



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.07.2008 Bulletin 2008/27

(51) Int Cl.:
F02B 61/02 (2006.01)

(21) Application number: **07254753.2**

(22) Date of filing: **07.12.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(30) Priority: **27.12.2006 JP 2006350779**

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(54) **Straddle-type vehicle**

(57) A straddle-type vehicle, for example a motorcycle, having an in-cylinder injection injector directly injecting a fuel into a combustion chamber has compact dimensions and good fuel injection. A low pressure pump carries fuel from a fuel tank, and a high pressure pump 123 pressurizes the fuel from the low pressure pump. The high pressure pump 123 is connected with each in-cylinder injection injector through a delivery pipe. The low pressure pump is connected with each in-pipe injection injector through the delivery pipe 118. The high pressure pump 123 is fixed to a cylinder head cover 50. At least one part of the high pressure pump 123 is disposed between left and right main frames 13. A high pressure fuel piping 127 is connected to the delivery pipe while passing above a right end part of the cylinder head cover 50 from the high pressure pump 123.

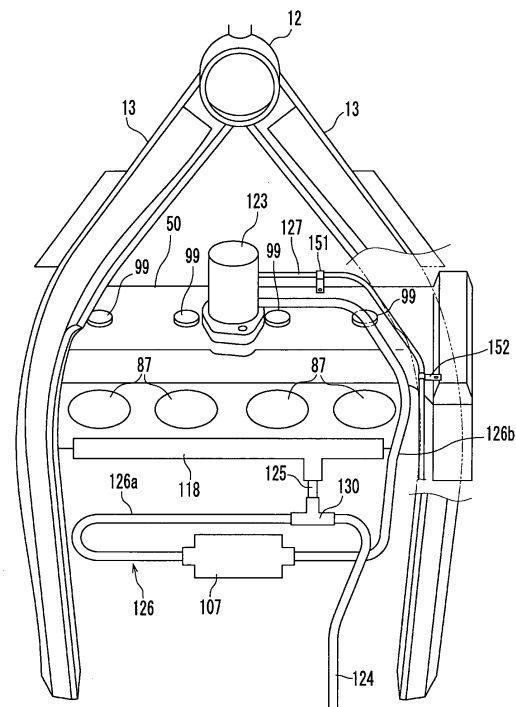


FIG. 10

Description

BACKGROUND

[0001] The present invention is one relating to a straddle-type vehicle such as motorcycle.

[0002] Engines for four-wheeled automobiles are known that include an in-cylinder injection injector directly injecting a fuel into a combustion chamber (see, for example, JP-A-2001-90630 Gazette). Further, engines for four-wheeled vehicles are known in which fuel injection is performed by jointly using an in-pipe injection injector injecting the fuel into an intake pipe and the in-cylinder injection injector directly injecting the fuel into the combustion chamber (see, for example, JP-A-2005-330961 Gazette).

[0003] In the case of an in-cylinder injection injector, the fuel must be injected under a very high pressure while resisting pressure in the combustion chamber. In such a case, the engine possessing the in-cylinder injection injector possesses a high pressure pump, besides a low pressure pump pressure-feeding the fuel from a fuel tank. The fuel pressure-fed from the low pressure pump is pressurized by the high pressure pump, and supplied to the in-cylinder injection injector to become high pressure fuel.

[0004] In comparison with a four-wheeled automobile, in the case of a straddle-type vehicle such as motorcycle, only restricted installation space for vehicle components is available. Accordingly, for an engine possessing an in-cylinder injection injector, the installation space for a high pressure pump, a high pressure fuel piping connecting the high pressure pump and the in-cylinder injection injector, and the like is limited. As a result, it is difficult to realize miniaturization of the vehicle with an improvement in injection performance of the high pressure fuel at the same time.

[0005] The present invention seeks to provide, in a straddle-type vehicle having an in-cylinder injection injector directly injecting the fuel into the combustion chamber, compact vehicle proportions while, at the same time, providing good injection performance of the high pressure fuel.

SUMMARY

[0006] Aspects of the invention are defined in the claims.

[0007] An embodiment of a straddle-type vehicle according to the invention comprises a body frame having a head pipe and one pair of left-right main frames extending rearward from the head pipe. Here it is to be noted that "extending rearward" means extending rearward in a broad meaning, and there is included extending rearward while slanting in a left-right direction or an up-down direction. The embodiment of the straddle type vehicle further comprises an engine which has plural cylinders, a cylinder head disposed above the cylinders and

partitioning together with each of the cylinders plural combustion chambers, and a cylinder head cover covering an upper part of the cylinder head, and which is supported by the body frame. The embodiment of the straddle type vehicle further comprises a fuel tank storing a fuel, a low pressure pump carrying the fuel in the fuel tank, a high pressure pump carrying the fuel discharged from the low pressure pump while pressurizing it, a high pressure fuel piping introducing the fuel discharged from the high pressure pump, plural in-cylinder injection injectors injecting the fuel into each of the plural combustion chambers, and a delivery pipe connected to the high pressure fuel piping and supplying the fuel to the plural in-cylinder injection injectors. The high pressure pump is fixed to the cylinder head cover, and at least one part of the high pressure pump is disposed between both the main frames. The high pressure fuel piping is connected to the delivery pipe while passing above one end part of the cylinder head cover in a vehicle width direction from the high pressure pump.

[0008] According to the above straddle-type vehicle, the high pressure pump is fixed to the cylinder head cover, and at least one part of the high pressure pump is disposed between both the main frames. Therefore, a space above the cylinder head cover and between both the main frames can be effectively put to practical use as the installation space for the high pressure pump, and it is possible compactly to dispose the high pressure pump. Accordingly, it is possible to realize compact vehicle proportions.

[0009] If the high pressure pump is disposed as mentioned above, a disposition of the high pressure fuel piping connecting the high pressure pump and the delivery pipe becomes difficult. Accordingly, the high pressure fuel piping is disposed so as to pass above one end part of the cylinder head cover in the vehicle width direction. Therefore, it is unnecessary to meander the high pressure fuel piping in a complicated manner, and it is possible to supply the fuel toward the in-cylinder injection injector from the high pressure pump. As a result, it is possible to realize good fuel injection performance.

[0010] Therefore, according to the above straddle-type vehicle, it is possible to reduce the size of the vehicle while providing an improvement in the injection performance of the high pressure fuel at the same time.

[0011] Thus, an embodiment of the invention, can provide a straddle-type vehicle with in-cylinder injection injector(s) directly injecting fuel into the combustion chamber(s), with, at the same time, compact dimensions for the vehicle and good injection performance of the high pressure fuel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Embodiments of the invention are described hereinafter, by way of example only, with reference to the accompanying drawings.

Fig. 1 is a left side view of an example of a motorcycle as an example embodiment of a straddle-type vehicle.

Fig. 2 is an enlarged side view showing an example of an engine unit.

Fig. 3 is an enlarged sectional view of an example of a cylinder head.

Fig. 4 is a perspective view showing an example of a cylinder head cover.

Fig. 5 is a sectional view showing a peripheral structure of an example of a cylinder.

Fig. 6 is a diagram showing a constitution of an example of a fuel system.

Fig. 7 is a plan view showing dispositions of various, devices and members constituting an example fuel system of a first embodiment (embodiment 1).

Fig. 8 is a side view of a constitution of the example of Fig. 7.

Fig. 9 is a back view showing example positional relationships of a high pressure pump, a delivery pipe and a pressure accumulation chamber.

Fig. 10 is a plan view showing dispositions of various devices and members constituting an example fuel system of a second embodiment (embodiment 2).

Fig. 11 is a plan view showing dispositions of various devices and members constituting an example fuel system of a third embodiment (embodiment 3).

Fig. 12 is a plan view showing dispositions of various devices and members constituting an example fuel system of a fourth embodiment (embodiment 4).

DETAILED DESCRIPTION

[0013] Example embodiments of the present invention are described in the following with reference to the drawings. First Embodiment

[0014] Fig. 1 illustrates an example motorcycle 10 as an embodiment of the straddle type vehicle. The motorcycle 10 possesses a body frame 11 forming a framework, and a seat 16 on which a rider sits. The rider sitting on the seat 16 rides while sitting astride the body frame 11. It should be noted that an embodiment of the invention is not limited to the motorcycle 10 shown in Fig. 1, but could be a motorcycle of another type. Embodiments of the invention are not limited as to the maximum speed, the displacement of the vehicle, a size of the vehicle, and the like are not limited as well. Further, an embodiment of the invention is not limited to a motorcycle, and may be any other form of straddle-type vehicle, for example a four-wheeled buggy such as a quad bike or the like.

[0015] In the following explanations, directions in front-rear and left-right are made to mean directions seen from the rider sitting on the seat 16.

[0016] In the example illustrated in Figure 1, the body frame 11 possesses a steering head pipe 12, one pair of left-right main frames 13 extending slantingly downward and rearward from the steering head pipe 12, and one pair of left-right seat rails 14 respectively extending slant-

ingly upward and rearward from midway parts of both the main frames 13.

[0017] In this example, a front wheel 19 is supported by the steering head pipe 12 through a front fork 18. A fuel tank 20 and the seat 16 are supported on seat rails 14. The seat 16 extends from a rear of the fuel tank 20 toward rear end parts of the seat rails 14.

[0018] In this example, one pair of left-right rear arm brackets 24 are provided in rear end parts of the main frames 13. The rear arm brackets 24 protrude downward from the rear end parts of the main frames 13. A pivot shaft 38 is provided in the rear arm brackets 24, and a front end part of a rear arm 25 is swingably supported to the pivot shaft 38. A rear wheel 26 is supported to a rear end part of the rear arm 25.

[0019] Further, in this example, an engine unit 28 driving the rear wheel 26 is supported by the body frame 11. A crank case 35 of the engine unit 28 is supported such that it is suspended from the main frames 13.

[0020] In this example, an engine 29 is an in-line four-cylinder engine, and it is mounted laterally such that a crank shaft (not shown in the drawing) is horizontally disposed in a vehicle width direction. The engine 29 is slantingly disposed such that an axis 41L (shown by an alternate long and short dash line in Fig. 1) of a cylinder 41 slants forward.

[0021] Fig. 2 is an enlarged side view showing an example engine unit 28, and Fig. 3 is an enlarged sectional view of an example cylinder head 40 of the engine unit 28. In the example illustrated in Fig. 2 and Fig. 3, the cylinder head 40 of the engine 29 is fixed by bolts 101 with upper faces and lower faces of two cylinder blocks (not shown in the drawing) being mated. Further, a cylinder head cover 50 is provided so as to cover an upper face of this cylinder head 40. The cylinder head 40 and the cylinder head cover 50 are fixed.

[0022] In this example, in an inside of the cylinder head 40, one or more combustion chambers 83 are formed (four combustion chambers are provided in the present embodiment, although only one is shown in Fig. 5), and there is provided a valve motion mechanism constituted by an intake valve 88 (refer to Fig. 5), an exhaust valve 98, an intake side cam shaft 70, an exhaust side cam shaft 80 (refer to Fig. 3), and the like. As shown in Fig. 3, the engine 29 is an overhead cam shaft (OHC) engine in which the intake side cam shaft 70 and the exhaust side cam shaft 80 are provided above the cylinder 41.

[0023] A cam 123b for pump is attached to the above-mentioned intake side cam shaft 70. This cam 123b for pump is one driving a high pressure pump 123 described below (refer to Fig. 6).

[0024] In the example illustrated in Fig. 2 and Fig. 4, the high pressure pump 123 is disposed in an approximate center of the engine 29 in a width direction, and one part of its upper part is disposed between both the main frames 13 (refer to Fig. 2). This high pressure pump 123 is fixed to the cylinder head cover 50. As shown in Fig. 4, an attachment flange 123g formed in the high pres-

sure pump 123 and a boss part 51 formed in the cylinder head cover 50 can be clamped together by bolts 133.

[0025] In the present example, the cylinder head cover 50 is formed by a metallic material such as aluminum. Although this cylinder head cover 50 can be provided as one object, it can be divided into a portion 50a placed above the cam shafts 70, 80 (not shown in Fig. 4, refer to Fig. 3), and a portion 50b placed above a cam chain 90 (not shown in Fig. 4, refer to Fig. 7). The high pressure pump 123 can be fixed to the portion 50a placed above the cam shafts 70, 80. The portion 50b placed above the cam chain 90 can be placed in a right end part of the cylinder head cover 50, and can be placed in outside (right side) compared to the four cylinders 41 juxtaposed in the vehicle width direction.

[0026] Fig. 5 is a sectional view showing an example peripheral structure of the cylinder 41 in the engine 29. In Fig. 5 one cylinder 41 among the four cylinders 41 is shown, with structures of its inside and periphery. A piston 82 is accommodated in the cylinder 41 of the engine 29 so as to be capable of reciprocating. The combustion chamber 83 is formed by an upper face of the piston 82, and inner wall faces of the cylinder 41 and the cylinder head 40.

[0027] In this example an intake pipe 85 and an exhaust pipe 86 are connected to this cylinder 41. The intake pipe 85 communicates with the combustion chamber 83 through an intake port 87. A throttle valve 46 adjusting an inflow air quantity into the intake pipe 85 is provided in the intake pipe 85. The intake pipe 85 and the intake port 87 form an intake passage introducing the air to the combustion chamber 83. In the intake port 87, an intake valve 88 is operable to alter a communication state between the intake pipe 85 and the combustion chamber 83 by being driven to open and close states. This intake valve 88 is driven by the intake side cam shaft 70 (refer to Fig. 3).

[0028] In this example, in the intake pipe 85, there is provided an in-pipe injection injector 89 supplying fuel into the intake pipe 85. In the cylinder head 40, there is provided an in-cylinder injection injector 189 supplying fuel into the combustion chamber 83. In this way, the present motorcycle 10 possesses the two kinds of injectors of the in-pipe injection injector 89 and the in-cylinder injection injector 189.

[0029] In this example the exhaust pipe 86 is connected to the combustion chamber 83 through an exhaust port 97. In the exhaust port 97, an exhaust valve 98 is operable to alter a communication state between the exhaust pipe 86 and the combustion chamber 83 by being driven to open and closed states. This exhaust valve 98 is driven by the exhaust side cam shaft 80 (refer to Fig. 3). Further, in an upper part of the combustion chamber 83, there is provided an ignition plug 99 igniting a gaseous mixture formed by the fuel and the air.

[0030] This example of the engine 29 thus possesses an engine main body 29a having the cylinder 41, the cylinder head 40, the cylinder head cover 50, the intake pipe

85 and the like, and the injectors 89, 189 and the like.

[0031] Fig. 6 is a view showing a constitution of an example fuel system in the motorcycle 10. As shown in Fig. 6, in the fuel tank 20, there is provided a low pressure pump 122. The low pressure pump 122 sucks the fuel from the fuel tank 20, and pressure-feeds the sucked fuel to a first low pressure fuel piping 124. The fuel flowing in the first low pressure fuel piping 124 is supplied to a second low pressure fuel piping 125 and a third low pressure fuel piping 126 by a branch pipe 130 connected with the first low pressure fuel piping 124.

[0032] In this example, the second low pressure fuel piping 125 is connected with the in-pipe injection injectors 89 through a delivery pipe 118. The delivery pipe 118 stores the fuel in its inside, and supplies the fuel to the in-pipe injection injector 89 corresponding to each of the four cylinders 41.

[0033] In this example, to the third low pressure fuel piping 126, there is connected the high pressure pump 123 (refer to Fig. 2 and Fig. 3 as well). The high pressure pump 123 additionally pressurizes the fuel pressure-fed by the low pressure pump 122, and supplies this pressurized fuel toward the in-cylinder injection injectors 189. Further, part way (e.g., midway) along the third low pressure fuel piping 126, there is provided a low pressure side pressure accumulation chamber 107. The low pressure side pressure accumulation chamber 107 is thus disposed between a piping 126a and a piping 126b. The low pressure side pressure accumulation chamber 107 is a hollow body, and can store the fuel.

[0034] In this example, the high pressure pump 123 possesses a pump chamber 123a in which the fuel is filled, a plunger 123c reciprocating up and down, and an electromagnetic valve 123d adjusting a fuel supply quantity to the pump chamber 123a.

[0035] In this example, in the pump chamber 123a, there is filled the fuel pressure-fed from the low pressure pump 122. The plunger 123c is driven by the pump cam 123b to reciprocate up and down in the pump chamber 123a. The pump cam 123b is attached to the intake side cam shaft 70 (refer to Fig. 3), and the intake side cam shaft 70 is connected with a crank shaft (not shown in the drawing) through a drive chain (not shown in the drawing). Accordingly, a rotation of the pump cam 123b synchronizes with a rotation of the engine 29 (rotation of the above crank shaft).

[0036] In this example, the electromagnetic valve 123d is constituted by a solenoid. This electromagnetic valve 123d possesses a spill valve 123e for opening/closing a portion becoming an inlet for the fuel. Further, in a portion connecting with a high pressure fuel piping 127 in the pump chamber 123a, there is provided a check valve 123f. The check valve 123f opens if a fuel pressure in the pump chamber 123a exceeds a predetermined value.

[0037] In this example, an open and closed state of the electromagnetic valve 123d is controlled by a control signal from an ECU not shown in the drawing. When no electricity is supplied, this electromagnetic valve 123d

presses down the spill valve 123e, thereby making a valve-opened state in which the fuel tank 20 and the pump chamber 123a communicate. Further, when the electricity is supplied to the electromagnetic valve 123d, the spill valve 123e is pulled up, thereby making a closed state in which the fuel tank 20 and the pump chamber 123a do not communicate. In Fig. 6, the valve-opened state of the spill valve 123e is shown.

[0038] By the fact that the above-mentioned plunger 123c is driven by the pump cam 123b to reciprocate in the pump chamber 123a, the fuel in the pump chamber 123a is pressurized to a high pressure. And, if the fuel pressure in the pump chamber 123a exceeds the predetermined value, by the fact that the check valve 123f opens, the fuel in the pump chamber 123a is supplied into a delivery pipe 128 through the high pressure fuel piping 127. And, the high pressure fuel supplied to the delivery pipe 128 is injected from the in-cylinder injection injectors 189. Since the engine 29 concerned with the present embodiment is the four-cylinder engine, it possesses four in-cylinder injection injectors 189 as shown in Fig. 6.

[0039] In this example, part way (e.g., midway) along the high pressure fuel piping 127, there is provided a high pressure side pressure accumulation chamber 117. The high pressure side pressure accumulation chamber 117 is a hollow body, and can store the fuel.

[0040] In this example, the high pressure pump 123 is connected with the in-cylinder injection injectors 189 through a piping 127a, the high pressure side pressure accumulation chamber 117, a piping 127b and the delivery pipe 128. The delivery pipe 128 stores the fuel in its inside, and supplies the fuel to the in-cylinder injection injector 189 corresponding to each of the four cylinders 41.

[0041] In the present embodiment, the high pressure side pressure accumulation chamber 117 is provided separately from the delivery pipe 128. Therefore, the fuel pressure-fed by the high pressure pump 123 is stored in both of the high pressure side pressure accumulation chamber 117 and the delivery pipe 128. By this, even in a case where a volume of the delivery tube 128 becomes small in relation to a disposition position and a disposition space, it is possible to ensure a sufficiently large volume in which the fuel is stored. As a result, it is possible to reduce a fluctuation of the fuel pressure, which is due to a fuel injection of the in-cylinder injection injector 189.

[0042] By the way, in order that the fuel pressure in the delivery pipe 128 is kept constant, if the fuel pressure in the pump chamber 123a becomes higher than the predetermined value, the above-mentioned high pressure pump 123 performs a constant-pressure-making control returning one part of the fuel in the pump chamber 123a to a third low pressure fuel piping 126 side. At this time, resulting from the fact that the returned fuel is supplied to the delivery pipe 118 while passing through the third low pressure fuel piping 126 and the second low pressure fuel piping 125, a pulsation of the fuel pressure becomes

liable to generate in the delivery pipe 118. However, in the present embodiment, since the low pressure side pressure accumulation chamber 107 is provided between the high pressure pump 123 and the delivery pipe 118, even in a case where the return of the fuel is performed from the high pressure pump 123, the pulsation of the fuel pressure can be absorbed by this low pressure side pressure accumulation chamber 107. As a result, it is possible to suppress the pulsation of the fuel pressure in the delivery pipe 118, so that a performance decrease of the in-pipe injection injector 89 can be prevented. Further, the fact can be prevented that the pulsation following upon the return control of the fuel is transmitted to the low pressure pump 122 and thus an adverse effect is exerted on a performance of the low pressure pump 122.

[0043] Fig. 7 is a plan view showing each device/member constituting a fuel system shown in Fig. 6. Further, Fig. 8 is a side view of Fig. 7. As shown in Fig. 7 and Fig. 8, the cylinder head cover 50 exists between the one pair of left-right main frames 13, and is disposed in a downside than the main frames 13. Left-right end parts of the cylinder head cover 50 are disposed just below the main frames 13.

[0044] As mentioned before, in this example the high pressure pump 123 exists in an upper face of the cylinder head cover 50, and is fixed to an approximate center of the cylinder head cover 50 in the longitudinal direction (width direction). As shown in Fig. 7, in the upper face of the cylinder head cover 50 and in both left-right sides of the high pressure pump 123, the ignition plug 99 corresponding to each of the four cylinders 41 (refer to Fig. 2 and Fig. 3) is provided so as to protrude upward. Among the four ignition plugs 99, the two are provided in a left side of the high pressure pump 123, and the remaining two are provided in a right side of the high pressure pump 123. The four ignition plugs 99 are disposed respectively in the same interval along the longitudinal direction (width direction) of the cylinder head cover 50.

[0045] In this example, the first low pressure fuel piping 124 connected with the fuel tank 20 (refer to Fig. 1 and Fig. 6) extends to a front (upward direction in Fig. 7), and is connected with the branch pipe 130 while bending in a left direction along (e.g. midway along) its length. The branch pipe 130 flow-branches the fuel flowing in the first low pressure fuel piping 124 to the second low pressure fuel piping 125 and the piping 126a of the third low pressure fuel piping 126. The second low pressure fuel piping 125 connected to the branch pipe 130 extends forward, and is connected with the delivery pipe 118. The delivery pipe 118 is disposed such that its longitudinal direction extends along the longitudinal direction (width direction) of the cylinder head cover 50.

[0046] Further, in this example, the piping 126a connected with the branch pipe 130 extends in a left direction, and extends in a right direction while being folded backward from a vicinity of the left side main frame 13. A U-turn part 126f is constituted by a portion 126c extending in the left direction in the piping 126a, a portion 126d

folded backward, and a portion 126e extending in the right direction. Since the U-turn part 126f forms a going, (or outward) path and returning path, hereafter, the above-mentioned portion 126c extending in the left direction is referred to as a going path, and the above-mentioned portion 126e extending in the right direction is referred to as a returning path.

[0047] In this example, a right end part of the returning path 126e of the U-turn part 126f in the third low pressure fuel piping 126 is connected with the low pressure side pressure accumulation chamber 107. This low pressure side pressure accumulation chamber 107 is connected with the piping 126b. The piping 126b extends in the right direction, and is connected with the high pressure pump 123 while being bent forward in its midway. In the present embodiment, the first low pressure fuel piping 124, the second low pressure fuel piping 125, and the piping 126a and the piping 126b of the third low pressure fuel piping 126 all comprise a resin-made hose, and have a flexibility. On the other hand, the branch pipe 130 is a metal-made pipe.

[0048] As shown in Fig. 8, the fuel tank 20 has a horizontal part 20a disposed in a front-rear direction (left-right direction in Fig. 8), and a hung, or hanging, part 20b that hangs downward from a rear end part of the horizontal part 20a. By the horizontal part 20a and the hung part 20b, there is formed a step part 20e of the fuel tank 20. Among the horizontal part 20a, the hung part 20b and the engine 29, there is formed a comparatively wide region A. And, in this region A, there are disposed the first - third low pressure fuel pipes 124, 125, 126, the delivery pipe 118, the low pressure side pressure accumulation chamber 107, and the like.

[0049] In this example, the hung part 20b of the fuel tank 20 has an outer face 20c extending downward or slanting downward. The low pressure side pressure accumulation chamber 107 is formed in an approximately cuboid shape, and disposed so as to become approximately parallel to this outer face 20c. Further, a greater part of the low pressure side pressure accumulation chamber 107 overlaps with the step part 20e of the fuel tank 20 in a plan view and a front view. In other words, the greater part of the low pressure side pressure accumulation chamber 107 is disposed in a space concaved upward and rearward in the fuel tank 20. By disposing like this, the low pressure side pressure accumulation chamber 107 can be made large in some extent, so that an internal volume of the low pressure side pressure accumulation chamber 107 can be ensured large. In the present embodiment the low pressure side pressure accumulation chamber 107 may be fixed to the engine 29, or may not be fixed to it.

[0050] As shown in Fig. 7, the piping 127a connected with the high pressure pump 123 extends in a right direction along the longitudinal direction (width direction) of the cylinder head cover 50. The high pressure side pressure accumulation chamber 117 is connected to a right end part of the piping 127a.

[0051] Although in this example the cylinder head cover 50 is made elongate in the vehicle width direction, in a downside of a right end portion, in which there is disposed the high pressure side pressure accumulation chamber 117, there is provided a cam chain 90 (refer to Fig. 8) connecting the cam shafts 70, 80 (refer to Fig. 3) and the crank shaft (not shown in the drawing). That is, the high pressure side pressure accumulation chamber 117 is located in the upper face of the cylinder head cover 50, and is disposed above the cam chain 90. Strictly, this high pressure side pressure accumulation chamber 117 is fixed to the portion 50b (refer to Fig. 4) placed above the cam chain 90 in the cylinder head cover 50.

[0052] As shown in Fig. 8, in a right end part of the upper face of the cylinder head cover 50, there is formed a boss part 52. On the other hand, in the high pressure side pressure accumulation chamber 117, there is formed an attachment flange 117a in which a threaded hole is formed. And, by the fact that this attachment flange 117a and the boss part 52 are clamped together by a bolt 134, the high pressure side pressure accumulation chamber 117 and the cylinder head cover 50 are fixed. Like this, the high pressure side pressure accumulation chamber 117 is fixed to the right end part of the upper face of the cylinder head cover 50.

[0053] As mentioned above, in this example the high pressure pump 123 is located in the upper face of the cylinder head cover 50, and is fixed to the approximate center in the longitudinal direction (width direction). Further, in the upper face of the cylinder head cover 50, the four ignition plugs 99 are disposed along the longitudinal direction so as to protrude upward. Therefore, as a disposition position of the high pressure side pressure accumulation chamber 117, an end part (especially, an upper position of the cam chain 90) of the cylinder head cover 50 in the longitudinal direction is desirable as mentioned above.

[0054] Although the shape of the high pressure side pressure accumulation chamber 117 is not limited at all, in the present embodiment it is formed in an approximately cuboid shape which is elongate in the front-rear direction.

[0055] In this example, the high pressure fuel piping 127b connected with the high pressure side pressure accumulation chamber 117 extends downward toward a rear, and is connected with the delivery pipe 128 (refer to Fig. 9).

[0056] In this example, therefore, the high pressure fuel piping 127 is connected with the delivery pipe 128 while passing above the right end part of the cylinder head cover 50 from the high pressure pump 123.

[0057] In this example, the piping 127a of the high pressure fuel piping 127, the high pressure side pressure accumulation chamber 117 and the piping 127b are all made of a metal and, in the present embodiment, the high pressure side pressure accumulation chamber 117 is formed by aluminum, and the pipings 127a and 127b by stainless (SUS 304). However, as long as they have

a pressure resistance, they may be formed by other metallic material, or may be formed by a nonmetallic material.

[0058] In the present embodiment, among the piping 127a, the high pressure side pressure accumulation chamber 117 and the piping 127b, which constitute the high pressure fuel piping 127, although the high pressure side pressure accumulation chamber 117 is fixed to the cylinder head cover 50, the piping 127a and the piping 127b are not fixed to the engine 29. In the high pressure fuel piping 127, only the high pressure side pressure accumulation chamber 117 is fixed to the cylinder head cover 50. '

[0059] As explained above, in the example motorcycle 10 of the present embodiment, the high pressure pump 123 is fixed to the cylinder head cover 50 (refer to Fig. 4), and one part of the high pressure pump 123 is disposed between both the main frames 13 (refer to Fig. 2). Therefore, a space above the cylinder head cover 50 and between both the main frames 13 can be effectively put to practical use as the installation space for the high pressure pump 123. Accordingly, the high pressure pump 123 can be compactly disposed and, in turn, it is possible to realize compact dimensions and miniaturization of the motorcycle 10.

[0060] Further, in the example of the present motorcycle 10, notwithstanding the fact that the high pressure pump 123 is disposed as mentioned above, since the high pressure fuel piping 127 is disposed as follows, it is possible to provide a good supply the high pressure fuel from the high pressure pump 123 toward each in-cylinder injection injector 189. That is, according to the present motorcycle 10, the high pressure fuel piping 127 is disposed so as to pass above one end part (which exists in an outside than the four cylinders 41 juxtaposed in the vehicle width direction, and is the right end part in the present embodiment) of the cylinder head cover 50 in the vehicle width direction. Accordingly, since it is unnecessary to use a complicatedly meander of the high pressure fuel piping 127 and the fuel is efficiently supplied to the in-cylinder injection injector 189, it is possible to realize the improvement in the injection performance of the high pressure fuel.

[0061] Therefore, in the example motorcycle 10, it is possible to realize the miniaturization of the vehicle and the improvement in the performance of the in-cylinder injection injector at the same time.

[0062] Further, in the present embodiment, the high pressure pump 123 is disposed in the center part of the cylinder head cover 50 in the vehicle width direction. Therefore, it follows that the high pressure pump 123 is disposed in a most separated place from both the left-right main frames 13 in regard to the vehicle width direction. Accordingly, a space between both the main frames 13 and the high pressure pump 123 can be large.

[0063] As further mentioned above, in the present embodiment, the high pressure pump 123 is disposed in the center part of the cylinder head cover 50 in the vehicle

width direction, and the high pressure fuel piping 127 is disposed so as to pass above one end part of the cylinder head cover 50 in the vehicle width direction. Therefore, the length of the high pressure fuel piping 127 can become comparatively long, which can have an effect on the life of the high pressure fuel piping 127 due to vibration of the engine 29.

[0064] Compared to a four-wheeled automobile, the engine of the motorcycle 10 or the like is frequently operated at high revolutions, and further a range of engine revolutions can be large as well. Additionally, compared to a four-wheeled automobile, a motorcycle 10 or the like is light in weight. As a result, in the motorcycle 10 or the like, high frequency vibrations not seen in a four-wheeled automobile can be generated.

[0065] In the four-wheeled automobile, the high pressure fuel piping connecting the high pressure pump and the in-cylinder injection injector is fixed only at both end parts to the engine. However, according to experiments of the present inventor, there was understood the fact that, in the motorcycle 10 or the like, there was a case where, by the fixation method like this, the life of the high pressure fuel piping 127 became short.

[0066] In an embodiment of the present invention therefore, an intermediate part of the high pressure fuel piping 127 can be fixed to the cylinder head cover 50. For example, in the present embodiment, the high pressure side pressure accumulation chamber 117 forms an intermediate part of the high pressure fuel piping 127 that is fixed to the cylinder head cover 50. Therefore, when the engine 29 vibrates, the high pressure side pressure accumulation chamber 117 rapidly follows a motion of the engine 29 (specifically, in the present example the cylinder head cover 50), and vibrates while becoming one body with the engine 29. Therefore, even if there exists a high frequency vibration peculiar to a straddle-type vehicle represented by the motorcycle 10, a breakage of the high pressure fuel piping 127 can be prevented, so that it is possible to realize prolongation of the life of the high pressure fuel piping 127.

[0067] As shown in Fig. 7, the piping 126b of the third low pressure fuel piping 126 exists above the cylinder head cover 50, and is connected to the high pressure pump 123 while passing one end part (right end part) of a side in which there is disposed the high pressure fuel piping 127 of the cylinder head cover 50 in the vehicle width direction. In other words, in the plan view, the piping 126b adjoins to the high pressure side pressure accumulation chamber 117 and the piping 127b of the high pressure fuel piping 127 above the right end part of the cylinder head cover 50. Therefore, notwithstanding the fact that there are two kinds of fuel pipings of the high pressure fuel piping 127 and the low pressure fuel piping 126, it is possible to compactly dispose these pipings 126, 127.

[0068] In the present embodiment, between the high pressure pump 123 and the delivery pipe 128, there is provided the high pressure side pressure accumulation

chamber 117 capable of storing fuel (refer to Fig. 9). Therefore, even in a case where a volume of the delivery pipe 128 becomes small in relation to a disposition position and a disposition space, a volume in which the high pressure fuel is stored can be ensured by both of the delivery pipe 128 and the high pressure side pressure accumulation chamber 117. As a result, it is possible to reduce the fluctuation in the fuel pressure by the fuel injection of the in-cylinder injection injector 189, so that the performance improvement of the in-cylinder injection injector 189 can be realized.

[0069] As shown in Fig. 7, in the present embodiment, the four ignition plugs 99 are disposed so as to protrude upward in the upper face (specifically, in the present example, an upper face of the portion 50a placed above the cam shafts 70, 80) of the cylinder head cover 50 along the longitudinal direction (width direction) of the cylinder head cover 50. However, the high pressure side pressure accumulation chamber 117 is disposed in one end part (in the present embodiment, the portion 50b existing in the right end part and placed above the cam chain 90) of the cylinder head cover 50 in the vehicle width direction. In other words, the high pressure side pressure accumulation chamber 117 is disposed in a position above the cam chain 90 in the cylinder head cover 50. Therefore, the high pressure side pressure accumulation chamber 117 can be prevented from interfering with the ignition plugs 99. Accordingly, a volume of the high pressure side pressure accumulation chamber 117 can be made comparatively large, and it is possible to effectively suppress a fuel pressure fluctuation of the in-cylinder injection injector 189.

[0070] In the present embodiment, between the branch pipe 130 of the low pressure fuel piping and the high pressure pump 123, there is provided the low pressure side pressure accumulation chamber 107. Therefore, even if the pulsation resulting from an operation of the high pressure pump 123 generates in the piping 126b, it is possible to absorb that pulsation in the low pressure side pressure accumulation chamber 107. As a result, it is possible to suppress an influence of the pulsation on the in-pipe injection injector 89 and the low pressure pump 122, so that the performance improvement of the in-pipe injection injector 89 and the low pressure pump 122 can be realized.

[0071] Further, according to the present embodiment, the high pressure pump 123 has the pump chamber 123a (refer to Fig. 6) and, if the fuel pressure in the pump chamber 123a becomes higher than the predetermined value, performs the constant-pressure-making control returning one part of the fuel to the low pressure fuel piping 126. Therefore, originally, the pulsation is liable to generate in the low pressure fuel piping 126. However, as mentioned before, according to the present embodiment, since the pulsation in the low pressure fuel piping 126 can be suppressed, it is possible to effectively suppress a performance decrease of the low pressure pump 122 and the in-pipe injection injector 89.

Embodiment 2

[0072] Embodiment 1 is one in which the high pressure side pressure accumulation chamber 117 is provided in an intermediate position in the high pressure fuel piping 127. However, it is also possible to omit the high pressure side pressure accumulation chamber 117. As shown in Fig. 10, a motorcycle concerned with embodiment 2 is one in which the high pressure side pressure accumulation chamber 117 of embodiment 1 is omitted.

[0073] As shown in Fig. 10, in this embodiment, one end of the high pressure fuel piping 127 is connected to the high pressure pump 123, and its other end is connected to the delivery pipe 128 (not shown in Fig. 10, refer to Fig. 6) supplying the fuel to each in-cylinder injection injector 189. The high pressure fuel piping 127 is formed by the metallic material such as stainless steel.

[0074] In the present embodiment, in the cylinder head cover 50, there are provided attachment brackets 151, 152 formed by the metal (e.g., stainless steel or the like). The high pressure fuel piping 127 is formed by a metal pipe comprising stainless steel or the like, and its midway parts are fixed to the cylinder head cover 50 through the attachment brackets 151, 152. In the present embodiment, a fixation place of the high pressure fuel piping 127 exists in two places. However, the number of the fixation places is not limited, and it may be one place or at least three places.

[0075] Also in the present embodiment, the high pressure fuel piping 127 is connected to the delivery pipe 128 (refer to Fig. 6) while passing above the right end part of the cylinder head cover 50 in the vehicle width direction from the high pressure pump 123. Other constitution is similar to embodiment 1.

[0076] Accordingly, also in the present embodiment, it is possible to obtain advantages (various advantages other than the advantages brought about by the high pressure side pressure accumulation chamber 117) approximately similar to embodiment 1.

[0077] Further, as shown in Fig. 10, according to the present embodiment, in the plan view, the high pressure fuel piping 127 and the piping 126b of the low pressure fuel piping 126 are disposed approximately parallel. Accordingly, these pipings 127, 126b can be disposed more compactly.

Embodiment 3

[0078] Embodiment 2 is one in which, when the high pressure fuel piping 127 is fixed to the cylinder head cover 50, there are used the attachment brackets 151, 152 made of metal. However, the fixation means fixing the high pressure fuel piping 127 to the cylinder head cover 50 is not limited to the attachment brackets 151, 152 made of metal, and may take another form.

[0079] As shown in Fig. 11, embodiment 3 is one in which an attachment seat 153 made of rubber is used instead of the attachment brackets 151, 152 in embodi-

ment 2. That is, in the present embodiment, the attachment seat 153 is provided in the right end part of the cylinder head cover 50, and the midway part of the high pressure fuel piping 127 is fixed to the cylinder head cover 50 through the attachment seat 153.

[0080] In the present embodiment, one attachment seat 153 is provided. However, another number of attachment seats 153 (i.e. two or more) may be provided. A material of the attachment seat 153 is not limited to rubber, and may comprise another damping material.

[0081] Also in the present embodiment, the high pressure fuel piping 127 is connected to the delivery pipe 128 (refer to Fig. 6) while passing above the right end part of the cylinder head cover 50 in the vehicle width direction from the high pressure pump 123. The other configurations are the same as in embodiment 2.

[0082] Accordingly, also in the present embodiment, it is possible to obtain advantages similar to embodiment 2. Additionally, according to the present embodiment, since the attachment seat 153 absorbs the vibration of the engine 29 in some degree, the breakage of the high pressure fuel piping 127 can be more suppressed, so that it is possible to realize an additional prolongation of the life of the high pressure fuel piping 127.

Embodiment 4

[0083] The engine 29 concerned with each of the above embodiments possesses two kinds of injectors (the in-cylinder injection injector 189 and the in-pipe injection injector 89). However, an engine of the straddle-type vehicle concerned with the present invention may be one possessing only the in-cylinder injection injector 189.

[0084] As shown in Fig. 12, embodiment 4 is one in which the in-pipe injection injector is omitted in the embodiment 2. That is, the engine concerned with embodiment 4 possesses only the in-cylinder injection injector 189.

[0085] In the present embodiment, the low pressure pump 122 and the high pressure pump 123 are connected by the low pressure fuel piping 126. The fuel discharged from the low pressure pump 122 is fed to the high pressure pump 123 through the low pressure fuel piping 126, and pressurized by the high pressure pump 123. And, the pressurized high pressure fuel is carried to the delivery pipe 128 through the high pressure fuel piping 127, and supplied to each in-cylinder injection injector 189 from the delivery pipe 128.

[0086] Similarly to embodiment 2, also in the present embodiment, the midway parts of the high pressure fuel piping 127 are fixed to the cylinder head cover 50 through the attachment brackets 151, 152. The high pressure fuel piping 127 is connected to the delivery pipe 128 while passing above the right end part of the cylinder head cover 50 in the vehicle width direction from the high pressure pump 123. Other constitution is similar to embodiment 2.

[0087] Accordingly, also in the present embodiment, it is possible to obtain advantages approximately similar to each of the above embodiments.

5 Other embodiments

[0088] In each of the above embodiments, an intermediate (e.g., midway part) of the high pressure fuel piping 127 is fixed to the cylinder head cover 50. However, in a case where the influence of the vibration of the engine 29 on the high pressure fuel piping 127 is small, it is not necessarily required that the midway part of the high pressure fuel piping 127 is fixed to the cylinder head cover 50. Even in a case like this, by the fact that the high pressure pump 123 is fixed to the cylinder head cover 50 and at least one part of the high pressure pump 123 is disposed between both of the left-right main frames 13, the high pressure pump 123 can be compactly disposed. Further, by the fact that the high pressure fuel piping 127 is disposed so as to pass above one end part of the cylinder head cover 50 in the vehicle width direction, it is possible to provide a good supply of fuel from the high pressure pump 123 toward the in-cylinder injection injector 189.

[0089] As explained above, the present invention is useful for a straddle-type vehicle, for example for a motorcycle.

DESCRIPTION OF REFERENCE NUMERALS AND 30 SIGNS

[0090]

10	motorcycle (straddle-type vehicle)
35	12 steering head pipe (head pipe)
	13 main frame
20	fuel tank
29	engine
29a	engine main body
40	40 cylinder head
	41 cylinder
	50 cylinder head cover
	83 combustion chamber
	85 intake pipe (intake passage)
45	87 intake port (intake passage)
	89 in-pipe injection injector
	107 low pressure side pressure accumulation chamber
	117 high pressure side pressure accumulation chamber
50	118 delivery pipe
	122 low pressure pump
	123 high pressure pump
	124 first low pressure fuel piping (low pressure fuel piping)
55	125 second low pressure fuel piping (low pressure fuel piping)
	126 third low pressure fuel piping (low pressure fuel piping)

piping)
 127 high pressure fuel piping
 128 delivery pipe
 130 branch pipe
 153 attachment seat
 189 in-cylinder injection injector

Claims

1. A straddle-type vehicle possessing:

a body frame having a head pipe, and a pair of
 left and right main frames extending rearward
 from the head pipe,
 an engine which has plural cylinders, a cylinder
 head disposed above the plural cylinders and
 partitioning together with each of the cylinders
 plural combustion chambers, and a cylinder
 head cover covering an upper part of the cylinder
 head, and which is supported by the body frame,
 a fuel tank storing a fuel,
 a low pressure pump carrying the fuel in the fuel
 tank,
 a high pressure pump carrying the fuel dis-
 charged from the low pressure pump while pres-
 surizing it,
 a high pressure fuel piping introducing the fuel
 discharged from the high pressure pump,
 plural in-cylinder injection injectors injecting the
 fuel into each of the plural combustion cham-
 bers, and
 a delivery pipe connected to the high pressure
 fuel piping and supplying the fuel to the plural
 in-cylinder injection injectors,

wherein the high pressure pump is fixed to the cyl-
 inder head cover, and at least one part of the high
 pressure pump is disposed between the main
 frames, and
 the high pressure fuel piping is connected to the de-
 livery pipe while passing above one end part of the
 cylinder head cover in a vehicle width direction from
 the high pressure pump.

2. A straddle-type vehicle according to claim 1, wherein
 the high pressure pump is disposed in a center part
 of the cylinder head cover in the vehicle width direc-
 tion.

3. A straddle-type vehicle according to claim 1 or claim
 2, wherein at least one part of a midway part of the
 high pressure fuel piping is fixed to the cylinder head
 cover of the engine.

4. A straddle-type vehicle according to claim 3, wherein
 at least one part of the high pressure fuel piping com-
 prises a metal pipe, and

the metal pipe is fixed to the cylinder head cover.

5. A straddle-type vehicle according to claim 4, wherein
 in the cylinder head cover there is provided at least
 one attachment bracket, and
 the metal pipe is fixed to the cylinder head cover
 through the attachment bracket(s).

6. A straddle-type vehicle according to claim 4, wherein
 in the cylinder head cover there is provided at least
 one attachment seat made of rubber, and
 the metal pipe is fixed to the cylinder head cover
 through the attachment seat(s).

7. A straddle-type vehicle according to any of claims 3
 to 6, wherein intermediate in the high pressure fuel
 piping there is provided a high pressure pressure-
 accumulation chamber accumulating the fuel from
 the high pressure pump, and
 the high pressure pressure-accumulation chamber
 is fixed to the cylinder head cover.

8. A straddle-type vehicle according to any preceding
 claim, comprising low pressure fuel piping introduc-
 ing the fuel to the high pressure pump from the low
 pressure pump, the low pressure fuel piping being
 connected to the high pressure pump while passing
 above one end part of the cylinder head cover in a
 vehicle width direction in a side in which the high
 pressure fuel piping is disposed.

9. A straddle-type vehicle according to any preceding
 claim, wherein the engine possesses:

plural intake passages introducing an air to each
 of the plural combustion chambers,
 plural in-pipe injection injectors injecting the fuel
 into each of the plural intake passages,
 a first low pressure fuel piping introducing the
 fuel supplied by the low pressure pump,
 a branch pipe flow-branching the fuel introduced
 by the first low pressure fuel piping,
 a second low pressure fuel piping connected to
 the branch pipe and introducing one fuel after
 flow-branched toward the in-pipe injection injec-
 tors, and
 a third low pressure fuel piping connected to the
 branch pipe and introducing the other fuel after
 flow-branched to the high pressure pump,
 the third low pressure fuel piping being connect-
 ed to the high pressure pump while passing
 above one end part of the cylinder head cover
 in a vehicle width direction in a side in which the
 high pressure fuel piping is disposed.

10. A straddle-type vehicle according to any preceding
 claim 1, in the form of a motorcycle.

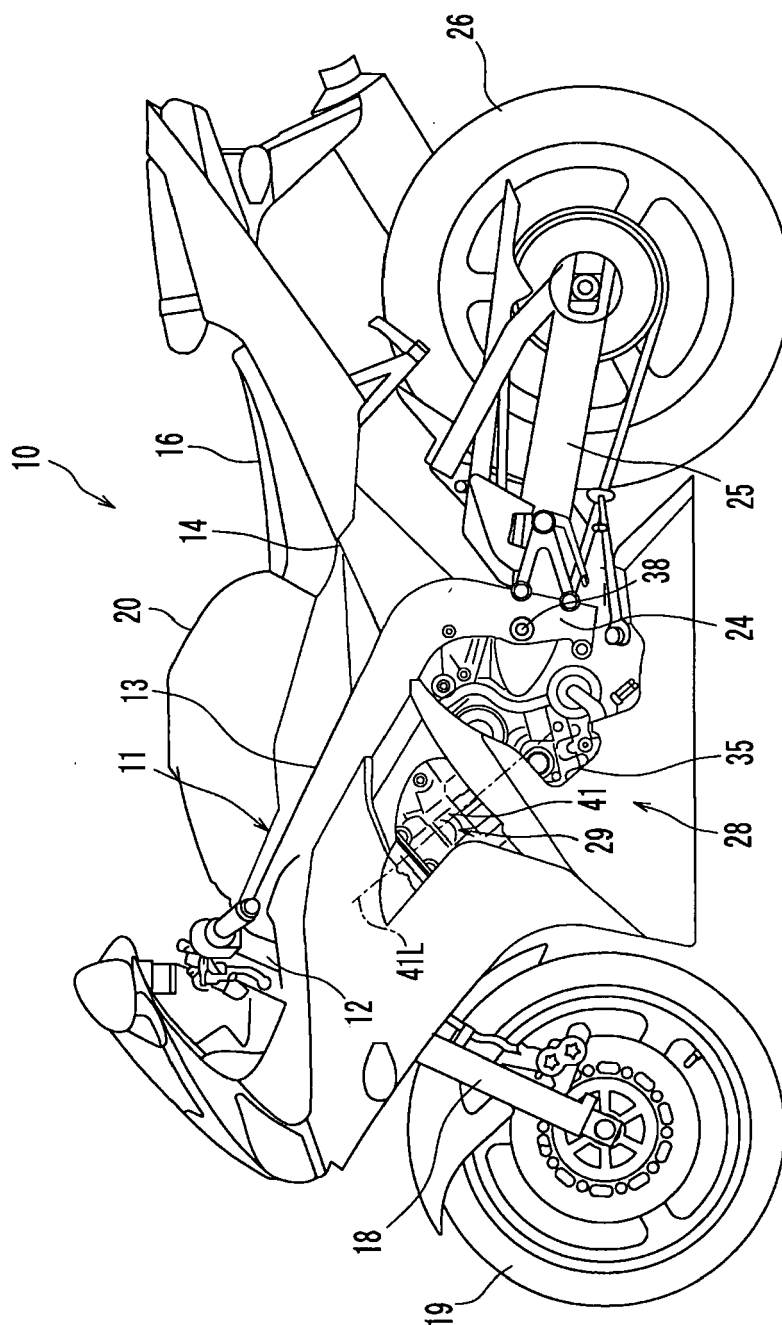


FIG. 1

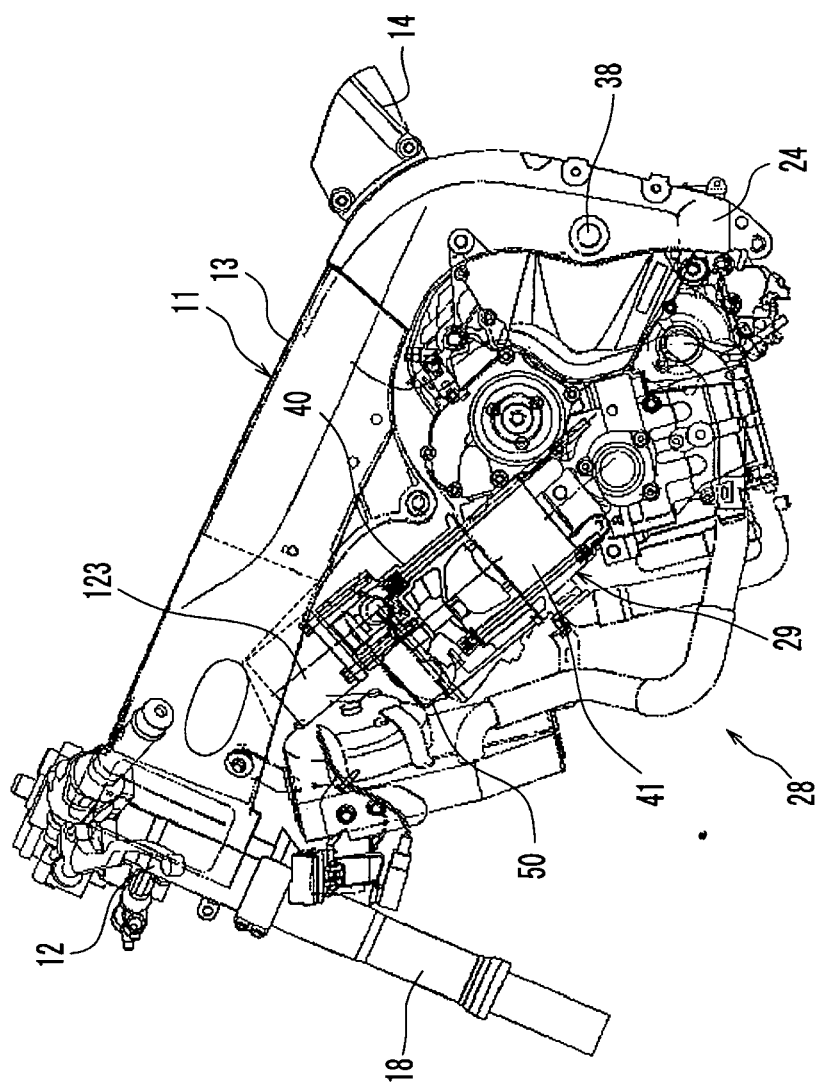


FIG. 2

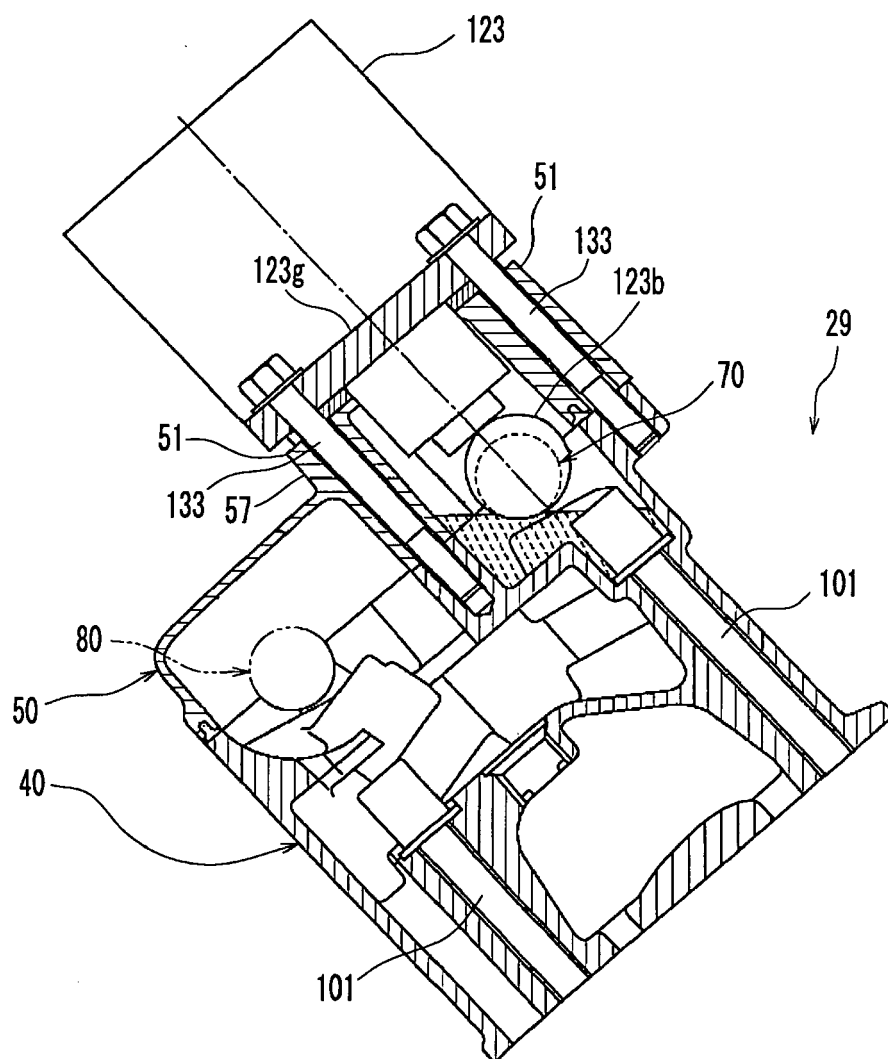


FIG. 3

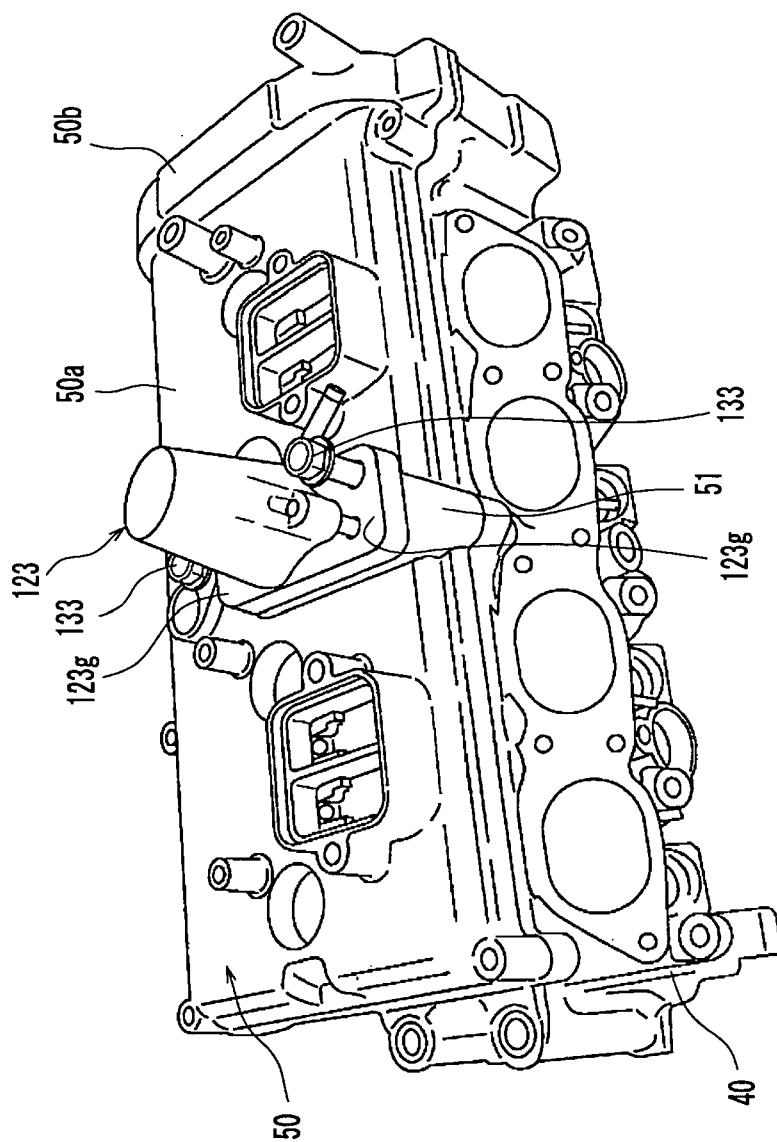


FIG. 4

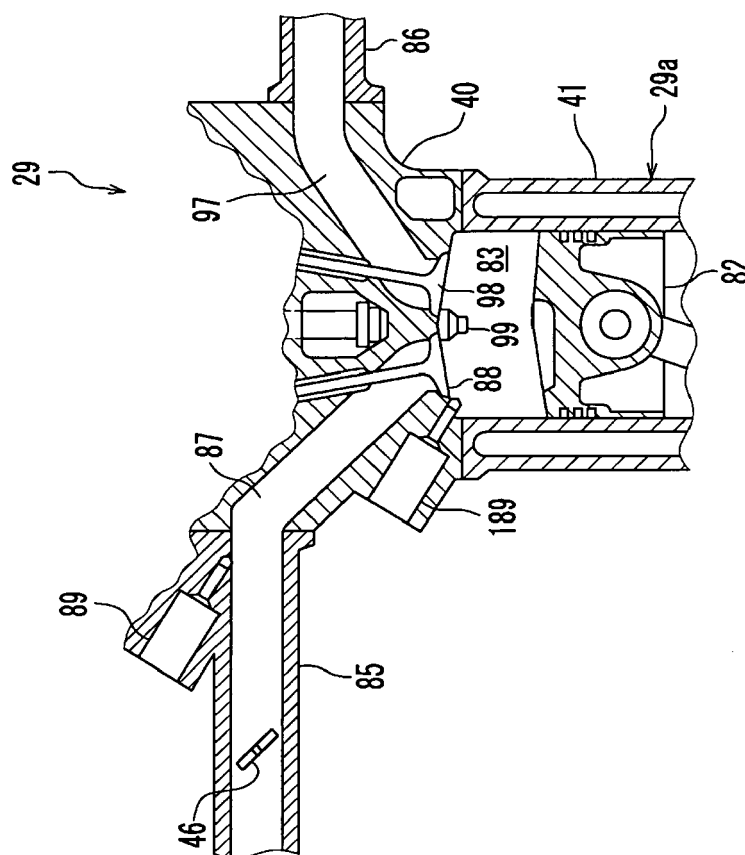


FIG. 5

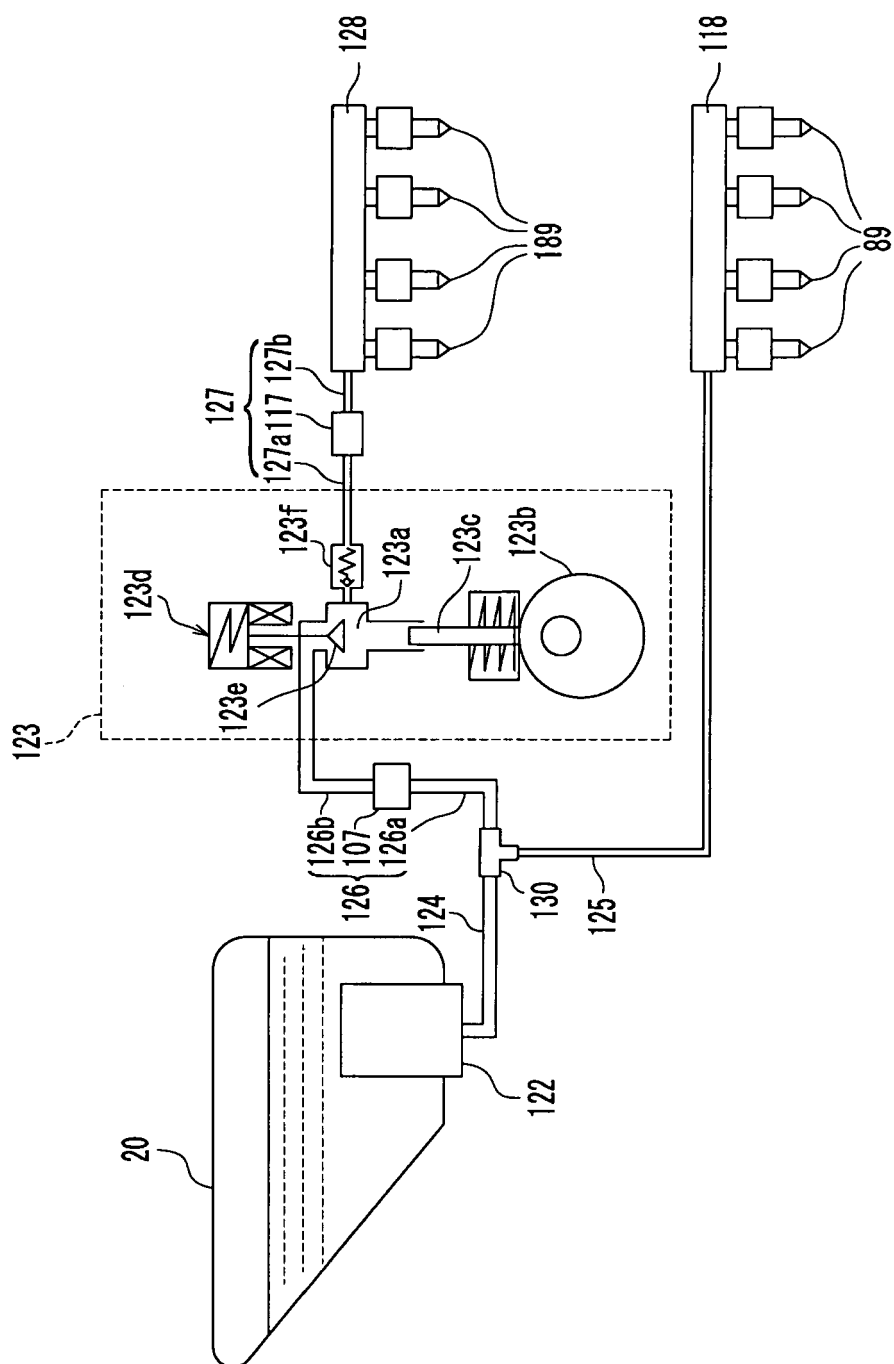


FIG. 6

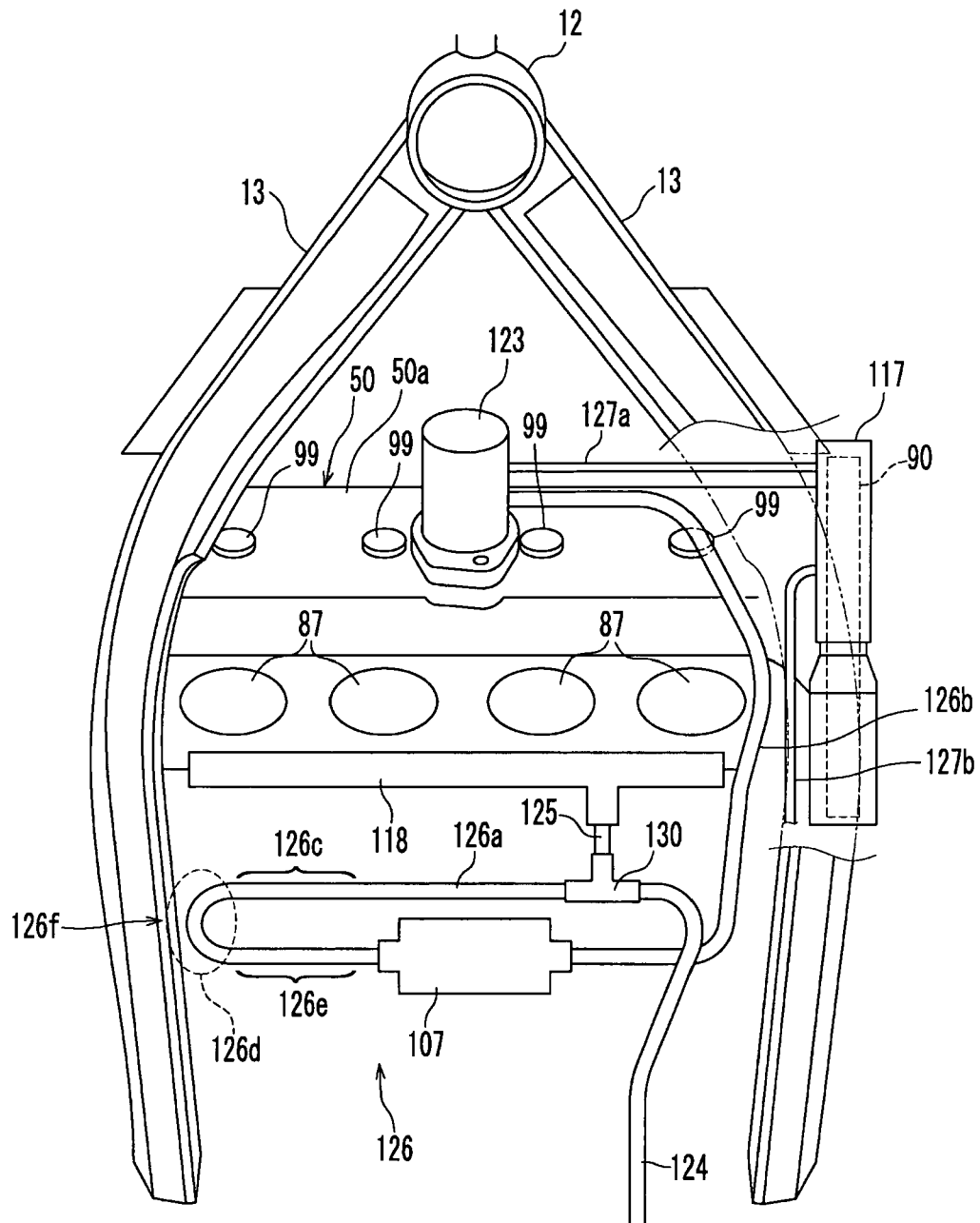


FIG. 7

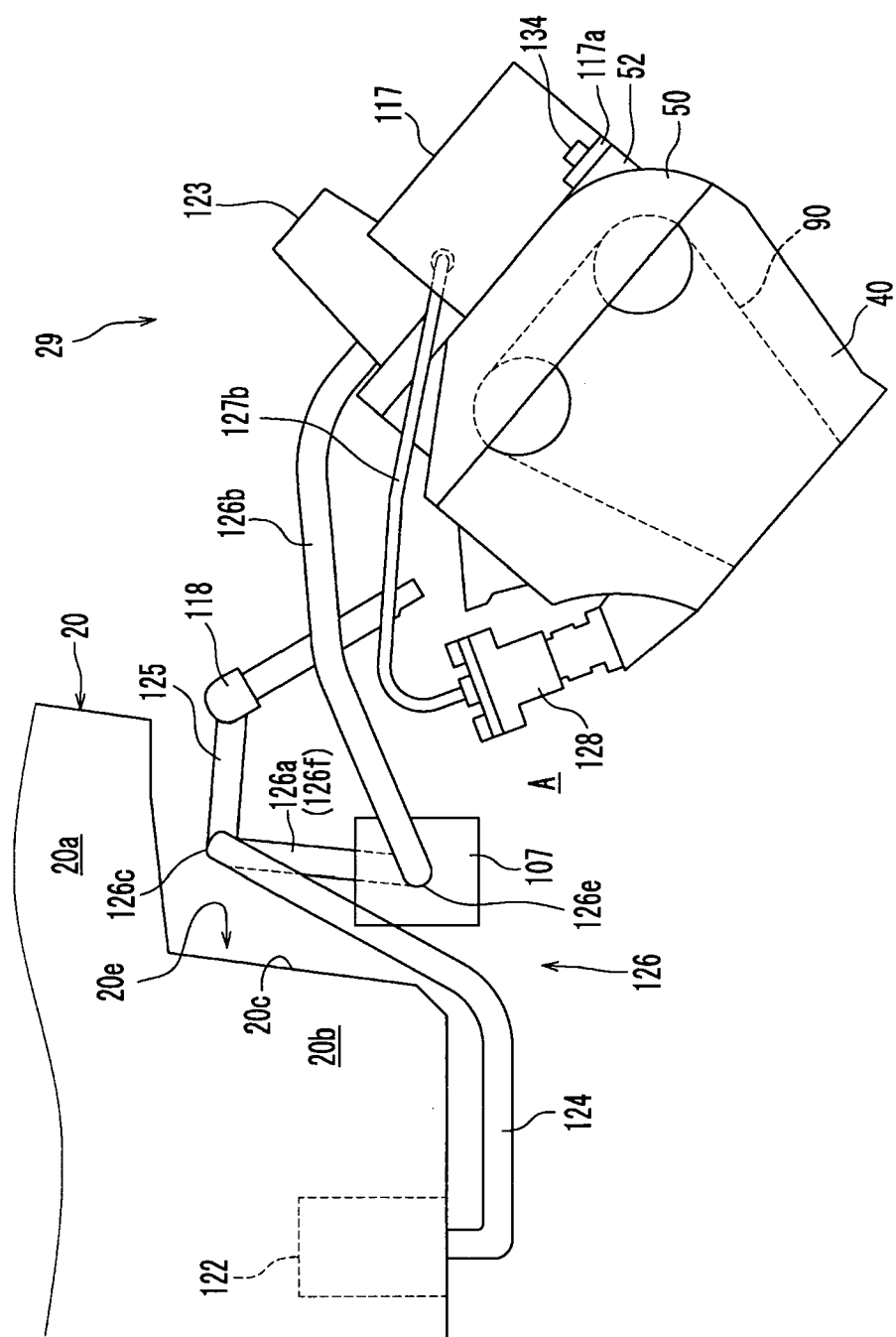


FIG. 8

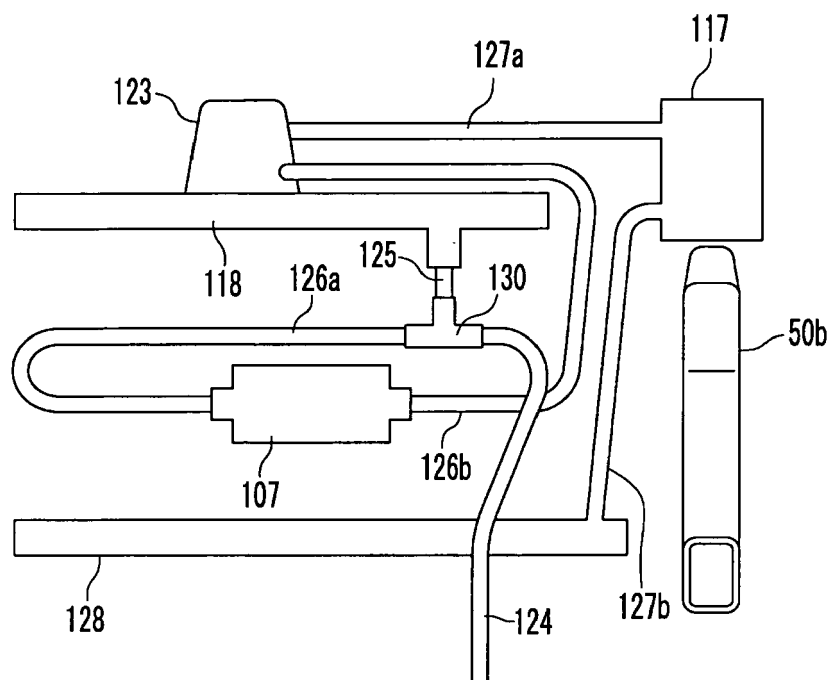


FIG. 9

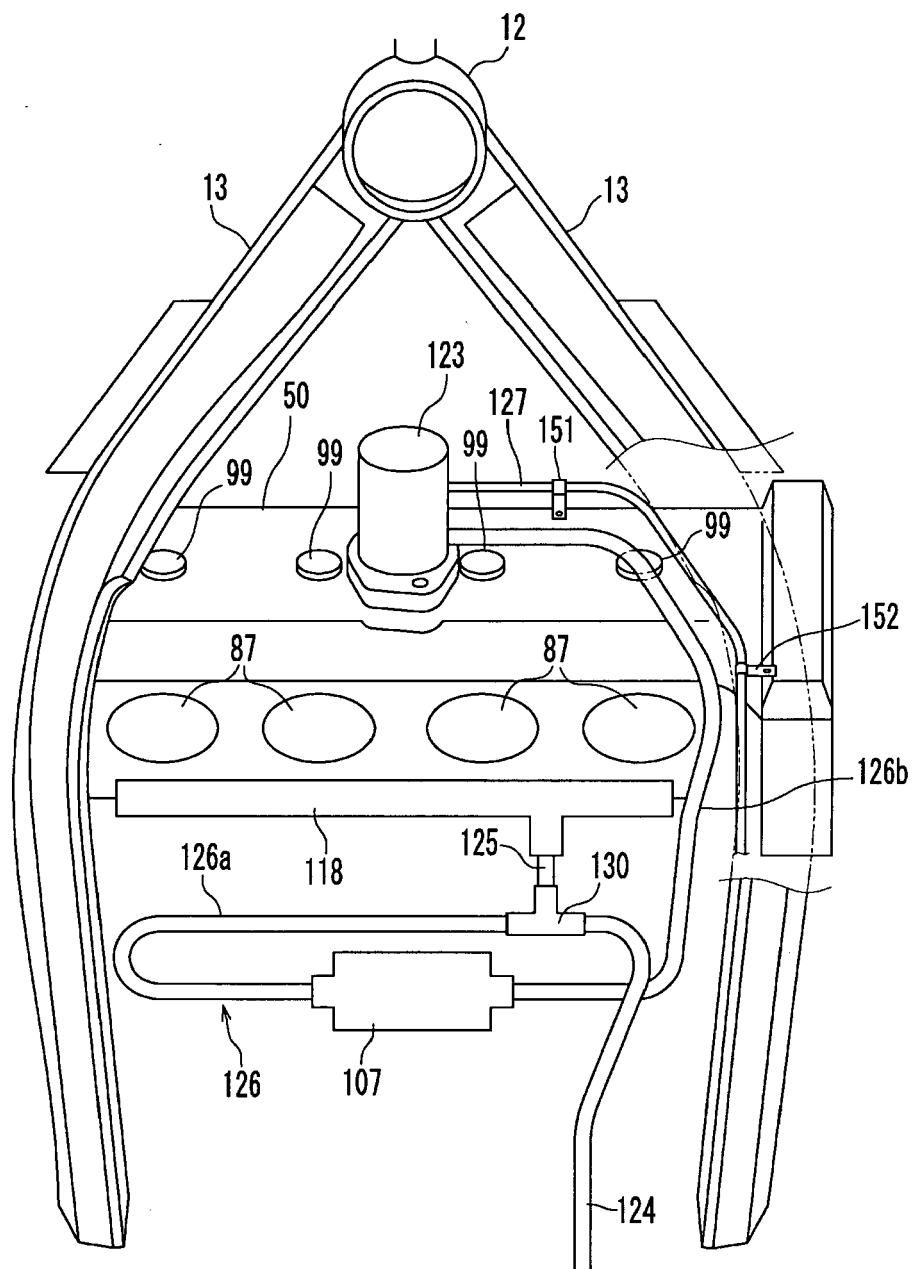


FIG. 10

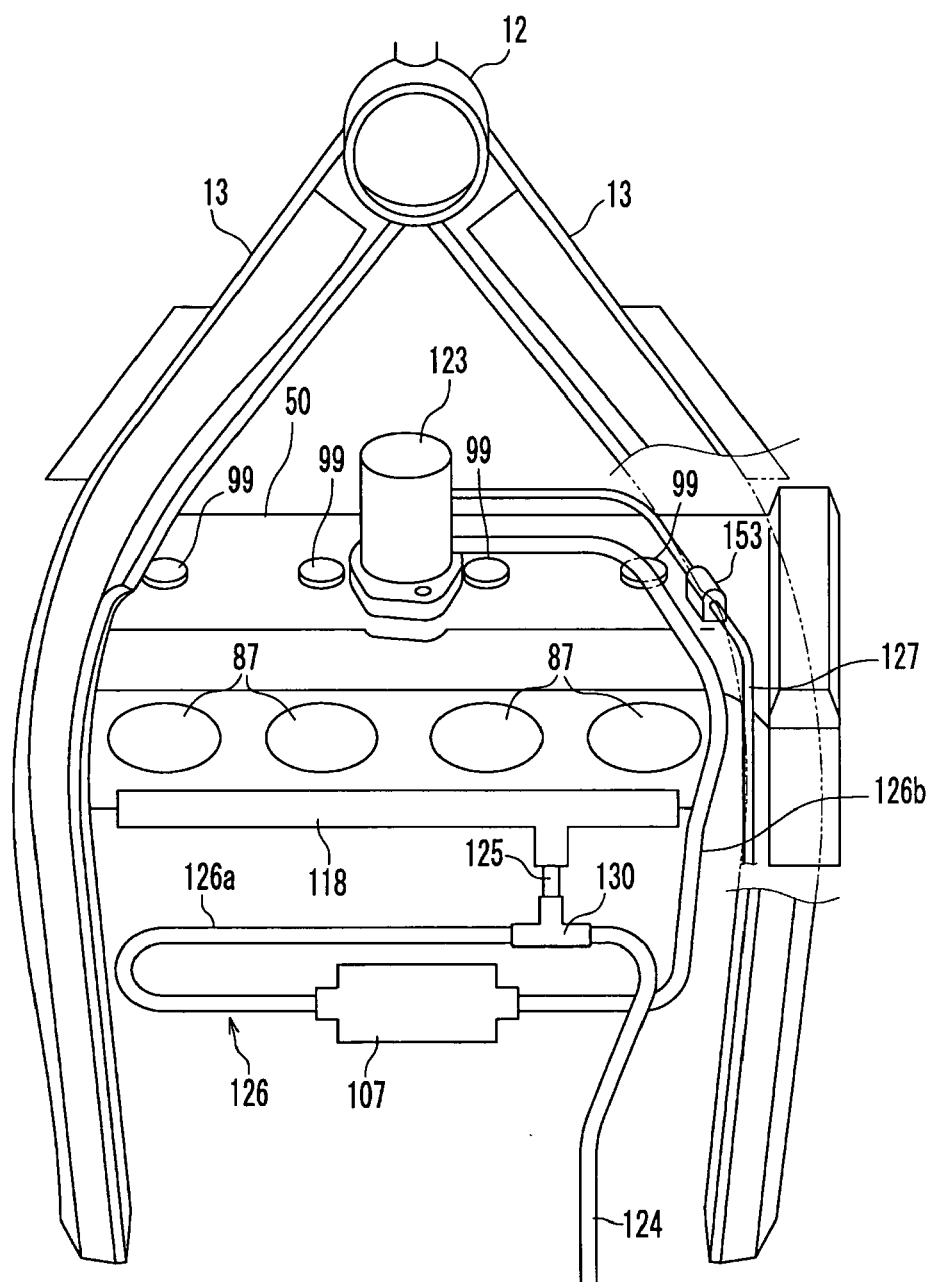


FIG. 11

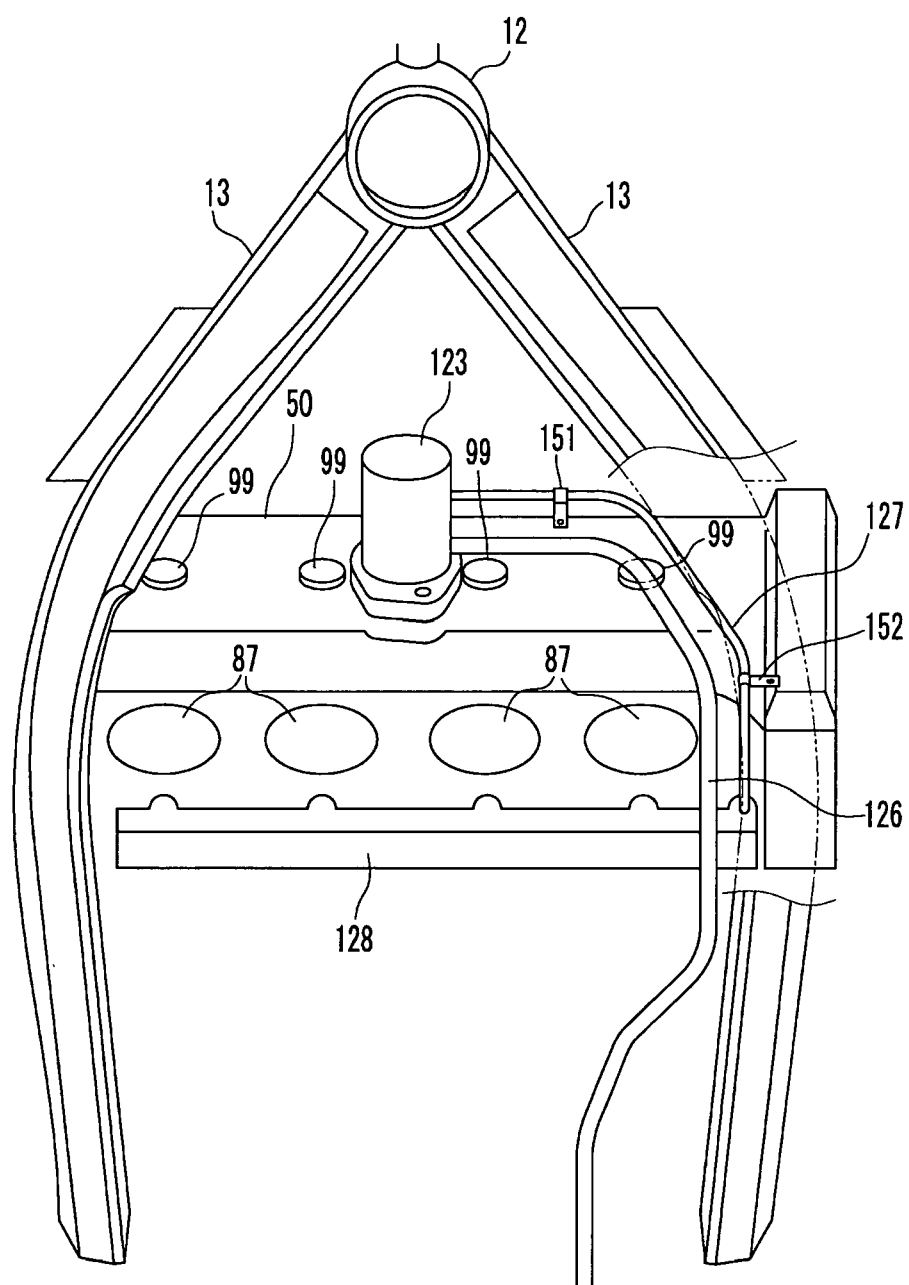


FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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