tached, of the side walls (100L, 100R) directed in the vehicle widthwise direction, and an inner wall (110) on an inner side of the one side wall.

3. The saddle type vehicle according to claim 2, wherein the camshaft (54) is supported for rotation on the inner wall (110) through a bearing (82), the cam chain chamber (52) is disposed adjacent and on one side in the vehicle widthwise direction of the bearing (82), and a decompression mechanism (85) is incorporated in an exhaust cam lobe (54e) provided adjacent and on the other side in the vehicle widthwise direction of the bearing (82).

4. The saddle type vehicle according to any one of claims 1 to 3, wherein the pressing force generation source (75) is provided with a boss portion (77bb) adapted to support the pressing force transmission member (76) for sliding movement, the boss portion (77bb) being formed in a projecting manner for fitting into the OHC type internal combustion engine (30), and the pressing force generation source (75) is fitted in the OHC type internal combustion engine (30) through an O-snap ring (84) which is provided on the boss portion (77bb), and a seal member (83) which is provided between the OHC type internal combustion engine (30) and an end portion of the boss portion (77bb).

5. The saddle type vehicle according to any one of claims 1 to 4, wherein part of the vehicle body frame is provided on an outer side of the pressing force generation source (75) in the vehicle widthwise direction.

6. The saddle type vehicle according to claim 5, wherein the vehicle body frame includes a head pipe (2), a down tube (3) extending downwardly from the head pipe (2), and a pair of left and right floor pipes (4) extending rearwardly below a floor section (1c), which is disposed between a vehicle body front section (1f) and a vehicle body rear section (1r), from the down tube (3), rising obliquely upwardly at a rear portion of the floor section (1c) and extending rearwardly, and the pressing force generation source (75) is located forwardly of those rear portions of the floor pipes (4) which rise obliquely upwardly and extend rearwardly, as viewed in side view.

7. The saddle type vehicle according to claim 5 or 6, wherein the vehicle body frame includes a head pipe (2), a down tube (3) extending downwardly from the head pipe (2), a pair of left and right floor pipes (4) extending rearwardly below a floor section (1c), which is disposed between a vehicle body front section (1f) and a vehicle body rear section (1r), from the down tube (3), rising obliquely upwardly at a rear portion of the floor section (1c) and extending rearwardly, a main pipe (5) connected to the floor pipes (4) and extending rearwardly, and a connection pipe (6) which is projected forwardly from those portions of the pair of left and right floor pipes (4) rising obliquely upwardly and extending rearwardly and is connected to the main pipe (5), and at least part of the pressing force generation source (75) is located below an upper end of the connection pipe (6), as viewed in side view.

8. The saddle type vehicle according to claim 6 or 7, wherein the vehicle body rear section (1r) including the pressing force generation source (75) is covered from left and right sides with a body cover (29e).

9. The saddle type vehicle according to any one of claims 1 to 8, wherein the power unit (20) is supported for rocking motion on the vehicle body frame through a pivot shaft (19), and the pressing force generation source (75) is located forwardly of the pivot shaft (19), as viewed in side view.

10. The saddle type vehicle according to any one of claims 1 to 9, wherein adjustment screws (57t, 58t) are screwed at action end portions (57vv, 58vv) of the rocker arms (57, 58), and an axial line (Cp) of the connection pin (71) is disposed between head side end portions (57tt, 58tt) of the adjustment screws (57t, 58t) and an axial line (Cr) of rocker arm shaft insertion holes (57h, 58h), and upwardly of the axial line (Cr) of the rocker arm shaft insertion holes (57h, 58h).

FIG.1

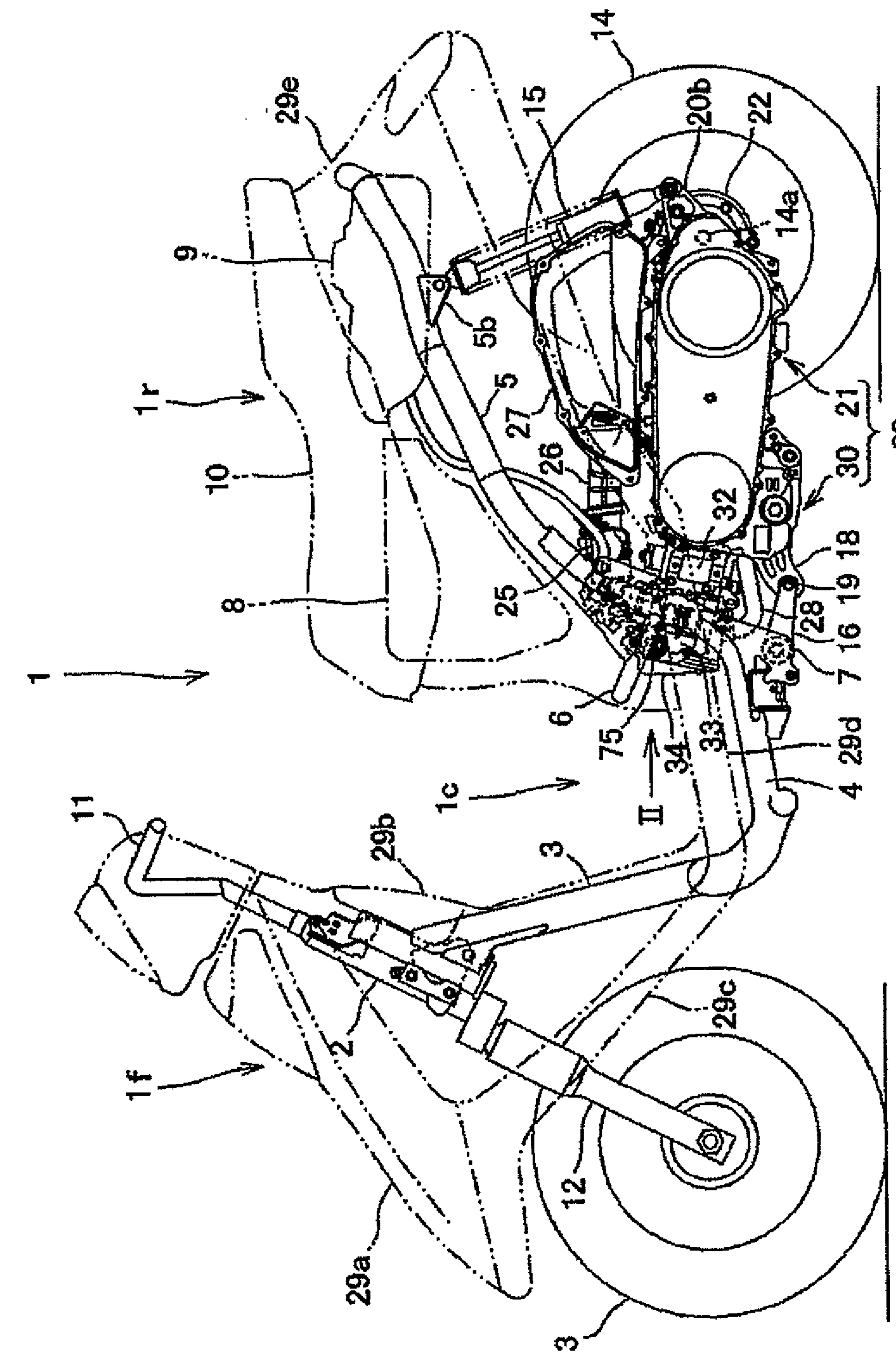

1
1r
1f
1c
2
3
4
5
5b
6
7
8
9
10
11
12
13
14
14a
15
16
18
19
20
20b
21
22
25
26
27
28
29a
29b
29c
29d
29e
30
32
33
34
75
II

FIG.2

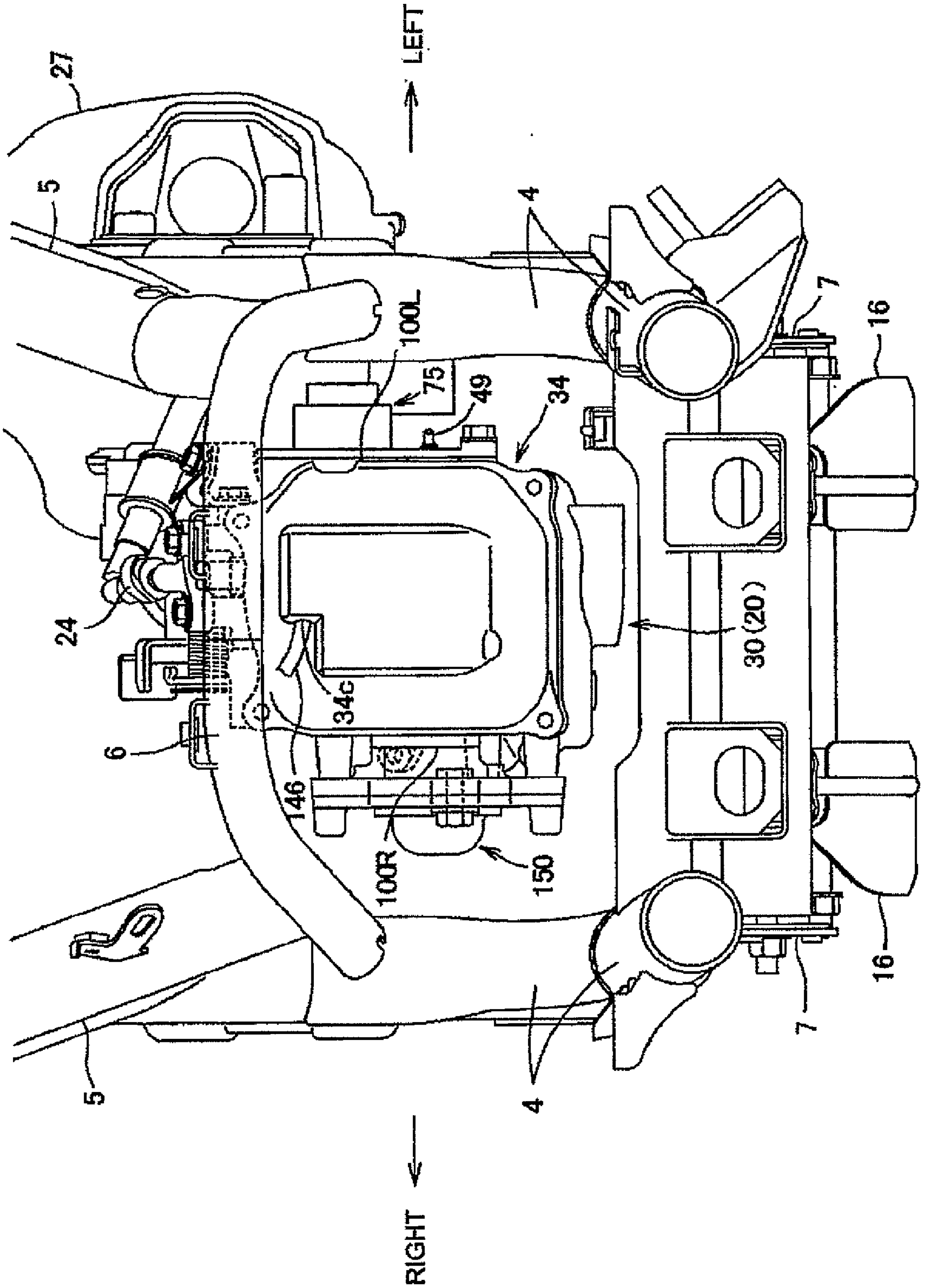

LEFT
RIGHT
27
5
5
4
4
7
7
16
16
100L
75
49
34
30(20)
24
34c
6
146
100R
150

FIG.3

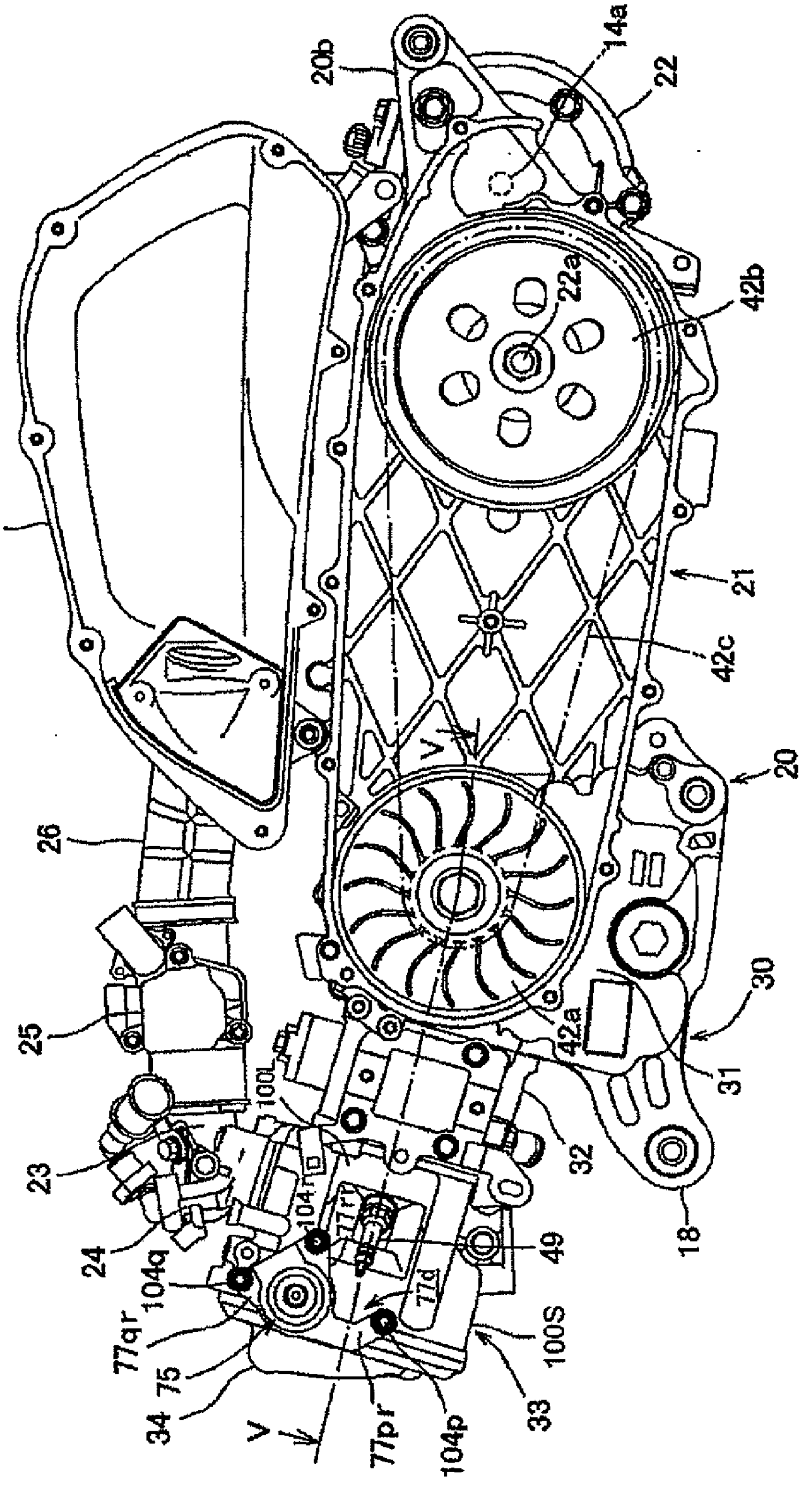

14a
20b
22
22a
42b
27
21
42c
20
26
30
25
42a
31
23
100L
32
24
104r
49
104q
18
77d
77qr
100S
75
34
33
V
77pr
104p

FIG.4

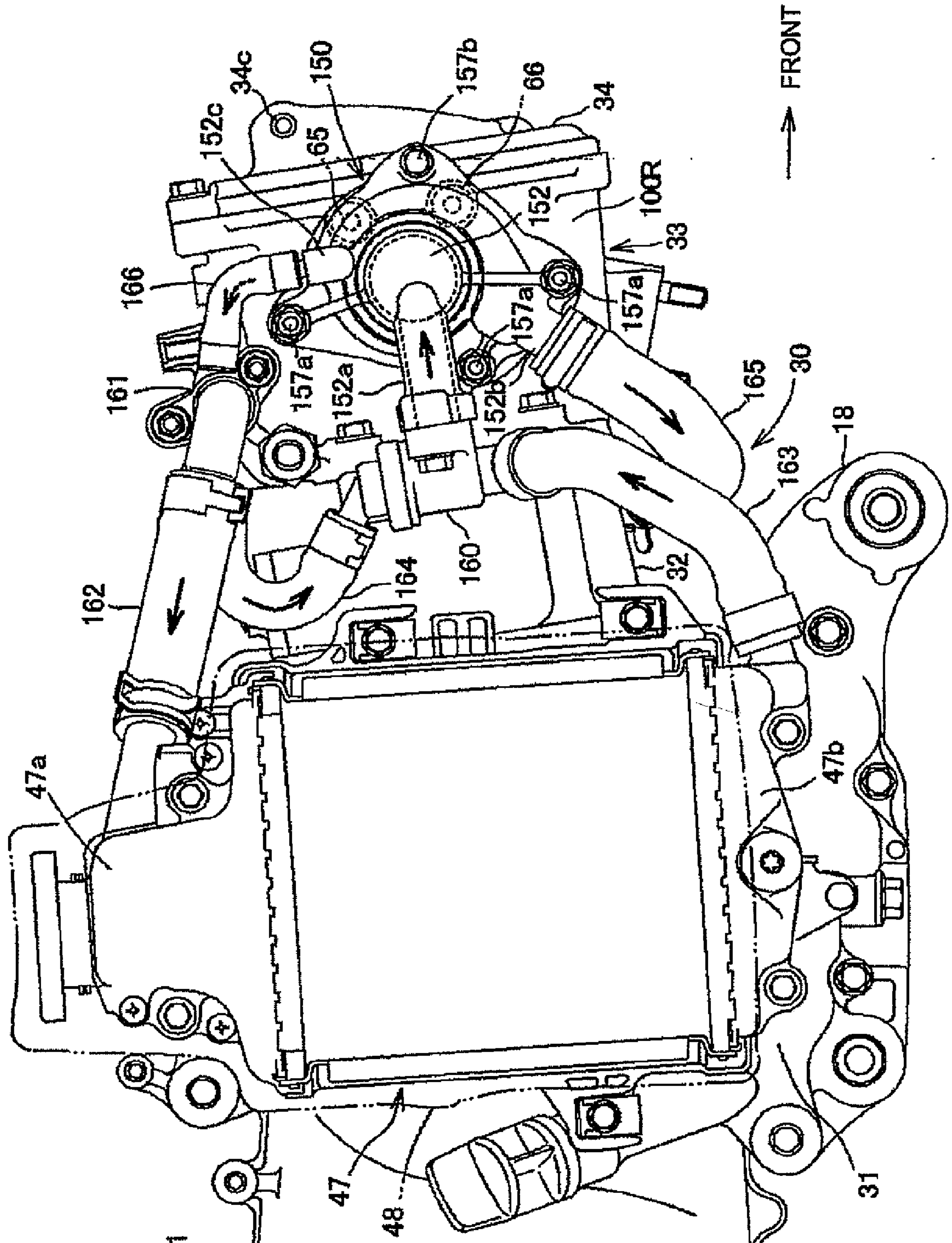

FRONT
34c
150
157b
66
34
152c
65
152
100R
33
166
157a
161
152a
152b
165
30
18
163
160
164
32
162
47a
47b
47
48
31
21

FIG.5

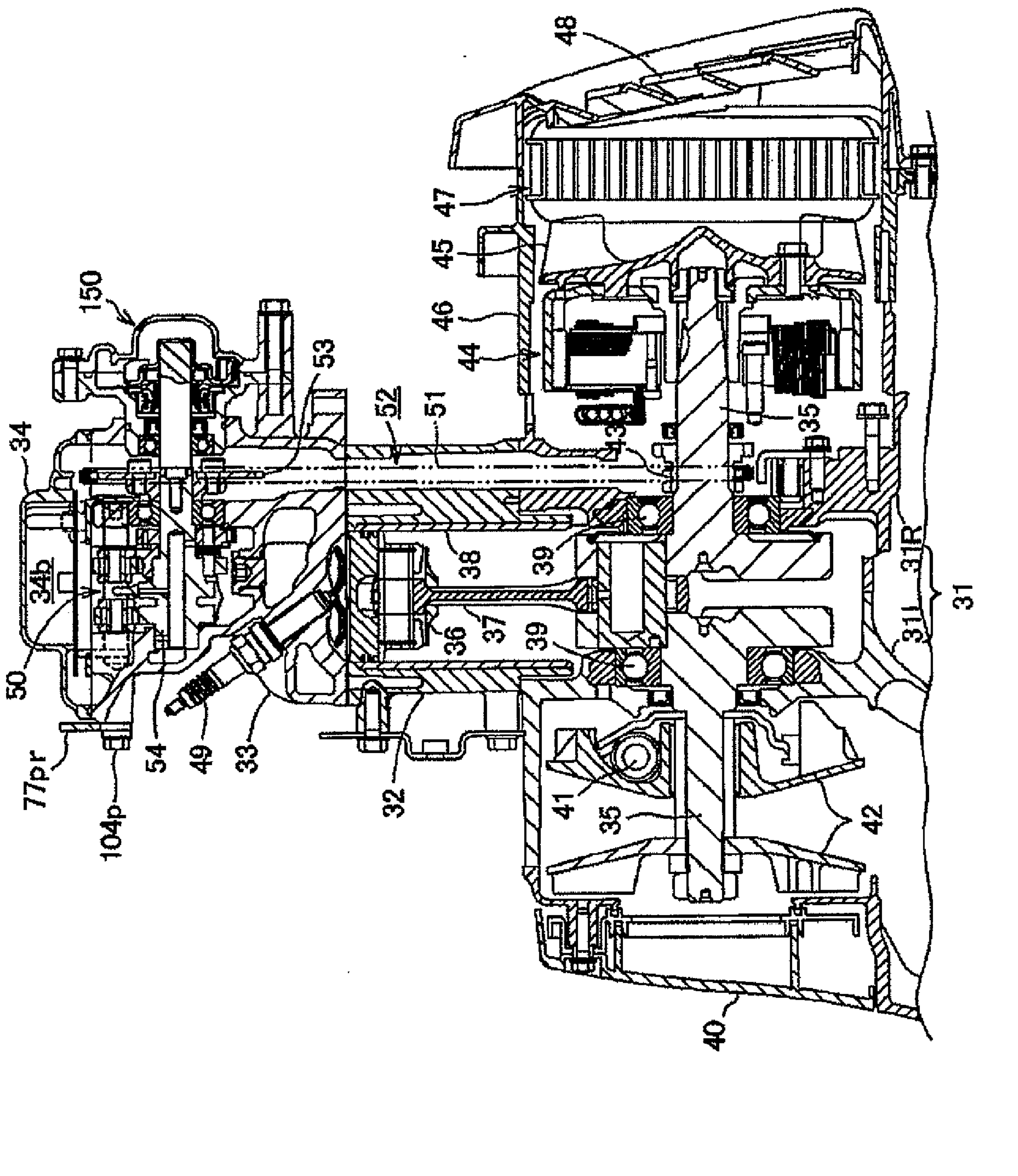

48
47
45
46
44
150
53
52
51
34
35
38
39
31R
31
31L
36
37
50
34b
54
49
33
32
41
42
77pr
104p
40

FIG.6

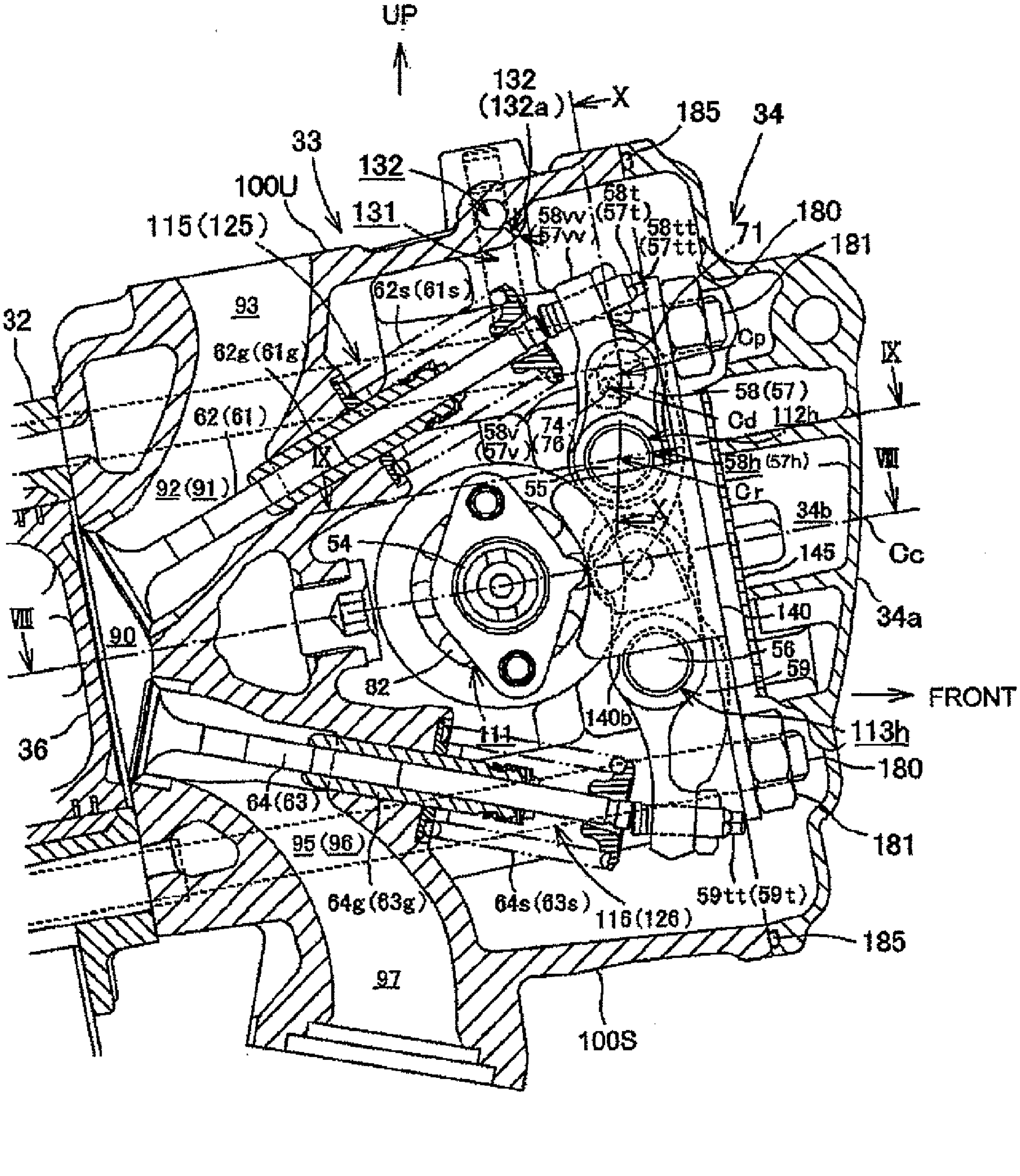

UP
FRONT
132
(132a)
X
185
34
33
100U
132
131
115(125)
58t
(57t)
58vv
57vv
58tt
(57tt)
71
180
181
93
62s(61s)
32
62g(61g)
Cp
IX
58(57)
62(61)
Cd
112h
58v
(57v)
74
(76)
58h (57h)
VIII
92(91)
55
Cr
34b
54
145
Cc
140
34a
VIII
90
56
59
82
111
140b
113h
36
180
64(63)
95(96)
181
64g(63g)
64s(63s)
116(126)
59tt(59t)
185
97
100S

FIG.7

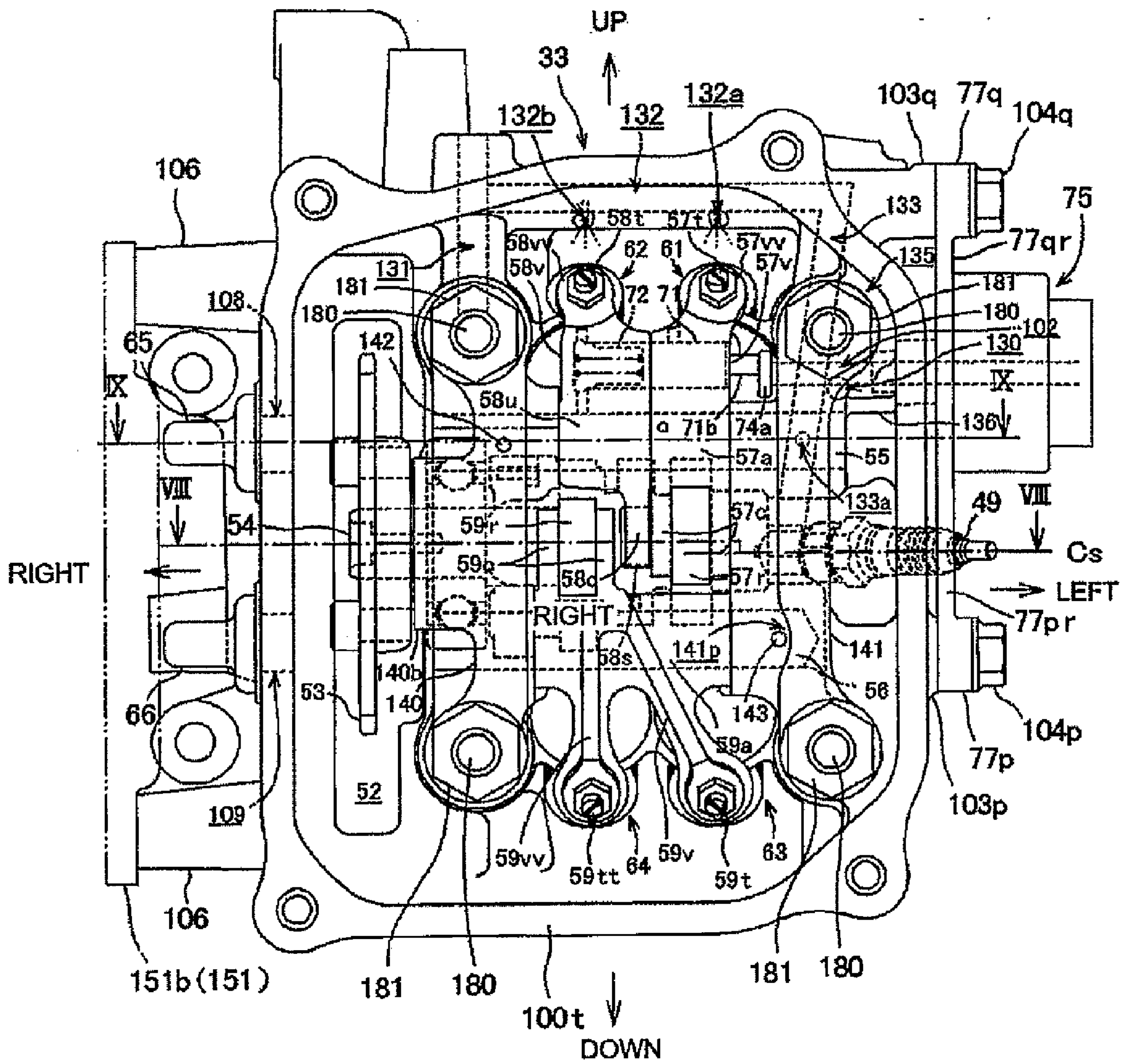


FIG.8

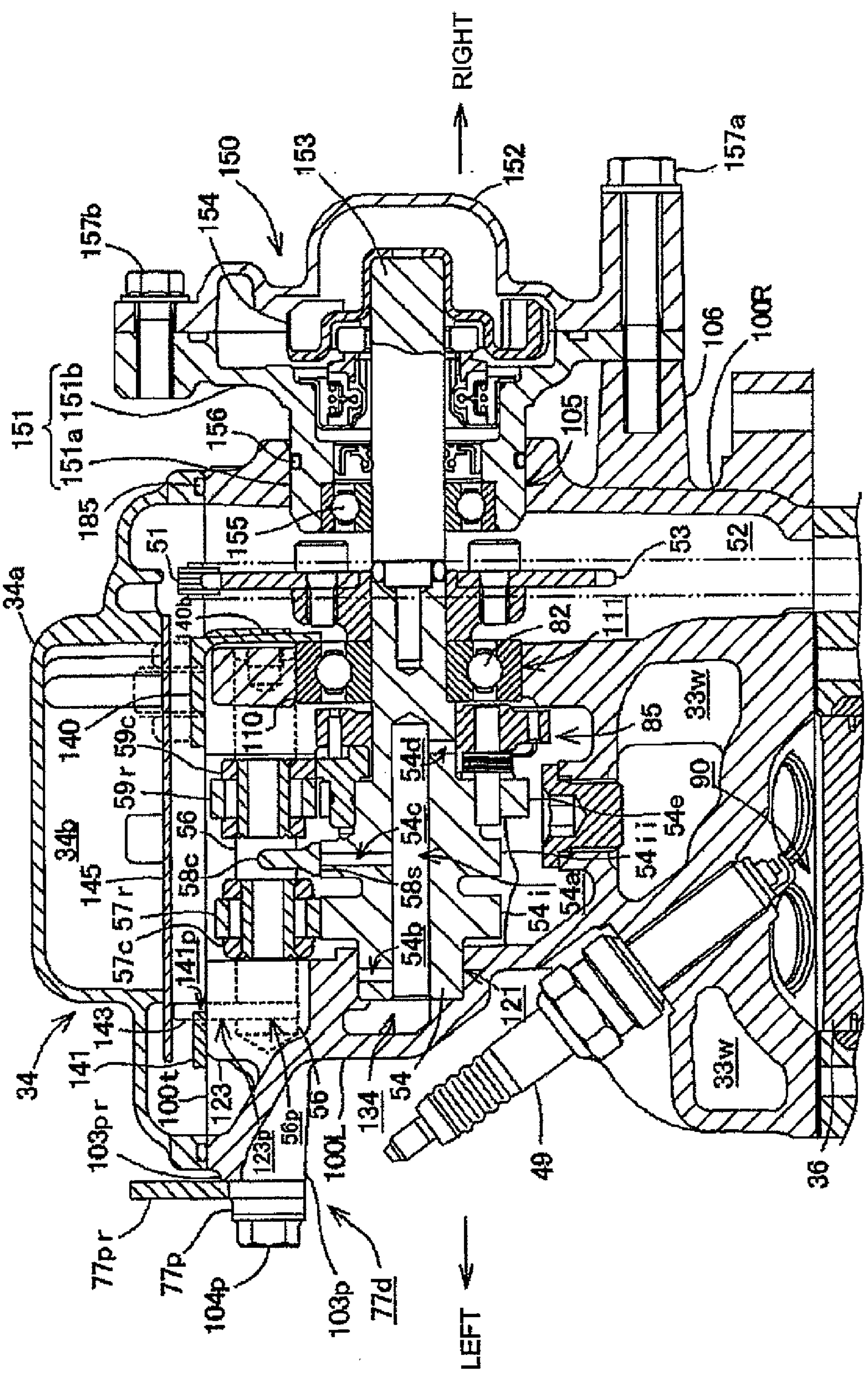

RIGHT
LEFT
150
151
151a
151b
152
153
154
155
156
157a
157b
185
105
106
100R
34a
51
52
53
82
111
110
140
140b
59c
59r
34b
56
58c
58s
54c
54d
85
33w
90
54e
54ii
54i
54a
145
57r
57c
141p
54b
121
143
34
141
100t
123
123p
56p
56
100L
134
54
49
36
103pr
77pr
77p
104p
103p
77d

FIG.9

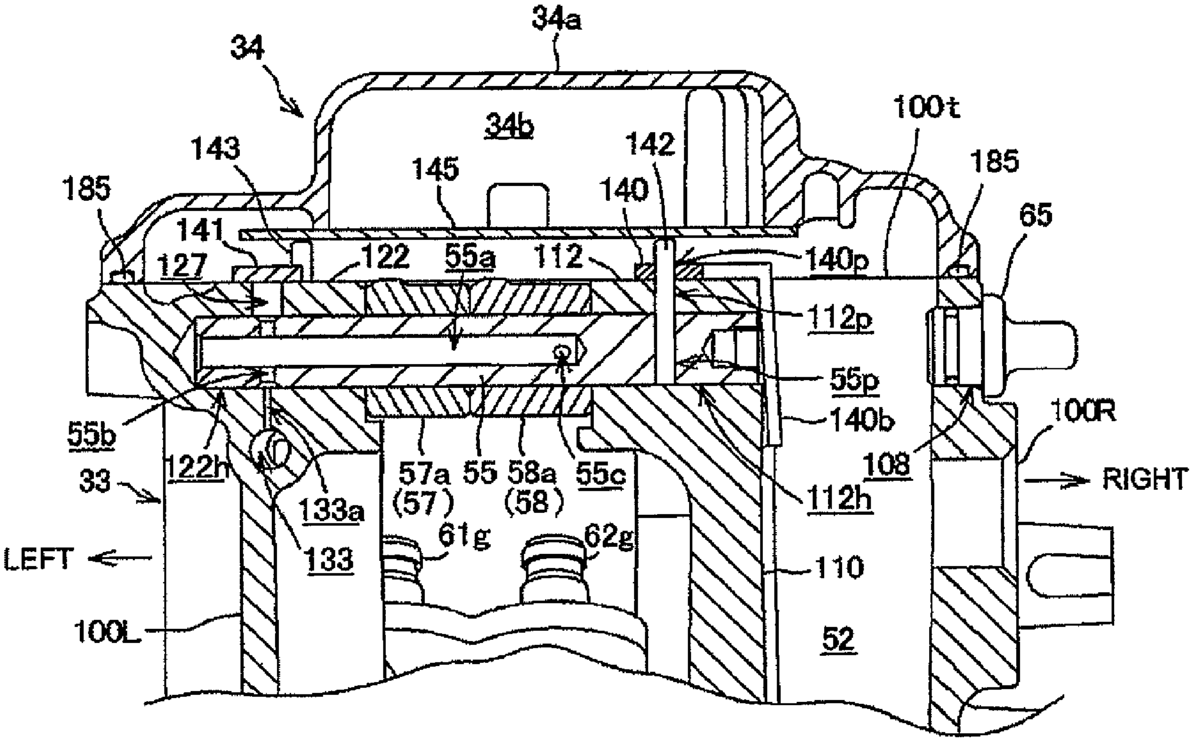

34a
34
34b
143
142
100t
185
145
140
185
141
65
127
122
55a
112
140p
112p
55p
140b
100R
55b
108
33
122h
57a
55
58a
55c
112h
RIGHT
133a
(57)
(58)
LEFT
133
61g
62g
110
100L
52

FIG.10

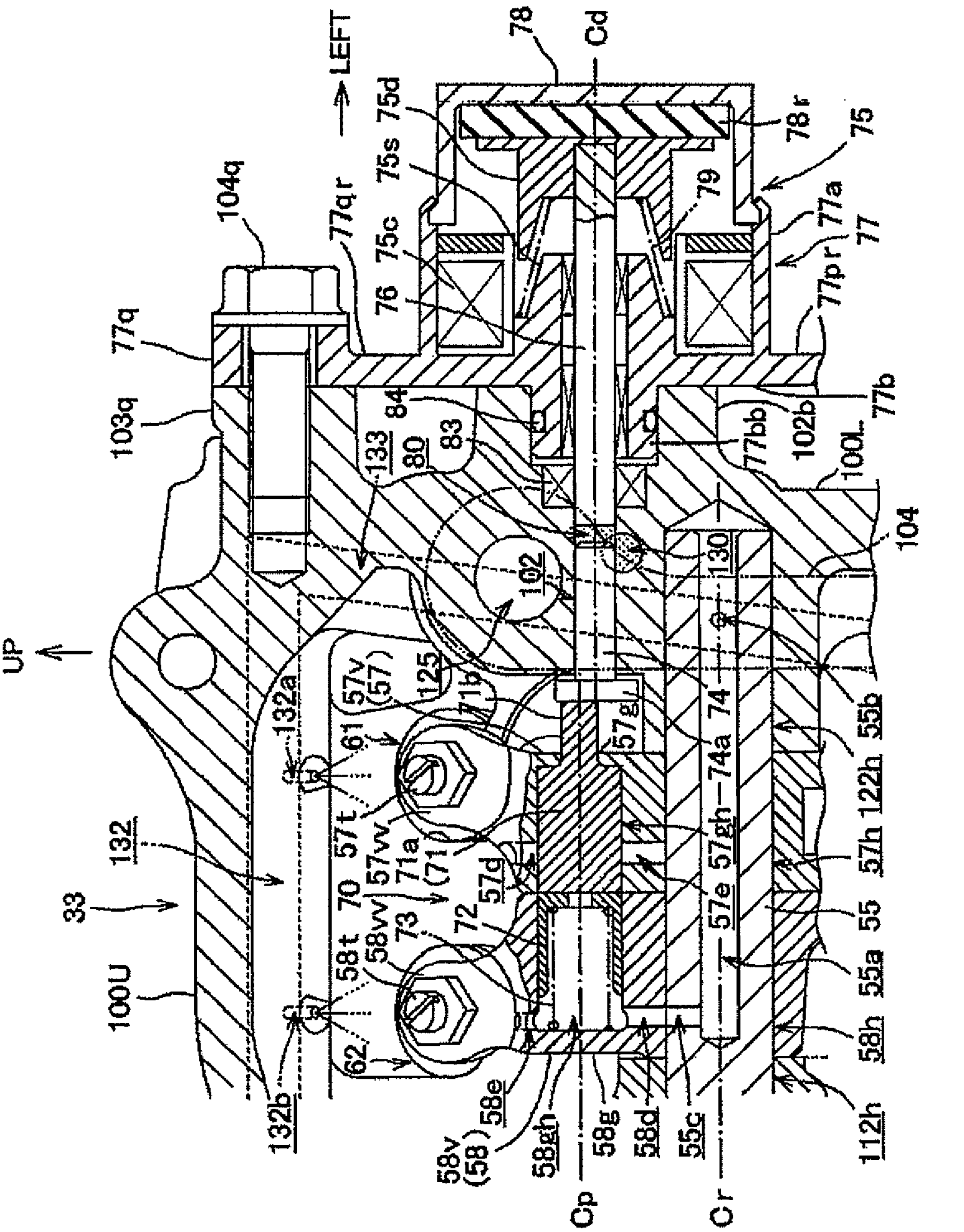


FIG.11

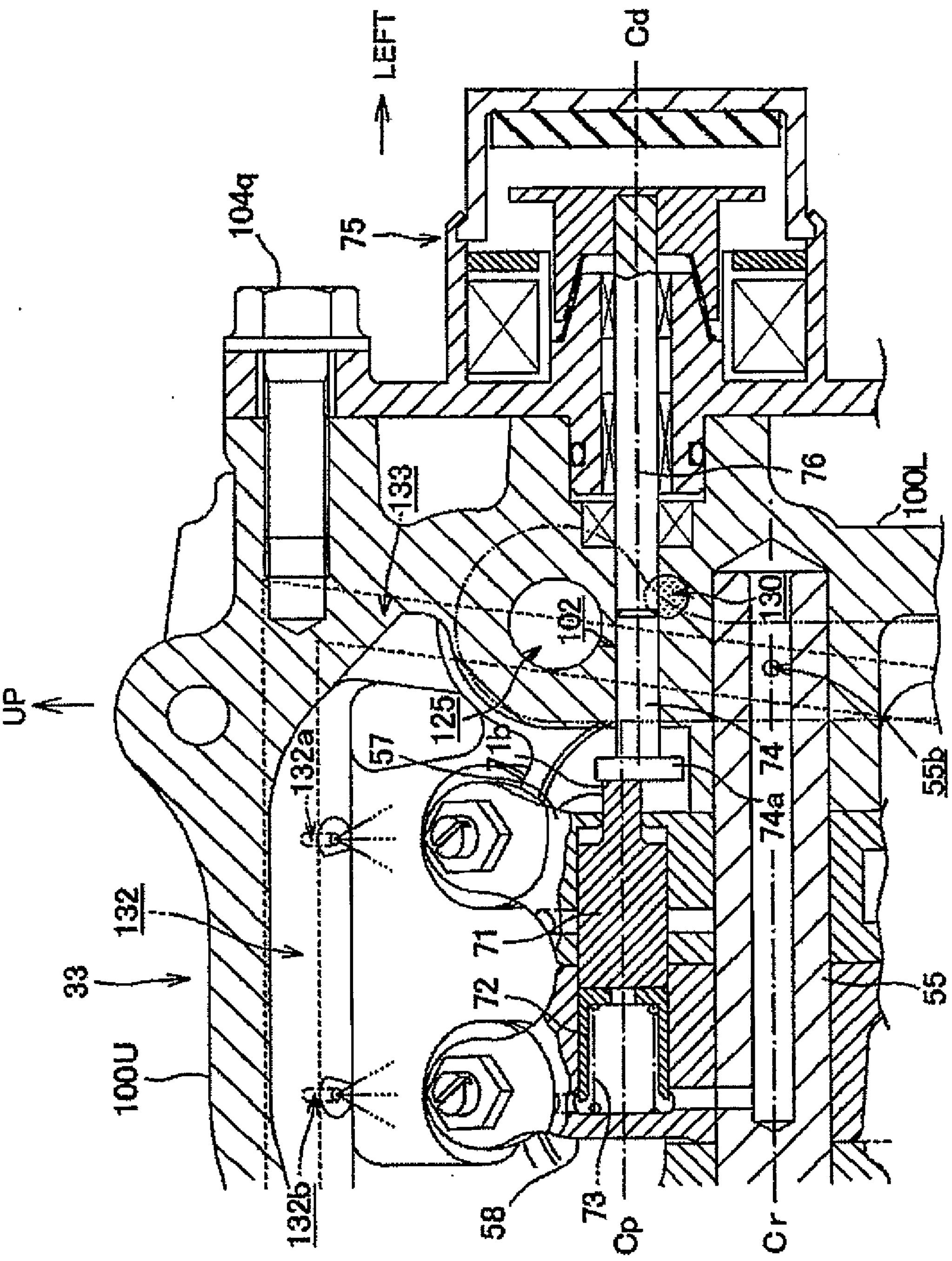
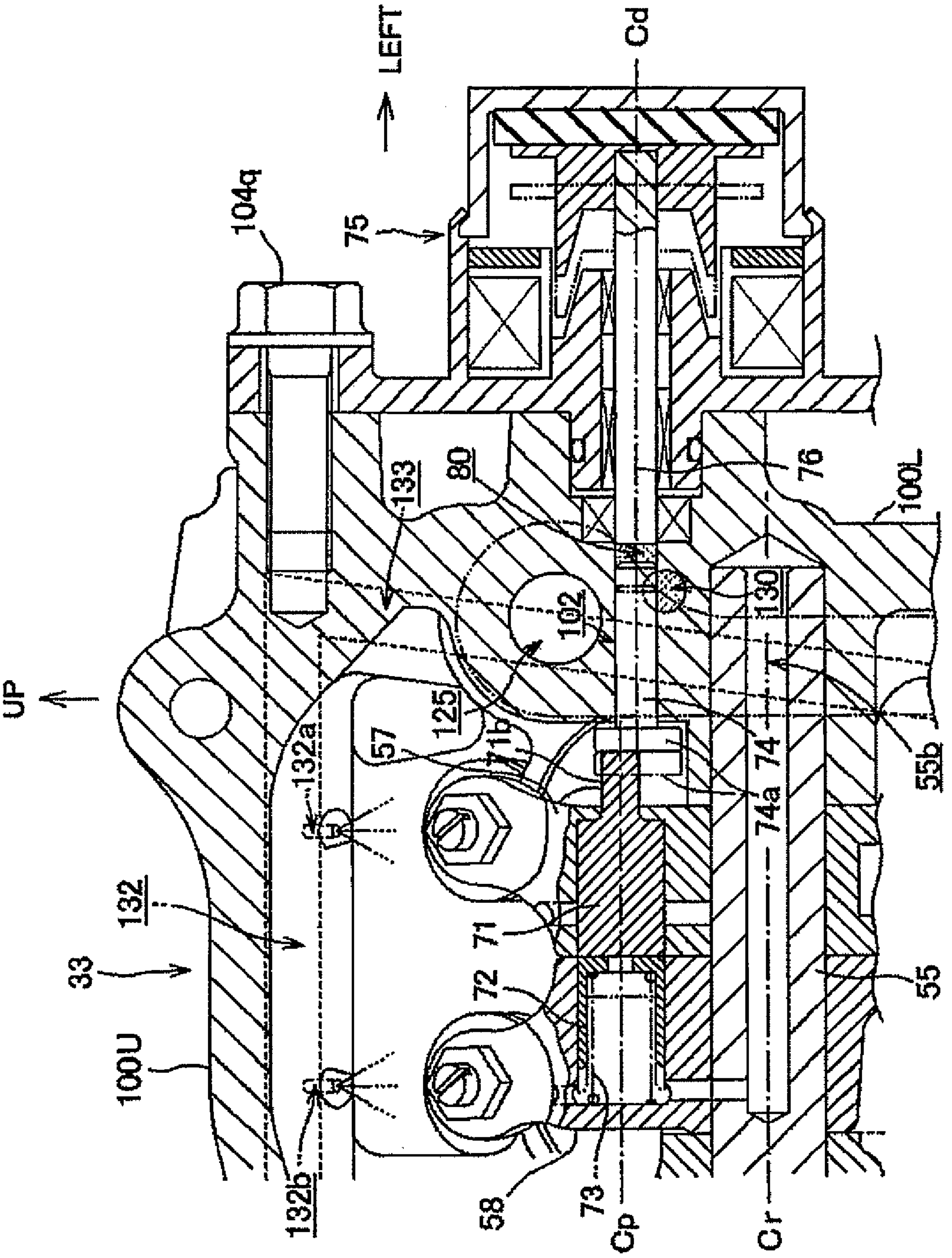

UP
LEFT
104q
75
Cd
133
76
100L
130
102
125
71b
57
132a
132
33
100U
72
71
74
74a
55b
55
58
73
Cp
Cr
132b

FIG.12


UP
LEFT
104q
75
Cd
33
100U
132
132a
132b
133
80
76
100L
130
102
125
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71b
74
74a
55b
71
72
55
58
73
Cp
Cr

FIG.13

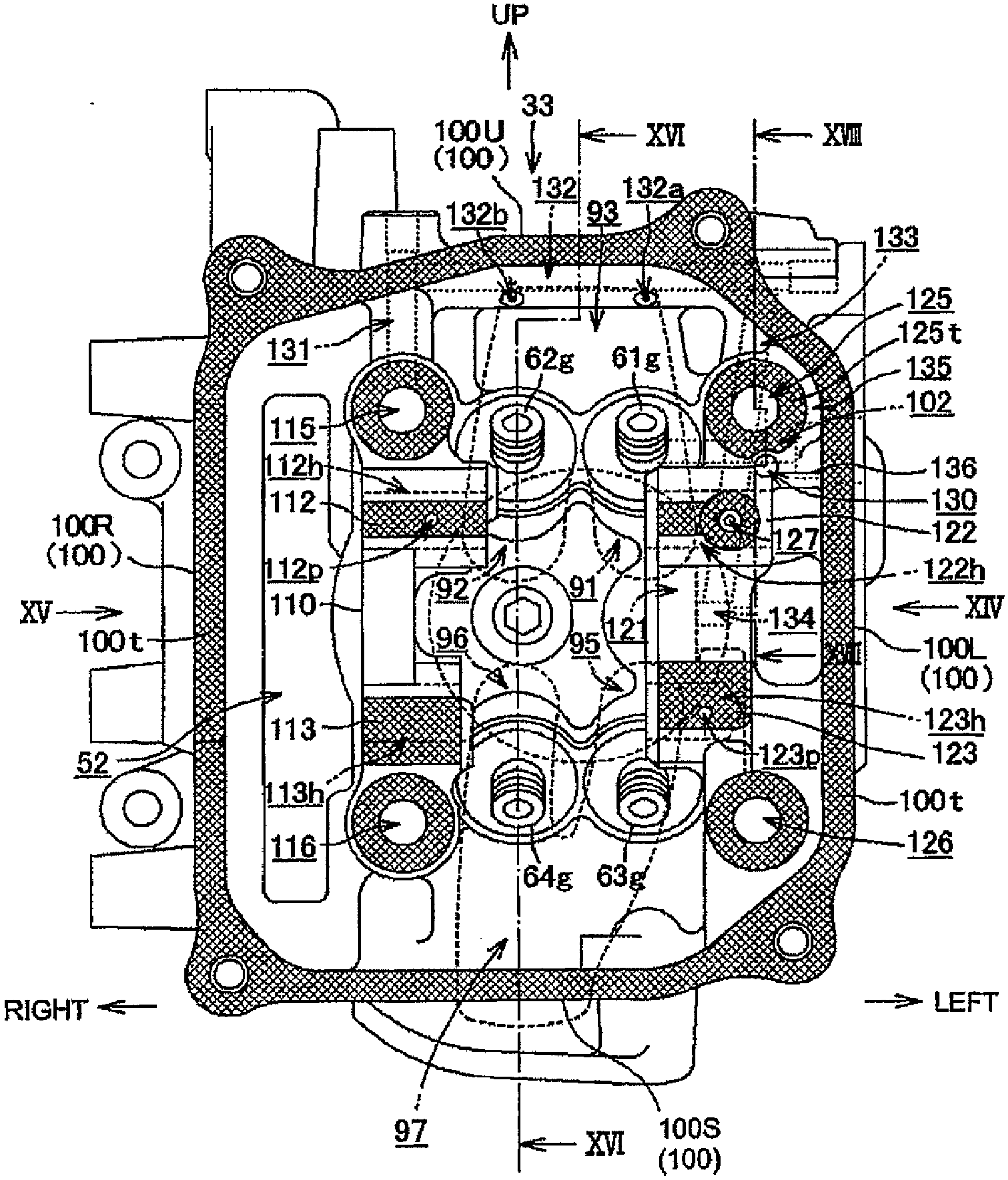

UP
33
100U
(100)
XVI
XVIII
132
132a
132b
93
133
125
125t
135
102
131
62g
61g
115
136
112h
130
112
122
100R
(100)
127
112p
122h
92
91
XV
110
121
134
XIV
100t
96
95
XVII
100L
(100)
123h
113
123
52
123p
113h
100t
116
126
64g
63g
RIGHT
LEFT
97
XVI
100S
(100)

FIG.14

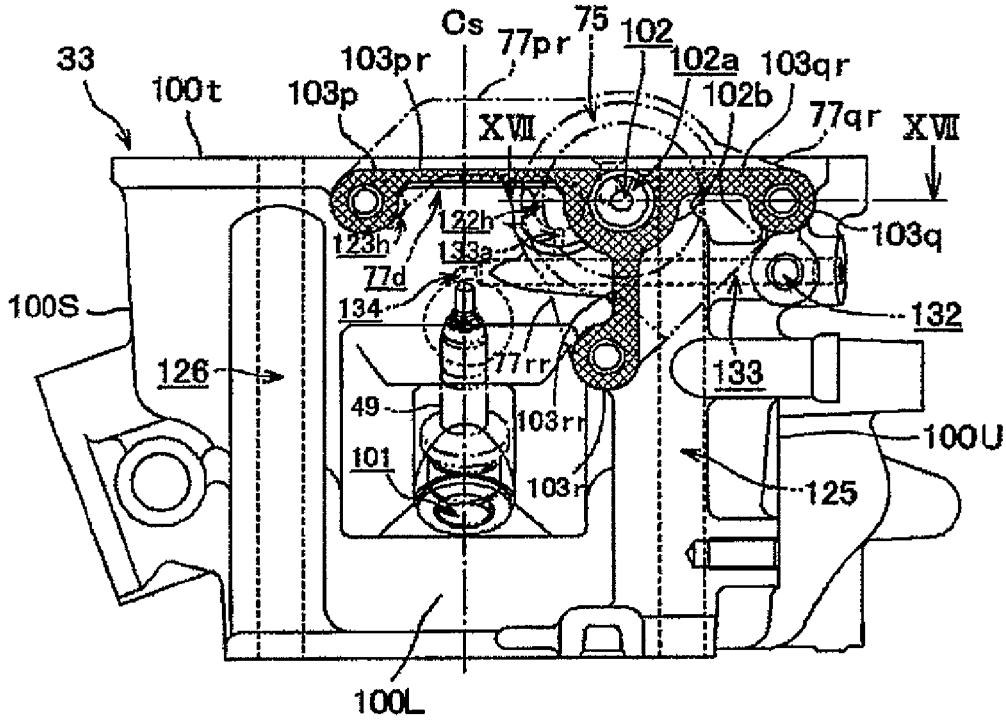

33
100t
103p
103pr
Cs
77pr
75
102
102a
102b
103qr
77qr
XVII
XVII
100S
122h
123h
133a
77d
134
103q
132
126
77rr
133
49
103rr
100U
101
103r
125
100L

FIG.15

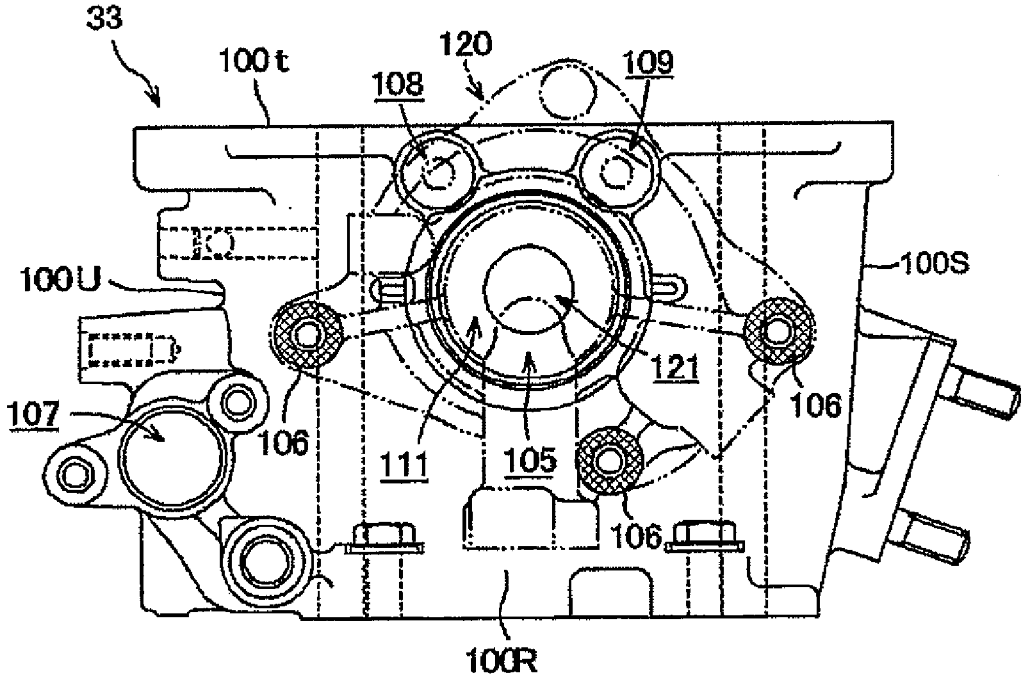

33
100t
120
108
109
100U
100S
121
106
107
106
111
105
106
100R

FIG.16

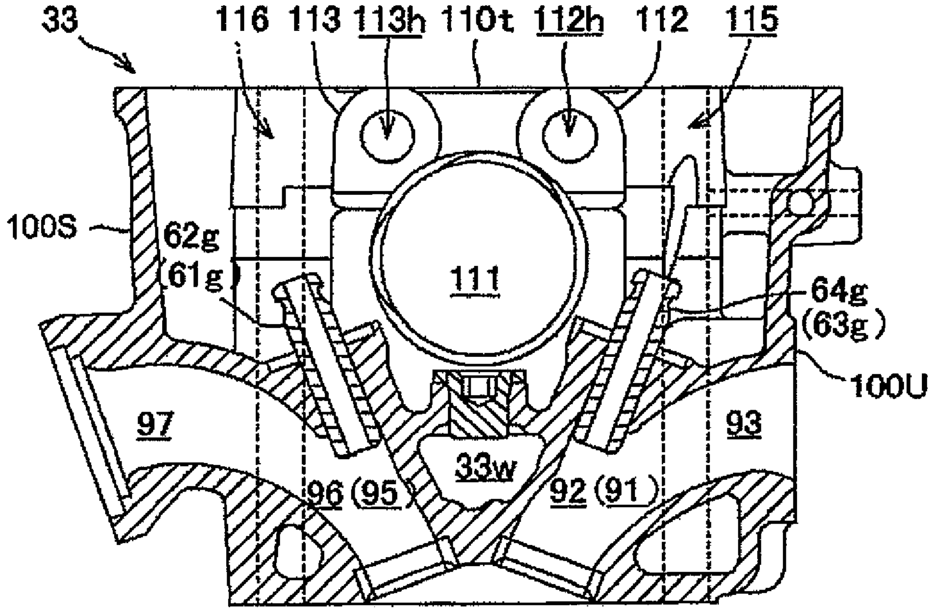

33
116
113
113h
110t
112h
112
115
100S
62g
(61g)
111
64g
(63g)
100U
97
93
33w
96 (95)
92 (91)

FIG.17

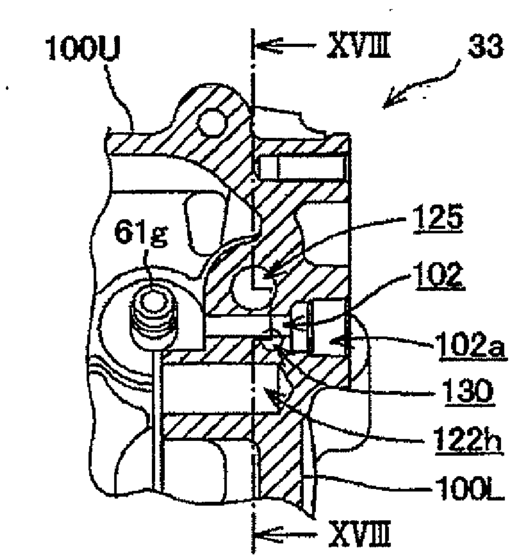
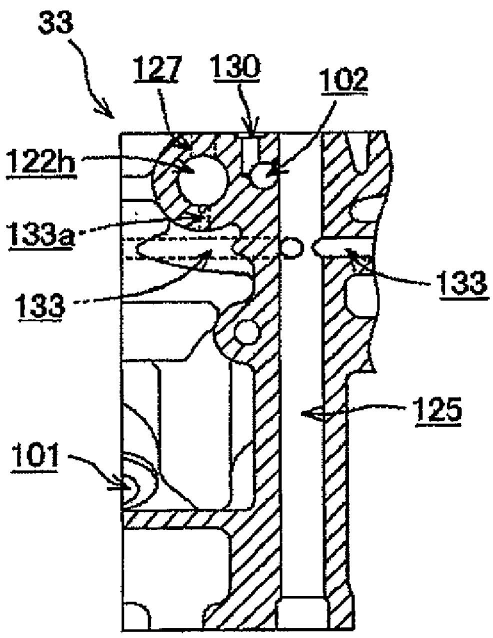

100U
XVIII
33
61g
125
102
102a
130
122h
100L
XVIII

FIG.18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EUROPEAN SEARCH REPORT

Application Number
EP 15 18 5073

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Place of search	Date of completion of the search	Examiner
The Hague	21 December 2015	Klinger, Thierry

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