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(71) Applicant: **YAMAHA HATSUDOKI KABUSHIKI KAISHA**
Iwata-shi Shizuoka 438-8501 (JP)

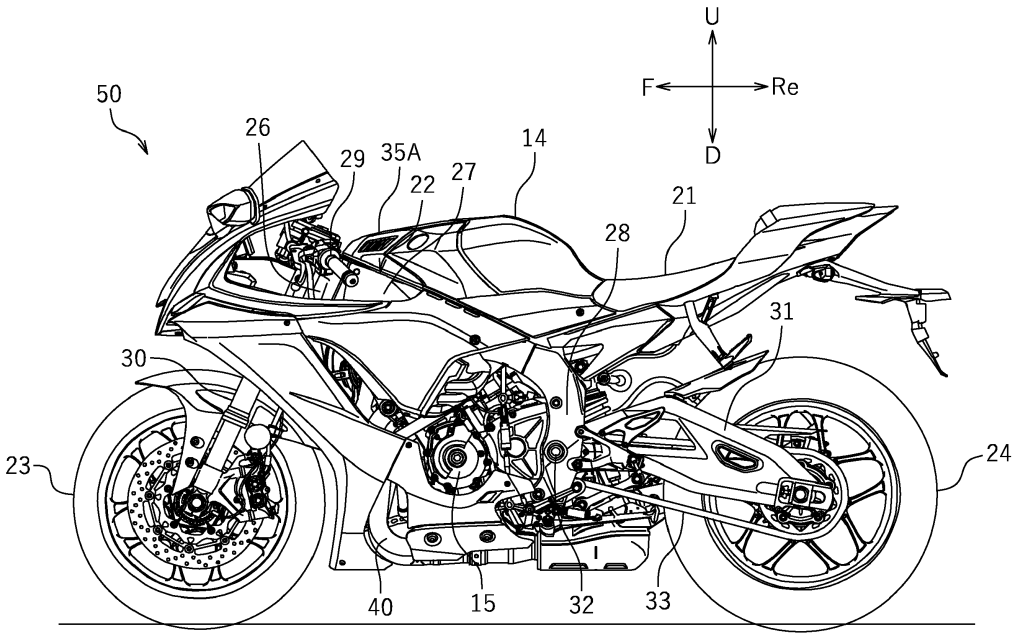
(72) Inventors:
- **KITAMURA, Eigo**
  Iwata-shi, Shizuoka 438-8501 (JP)
- **ARAKI, Kazuya**
  Iwata-shi, Shizuoka 438-8501 (JP)

(74) Representative: **Grünecker Patent- und Rechtsanwälte**
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) **STRADDLED VEHICLE**

(57) An internal combustion engine **15** includes a cylinder body **3** extending forward and upward from a crankcase **2,** an intake pipe **10** extending upward from a cylinder head **5,** and a motor **13** that actuates a throttle valve **11.** At least a portion of a fuel injector **12** is arranged forward of the intake pipe **10.** At least a portion of the motor **13** is arranged rearward of the intake pipe **10.** At least a portion of the fuel injector **12** and at least a portion of the throttle valve **11** are arranged downward relative to an upper end **13a** of the motor **13** and upward relative to a lower end **13b** of the motor **13.**

FIG.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a straddled vehicle having an internal combustion engine including a motor for actuating a throttle valve and a fuel injector.

BACKGROUND ART

[0002] Conventional straddled vehicles including an internal combustion engine of which the cylinder axial line extends forward and upward from the crankcase are known in the art. Internal combustion engines including a motor for actuating a throttle valve arranged in the intake passage and a fuel injector for injecting the fuel into the intake passage are known as such internal combustion engines. For example, FIG **8** of Japanese Patent No. 4916563 describes such an internal combustion engine. With the internal combustion engine described in Japanese Patent No. 4916563, the intake passage extends upward from the cylinder head. The motor is arranged forward of the intake passage, and the fuel injector is arranged rearward of the intake passage.

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0003] With the internal combustion engine described above, the cylinder axial line extends forward and upward and the intake passage extends upward from the cylinder head. The upstream end portion of the intake passage is connected to the air cleaner, and the downstream end portion of the intake passage is connected to the cylinder head. A portion of the cylinder head and a portion of the cylinder head cover are arranged forward of the intake passage. Therefore, there is no margin of space forward of the downstream end portion of the intake passage. That is, there is no margin of space forward of the connection between the intake passage and the cylinder head.

[0004] In order to appropriately actuate the throttle valve and enhance the responsiveness of the throttle valve, the motor is preferably arranged in the vicinity of the throttle valve. However, the motor for actuating the throttle valve is a relatively large device. With conventional internal combustion engines, since there is no margin of space forward of the downstream end portion of the intake passage, the motor is arranged more toward the upstream end portion. This as a result increases the distance between the throttle valve and the combustion chamber. This has been a limiting factor for reducing the size of the internal combustion engine.

[0005] It is an object of the present invention to reduce the size of a straddled vehicle having an internal combustion engine including a motor for actuating a throttle valve and a fuel injector.

SOLUTION TO PROBLEM

[0006] A straddled vehicle disclosed herein includes an internal combustion engine. The internal combustion engine includes: a crankcase that rotatably supports a crankshaft extending in a vehicle width direction; a cylinder body extending forward and upward from the crankcase; a cylinder formed inside the cylinder body; a cylinder head connected to the cylinder body; an intake port that is formed inside the cylinder head and has an opening facing toward an inside of the cylinder; an intake valve that is supported on the cylinder head and opens/closes the intake port; an intake cam that is rotatably supported on the cylinder head and actuates the intake valve; an intake passage that is formed inside the cylinder head and is connected to the intake port; an intake pipe that is connected to the cylinder head, extends upward from the cylinder head and is connected to the intake passage; a throttle valve that is arranged inside the intake pipe; a fuel injector that has an injection port arranged between the throttle valve and the intake port; and a motor that is linked to the throttle valve and actuates the throttle valve. At least a portion of the fuel injector is arranged forward of the intake pipe. At least a portion of the motor is arranged rearward of the intake pipe. At least a portion of the fuel injector and at least a portion of the throttle valve are arranged downward relative to an upper end of the motor and upward relative to a lower end of the motor.

[0007] With the straddled vehicle, the cylinder body and the cylinder head extend forward and upward from the crankcase, and the intake pipe extends upward from the cylinder head. Therefore, there is no margin of space forward of a portion of the intake pipe that is close to the cylinder head. With the straddled vehicle, however, at least a portion of the motor is arranged rearward of the intake pipe. Therefore, the motor is arranged at a portion of the intake pipe that is close to the cylinder head. With the straddled vehicle, at least a portion of the fuel injector is arranged forward of the intake pipe. This realizes a compact arrangement of the fuel injector, wherein the fuel injector and the motor do not interfere with each other. Furthermore, with the straddled vehicle, at least a portion of the fuel injector and at least a portion of the throttle valve are arranged downward relative to the upper end of the motor and upward relative to the lower end of the motor. Therefore, it is possible to suppress the overall dimension in the up-down direction of the motor, the fuel injector and the throttle valve. Thus, it is possible to reduce the size of the internal combustion engine, and hence to reduce the size of the straddled vehicle.

[0008] According to one preferred embodiment, at least a portion of the intake cam is arranged downward relative to the upper end of the motor and upward relative to the lower end of the motor.

[0009] According to the embodiment described above, since it is possible to suppress the overall dimension in the up-down direction of the motor, the fuel injector, the throttle valve and the cylinder head (specifically, a portion

of the cylinder head where the intake cam is provided), it is possible to further reduce the size of the internal combustion engine.

[0010] According to one preferred embodiment, a center of rotation of the intake cam, the injection port of the fuel injector and a center of rotation of the throttle valve are arranged downward relative to the upper end of the motor and upward relative to the lower end of the motor.

[0011] According to the embodiment described above, since it is possible to further suppress the overall dimension in the up-down direction of the motor, the fuel injector, the throttle valve and the cylinder head, it is possible to further reduce the size of the internal combustion engine.

[0012] According to one preferred embodiment, the fuel injector and the throttle valve are arranged rearward relative to a front end of a rotation path of the intake cam and forward relative to a rear end of the motor.

[0013] According to the embodiment described above, since it is possible to suppress the overall dimension in the front-rear direction of the motor, the throttle valve, the fuel injector and the intake cam, it is possible to further reduce the size of the internal combustion engine.

[0014] According to one preferred embodiment, the fuel injector and the throttle valve are arranged rearward relative to the center of rotation of the intake cam and forward relative to a center of the motor.

[0015] According to the embodiment described above, since it is possible to further suppress the overall dimension in the front-rear direction of the motor, the throttle valve, the fuel injector and the intake cam, it is possible to further reduce the size of the internal combustion engine.

[0016] According to one preferred embodiment, the fuel injector and the throttle valve are arranged rearward relative to the center of rotation of the intake cam and forward relative to a center of rotation of the crankshaft.

[0017] According to the embodiment described above, since it is possible to suppress the overall dimension in the front-rear direction of the motor, the throttle valve, the fuel injector and the intake cam, it is possible to further reduce the size of the internal combustion engine.

[0018] According to one preferred embodiment, where a first line is defined as a straight line that passes through a center of rotation of the intake cam and is perpendicular to an axial line of the cylinder and a second line as a straight line that passes through a center of the intake port and is perpendicular to the axial line of the cylinder, the injection port of the fuel injector, a center of the throttle valve and a center of the motor are arranged between the first line and the second line, as the vehicle is seen from the side.

[0019] According to the embodiment described above, it is possible to suppress the overall dimension of the motor, the throttle valve, the fuel injector and the intake cam for the direction along the cylinder axial line. It is possible to further reduce the size of the internal combustion engine.

[0020] According to one preferred embodiment, the injection port of the fuel injector, an entirety of the throttle valve and an entirety of the motor are arranged between the first line and the second line, as the vehicle is seen from the side.

[0021] According to the embodiment described above, it is possible to further suppress the overall dimension of the motor, the throttle valve, the fuel injector and the intake cam for the direction along the cylinder axial line. It is possible to further reduce the size of the internal combustion engine.

[0022] According to one preferred embodiment, a center line of the intake pipe is located rearward relative to a center of rotation of the intake cam and forward relative to a rear end of the motor.

[0023] According to the embodiment described above, the dimension of the intake pipe in the front-rear direction is small. It is possible to further reduce the size of the internal combustion engine.

[0024] According to one preferred embodiment, an angle formed between an axial line of the cylinder and a horizontal line is 45 degrees or more, as the vehicle is seen from the side.

[0025] According to the embodiment described above, since the inclination of the cylinder is large, there is a small space between the cylinder body and the cylinder head and the intake pipe. Therefore, the aforementioned effects, e.g., being able to arrange the motor at a portion of the intake pipe that is close to the cylinder head, are particularly pronounced.

[0026] According to one preferred embodiment, an angle formed between an axial line of the fuel injector and a horizontal line is greater than an angle formed between an axial line of the cylinder and the horizontal line, as the vehicle is seen from the side.

[0027] According to the embodiment described above, the fuel injector is arranged in an attitude that is more along the vertical direction. It is possible to suppress the dimension of the fuel injector in the front-rear direction. Thus, the fuel injector is arranged in a compact arrangement in a small space between the cylinder head and the intake pipe.

[0028] According to one preferred embodiment, the straddled vehicle includes a vehicle frame that supports the internal combustion engine. The vehicle frame includes a side frame that overlaps with at least a portion of the throttle valve, at least a portion of the fuel injector and at least a portion of the motor, as the vehicle is seen from the side.

[0029] With the straddled vehicle, at least a portion of the fuel injector is arranged forward of the intake pipe, and at least a portion of the motor is arranged rearward of the intake pipe. The side frame is arranged sideward of the intake pipe without being interfered by the fuel injector and the motor. According to the embodiment described above, at least a portion of the throttle valve, at least a portion of the fuel injector and at least a portion of the motor are arranged in a compact arrangement side-

ward of the side frame. It is possible to suppress the overall dimension in the up-down direction of the throttle valve, the fuel injector, the motor and the side frame. Thus, it is possible to reduce the size of the straddled vehicle.

[0030] According to one preferred embodiment, the straddled vehicle includes: a fuel tank arranged rearward relative to the intake pipe; and a fuel hose connected to the fuel tank and the fuel injector. A portion of the fuel hose is arranged sideward of the intake pipe.

[0031] According to the embodiment described above, the fuel hose extends from the fuel tank toward the fuel injector through the side of the intake pipe. Since the motor is arranged rearward of the intake pipe, it is possible to easily avoid the interference between the fuel hose and the motor.

[0032] The straddled vehicle may include an air cleaner case including a connection port to which the intake pipe is connected.

[0033] According to one preferred embodiment, the internal combustion engine includes: a piston arranged in the cylinder; a crank pin provided on the crankshaft; and a connecting rod linked to the piston and the crank pin. At least a portion of the connection port of the air cleaner case, at least a portion of the throttle valve and at least a portion of the motor are located rearward relative to a front end of a rotation path of the crank pin and forward relative to a rear end of the rotation path.

[0034] According to the embodiment described above, since it is possible to suppress the overall dimension in the front-rear direction of the connection port of the air cleaner case, the throttle valve and the motor, it is possible to reduce the size of the straddled vehicle.

[0035] According to one preferred embodiment, at least a portion of the fuel injector is located downward relative to an upper end of the connection port of the air cleaner case and upward relative to a lower end of the connection port.

[0036] According to the embodiment described above, the distance between the connection port of the air cleaner case and the fuel injector in the up-down direction is short. It is possible to reduce the size of the straddled vehicle.

[0037] According to one preferred embodiment, a straight line that passes through a center of the motor and is parallel to an axial line of the cylinder overlaps with the air cleaner case, as the vehicle is seen from the side.

[0038] According to the embodiment described above, the motor is arranged close to the air cleaner case. The motor and the air cleaner case are arranged in a compact arrangement.

[0039] According to one preferred embodiment, the fuel injector is a slant injector of which an injection direction is inclined from an axial line of the fuel injector toward the intake port.

[0040] According to the embodiment described above, it is possible to effectively inject the fuel toward the intake port.

[0041] According to one preferred embodiment, the intake valve is implemented as a poppet valve including an umbrella portion that covers the intake port and a rod-shaped stem that extends from the umbrella portion. The fuel injector is arranged so that a straight line that extends in the injection direction from the injection port crosses the umbrella portion.

[0042] According to the embodiment described above, it is possible to effectively inject the fuel toward the intake port.

ADVANTAGEOUS EFFECTS OF INVENTION

[0043] According to the present invention, it is possible to reduce the size of a straddled vehicle having an internal combustion engine including a motor for actuating a throttle valve and a fuel injector.

BRIEF DESCRIPTION OF DRAWINGS

[0044]

FIG **1** is a left side view of a motorcycle according to an embodiment.

FIG **2** is a right side view of a portion of a vehicle frame, an internal combustion engine, an air cleaner and a fuel tank.

FIG. **3** is a cross-sectional view of the internal combustion engine and the air cleaner.

FIG. **4** is an enlarged cross-sectional view of a portion of the internal combustion engine and a portion of the air cleaner.

FIG. **5** is equivalent to FIG **3,** except for the addition of auxiliary lines.

FIG. **6** is equivalent to FIG **4,** except for the addition of auxiliary lines.

DESCRIPTION OF EMBODIMENTS

[0045] An embodiment of the present invention will now be described with reference to the drawings. FIG **1** is a left side view of a motorcycle **50** according to the present embodiment.

[0046] The terms front, rear, left, right, up and down, as used in the description below, refer to these directions as seen from a virtual rider seated on a seat **21** while the motorcycle **50** is standing upright on a horizontal surface with no rider, no fuel and no load thereon, unless specified otherwise. The designations F, Re, L, R, U and D, as used in the figures, refer to front, rear, left, right, up and down, respectively. Unless specified otherwise, the term "front/forward" refers not only to the direction that extends in the front direction along the vehicle center line, as the vehicle is seen from above, but also to directions that are inclined left/right from that direction by an angle that is less than or equal to 45 degrees. Similarly, the term "rear/rearward" refers not only to the direction that extends rearward along the vehicle center line, as

the vehicle is seen from above, but also to directions that are inclined left/right from that direction by an angle of 45 degrees of less. The term "left/leftward" refers not only to the direction that extends leftward vertical to the vehicle center line, as the vehicle is seen from above, but also to directions that are inclined frontward/rearward from that direction by an angle of 45 degrees of less. The term "right/rightward" refers not only to the direction that extends rightward vertical to the vehicle center line, as the vehicle is seen from above, but also to directions that are inclined frontward/rearward from that direction by an angle of 45 degrees of less. The term "up/upward" refers not only to the vertically upward direction, as the vehicle is seen from sideways, but also to directions that are inclined frontward/rearward from that direction by an angle of 45 degrees of less. The term "down/downward" refers not only to the vertically downward direction, as the vehicle is seen from sideways, but also to directions that are inclined frontward/rearward from that direction by an angle of 45 degrees of less.

[0047] As shown in FIG **1,** the motorcycle **50** includes a vehicle frame **22,** a front wheel **23,** a rear wheel **24,** an internal combustion engine (hereinafter "engine") **15,** an air cleaner **35** covered by an external cover **35A** (see FIG **2**), a fuel tank **14,** and the seat **21.** The seat **21** is arranged rearward of the fuel tank **14.**

[0048] The vehicle frame **22** includes a head pipe **26,** left and right side frames **27** extending rearward and outward in the vehicle width direction from the head pipe **26,** and left and right down frames **28** extending downward from the rear end of the left and right side frames **27.** A steering shaft (not shown), to which a handle **29** is secured, is supported on the head pipe **26** so that the steering shaft can pivot left and right. The steering shaft is secured to a front fork **30.**

[0049] The front wheel **23** is supported on the front fork **30.** The rear wheel **24** is supported on a rear end portion of a rear arm **31.** The front end portion of the rear arm **31** is supported by a pivot shaft **32** so that the rear arm **31** can pivot up and down relative to the down frame **28.** The front wheel **23** is a driven wheel. The rear wheel **24** is a driving wheel that is driven by the engine **15.** The engine **15** and the rear wheel **24** are linked by a chain **33.** The chain **33** is an example of a power transmission member. Note however that the power transmission member that transmits the power of the engine **15** to the rear wheel **24** is not limited to the chain **33,** but it may be a transmission belt, a drive shaft, etc.

[0050] FIG **2** is a right side view of a portion of the vehicle frame **22,** the engine **15,** the air cleaner **35** and the fuel tank **14.** FIG **3** is a cross-sectional view of the engine **15** and the air cleaner **35.** FIG. **4** is an enlarged cross-sectional view of a portion of the engine **15** and a portion of the air cleaner **35.** Note that FIG **3** and FIG **4** are cross-sectional views along a direction orthogonal to the vehicle width direction.

[0051] As shown in FIG **2,** the engine **15** is supported on the vehicle frame **22.** As shown in FIG **3,** the engine **15** includes a crankshaft **1,** a crankcase **2,** a cylinder body **3,** a cylinder head **5,** and a cylinder head cover **36.** The engine **15** includes an intake valve **7,** an exhaust valve **37,** an intake cam **8,** an exhaust cam **38,** an intake pipe **10,** an exhaust pipe **40** (see FIG **1**), a fuel injector **12,** a fuel injector **12B,** a throttle valve **11,** and a motor **13** for actuating the throttle valve **11.**

[0052] The crankshaft **1** extends in the vehicle width direction. The crankshaft **1** is arranged inside the crankcase **2.** The crankcase **2** rotatably supports the crankshaft **1.** The cylinder body **3** extends forward and upward from the crankcase **2.** A cylinder **4** is formed inside the cylinder body **3.** A piston **18** is arranged inside the cylinder **4.** A crank pin **19** is provided on the crankshaft **1.** A connecting rod **20** is linked to the piston **18** and the crank pin **19.** The piston **18** is linked to the crankshaft **1** via the connecting rod **20** and the crank pin **19.** Note that reference sign 67 denotes a balancer gear, and reference sign 68 denotes a clutch.

[0053] The engine **15** of the present embodiment is an engine in which the cylinder **4** is upright at a relatively steep angle relative to the horizontal line. As shown in FIG **5,** the angle $\theta 1$ formed between a cylinder axial line **4c** and the horizontal line **PL** is 45 degrees or more. Note however that there is no particular limitation on the value of the angle $\theta 1$. $\theta 1$ may be less than 45 degrees.

[0054] As shown in FIG. **4,** the cylinder head **5** is connected to the cylinder body **3.** The cylinder head **5** extends forward and upward from the cylinder body **3.** The cylinder head cover **36** is connected to the cylinder head **5.** The cylinder head cover **36** extends forward and upward from the cylinder head **5.** An intake port **6** and an exhaust port **39** are formed inside the cylinder head **5** with their openings facing toward the inside of the cylinder **4.** An intake passsage **9** connected to the intake port **6** and an exhaust passage **41** connected to the exhaust port **39** are formed inside the cylinder head **5.** The intake valve **7** is implemented as a poppet valve including an umbrella portion **42** that closes the intake port **6** and a shaft-shaped stem **43** that extends from the umbrella portion **42.** The exhaust valve **37** is also implemented as a poppet valve. The intake valve **7** and the exhaust valve **37** are supported on the cylinder head **5** so that they can move in the axial direction of the stem **43.** The intake valve **7** covers the intake port **6** so that it can open/close the intake port **6,** and the exhaust valve **37** covers the exhaust port **39** so that it can open/close the exhaust port **39.**

[0055] The intake cam **8** and the exhaust cam **38** are rotatably supported on the cylinder head **5.** The intake cam **8** rotates to thereby actuate the intake valve **7.** The exhaust cam **38** rotates to thereby actuate the exhaust valve **37.** The center of rotation **8c** of the intake cam **8** is located rearward and upward relative to the center of rotation **38c** of the exhaust cam **38.**

[0056] The intake pipe **10** is connected to the cylinder head **5** and is connected to the intake passage **9.** The intake pipe **10** is configured to guide the air to the intake

passage **9.** As shown in FIG **3,** the intake pipe **10** extends upward from the cylinder head **5.** Specifically, the intake pipe **10** extends upward and rearward from the cylinder head **5.** The dimension in the front-rear direction of the intake pipe **10** is relatively small. Herein, the center line **10c** of the intake pipe **10** is located rearward relative to the center of rotation **8c** of the intake cam **8** and forward relative to a rear end **13r** of the motor **13.**

[0057] The intake pipe **10** includes a first intake pipe **10A** and a second intake pipe **10B.** The first intake pipe **10A** is arranged upward of the second intake pipe **10B.** The first intake pipe **10A** is arranged on the upstream side relative to the second intake pipe **10B.** The first intake pipe **10A** is attachable to and detachable from the second intake pipe **10B.** The motorcycle **50** includes an actuator **10K** that actuates the first intake pipe **10A.**

[0058] As the actuator **10K** moves the first intake pipe **10A** downward, the first intake pipe 10A is connected to the second intake pipe **10B.** Then, the air is sucked in through an inlet **10Ai** of the first intake pipe **10A,** passes through the first intake pipe **10A** and the second intake pipe **10B,** and then flows into the intake passage **9.** As the actuator **10K** moves the first intake pipe **10A** upward, the first intake pipe **10A** moves apart from the second intake pipe **10B.** Then, the air is sucked in through an inlet **10Bi** of the second intake pipe **10B,** passes through the second intake pipe **10B,** and is then sucked into the intake passage **9.**

[0059] As the first intake pipe **10A** is connected to the second intake pipe **10B,** the length of the intake pipe **10** becomes the total length of the length of the first intake pipe **10A** and the length of the second intake pipe **10B.** As the first intake pipe **10A** is moves apart from the second intake pipe **10B,** the length of the intake pipe **10** becomes equal to the length of the second intake pipe **10B.** Thus, by attaching and detaching the first intake pipe **10A** to and from the second intake pipe **10B,** the length of the intake pipe **10** is varied. Note however that the length of the intake pipe **10** does not always need to be variable. The first intake pipe **10A** and the second intake pipe **10B** may be always connected to each other. The first intake pipe **10A** and the second intake pipe **10B** may be integral with each other. The first intake pipe **10A** may be omitted.

[0060] The throttle valve **11** is arranged inside the intake pipe **10** (specifically, the second intake pipe **10B**). The throttle valve **11** is actuated by the motor **13.** The motor **13** is linked to the throttle valve **11** so that power is transmitted therebetween. At least a portion of the motor **13** is arranged rearward of the intake pipe **10.** Herein, the entirety of the motor **13** is arranged rearward relative to the center line **10c** of the intake pipe **10.** The entirety of the motor **13** is arranged rearward relative to the intake pipe **10.**

[0061] As shown in FIG **4,** the fuel injector **12** is attached to the intake pipe **10** (specifically, the second intake pipe **10B**). The fuel injector **12** is attached so as to extend upward from the intake pipe **10.** Although the fuel injector **12** may be attached so as to extend in the vertically upward direction, an axial line **12c** of the fuel injector **12** is herein inclined from the horizontal line **PL** and the vertical line **VL** as shown in FIG **6.** The angle $\theta 2$ formed between the axial line **12c** of the fuel injector **12** and the horizontal line **PL** is greater than the angle $\theta 1$ formed between the cylinder axial line **4c** and the horizontal line **PL** (see FIG **5**). $\theta 2 > \theta 1$.

[0062] As shown in FIG **4,** a portion of the fuel injector **12** is arranged outside the intake pipe **10,** and the other portion of the fuel injector **12** is arranged inside the intake pipe **10.** At least a portion of the fuel injector **12** is arranged forward of the intake pipe **10.** The entirety of the fuel injector **12** is arranged forward relative to the center line **10c** of the intake pipe **10** (see FIG **3**). An injection port **12a** of the fuel injector **12** is arranged between the throttle valve **11** and the intake port **6.** The injection port **12a** is arranged on the downstream side relative to the throttle valve **11** in the air flow direction.

[0063] In the present embodiment, the fuel injector **12** is a slant injector of which the fuel injection direction **12s** is inclined from the axial line **12c** of the fuel injector **12,** as shown in FIG **6.** The injection direction **12s** of the fuel injector **12** is inclined from the axial line **12c** of the fuel injector **12** toward the intake port **6.** Note that strictly speaking, the injected fuel spreads as a jet, and the injection direction is not a single direction. The injection direction of the fuel injector **12** as used herein is the direction of the center line of the jet. In the present embodiment, the injection port **12a** of the fuel injector **12** has an opening inclined from the axial line **12c** of the fuel injector **12** toward the intake port **6.** The straight line extending from the injection port **12a** to the injection direction **12s** crosses the umbrella portion **42** of the intake valve **7.**

[0064] There is no particular limitation on the timing for the fuel injector **12** to inject the fuel. The fuel injector **12** may inject the fuel when the intake valve **7** is open or may inject the fuel when the intake valve **7** is closed. In the present embodiment, the fuel injector **12** injects the fuel when the intake valve **7** is closed and does not inject the fuel when the intake valve **7** is open. A portion of the fuel injected from the fuel injector **12** attaches to the umbrella portion **42** of the intake valve **7** and then evaporates to be mixed with the air.

[0065] As indicated by a phantom line in FIG **5,** the fuel injector **12** and the fuel tank **14** are connected together by a fuel hose **16.** In the present embodiment, since the fuel tank **14** is arranged rearward relative to the intake pipe **10** and a proximal portion of the fuel injector **12** is arranged forward relative to the intake pipe **10,** the fuel hose **16** needs to extend from a position rearward of the intake pipe **10** to a position forward of the intake pipe **10.** The fuel hose **16** extends forward passing through the side of the intake pipe **10.** Herein, the fuel hose **16** extends forward passing through the right side of the intake pipe **10.** A portion of the fuel hose **16** is arranged sideward of the intake pipe **10.**

[0066] The straight line **13aL** of FIG **6** is a horizontal

line passing through an upper end **13a** of the motor **13.** The straight line **13bL** is a horizontal line passing through a lower end **13b** of the motor **13.** At least a portion of the fuel injector **12** and at least a portion of the throttle valve **11** are arranged downward relative to the upper end **13a** of the motor **13** and upward relative to the lower end **13b** of the motor **13.** Note that in the present specification, the position of the throttle valve **11** is assumed to mean the position when the throttle valve **11** is fully open (see FIG **3** to FIG **6**), unless specified otherwise. In the present embodiment, the fuel injector **12,** the throttle valve **11** and the motor **13** are arranged close to each other for the up-down direction. The overall dimension in the up-down direction of the fuel injector **12,** the throttle valve **11** and the motor **13** is small. The fuel injector **12,** the throttle valve **11** and the motor **13** are arranged downward relative to an upper end **36u** of the cylinder head cover **36.**

[0067] At least a portion of the intake cam **8** is arranged downward relative to the upper end **13a** of the motor **13** and upward relative to the lower end **13b** of the motor **13.** In the present embodiment, the intake cam **8** is also arranged at a position close to the fuel injector **12,** the throttle valve **11** and the motor **13** for the up-down direction. The overall dimension in the up-down direction of the fuel injector **12,** the throttle valve **11,** the motor **13** and the intake cam **8** is small. The center of rotation **8c** of the intake cam **8,** the injection port **12a** of the fuel injector **12** and the center of rotation **11c** of the throttle valve **11** are arranged downward relative to the upper end **13a** of the motor **13** and upward relative to the lower end **13b** of the motor **13.**

[0068] In FIG **6,** the phantom line denoted by reference sign **8d** represents the rotation path of the intake cam **8.** Reference sign **8f** represents the front end of the rotation path **8d,** and the straight line **8fL** is a vertical line passing through the front end **8f** of the rotation path **8d.** The straight line **13rL** is a vertical line passing through the rear end **13r** of the motor **13.** The fuel injector **12** and the throttle valve **11** is arranged rearward relative to the front end **8f** of the rotation path **8d** of the intake cam **8** and forward relative to the rear end **13r** of the motor **13.**

[0069] In FIG **6,** the straight line **8cL** is a vertical line passing through the center of rotation **8c** of the intake cam **8.** The straight line **13cL** is a vertical line passing through a center **13c** of the motor **13.** Note that the center **13c** of the motor **13** refers to the center of rotation of the rotor (not shown) of the motor **13.** The fuel injector **12** and the throttle valve **11** are arranged rearward relative to the center of rotation **8c** of the intake cam **8** and forward relative to the center **13c** of the motor **13.**

[0070] In FIG **6,** the straight line **1cL** is a vertical line passing through the center of rotation **1c** of the crankshaft **1.** The fuel injector **12** and the throttle valve **11** are arranged rearward relative to the center of rotation **8c** of the intake cam **8** and forward relative to the center of rotation **1c** of the crankshaft **1.**

[0071] As shown in FIG. **3,** at least a portion of the motor **13** overlaps with the side frame **27,** as the vehicle is seen from the side. At least a portion of the throttle valve **11** overlaps with the side frame **27,** as the vehicle is seen from the side. At least a portion of the fuel injector **12** overlaps with the side frame **27,** as the vehicle is seen from the side. At least a portion of the intake cam **8** overlaps with the side frame **27,** as the vehicle is seen from the side. Herein, the entirety of the fuel injector **12** overlaps with the side frame **27** and the entirety of the intake cam **8** overlaps with the side frame **27,** as the vehicle is seen from the side.

[0072] As shown in FIG **6,** the first line **L1** denotes a straight line that passes through the center of rotation **8c** of the intake cam **8** and is perpendicular to the cylinder axial line **4c,** as the vehicle is seen from the side. The second line **L2** denotes a straight line that passes through the center **6c** of the intake port **6** and is perpendicular to the cylinder axial line **4c,** as the vehicle is seen from the side. The injection port **12a** of the fuel injector **12,** the center **11c** of the throttle valve **11** and the center **13c** of the motor **13** are arranged between the first line **L1** and the second line **L2.** Herein, the injection port **12a** of the fuel injector **12,** the entirety of the throttle valve **11** and the entirety of the motor **13** are arranged between the first line **L1** and the second line **L2,** as the vehicle is seen from the side.

[0073] As shown in FIG **3,** the air cleaner **35** includes an air cleaner case **17** and an element **45** arranged inside the air cleaner case **17.** The air cleaner case **17** includes an inlet opening **17b** through which the air flows in, and a connection port **17a** to which the intake pipe **10** is connected. An upper portion of the intake pipe **10** is inserted into the air cleaner case **17** through the connection port **17a.** The air flows into the air cleaner case **17** through the inlet opening **17b** and is cleaned while passing through the element **45,** after which the air is sucked into the intake pipe **10.**

[0074] The motor **13,** the throttle valve **11,** the fuel injector **12** and the intake cam **8** are located downward of the air cleaner **35.** The motor **13,** the throttle valve **11,** the fuel injector **12** and the intake cam **8** are arranged rearward relative to the front end of the air cleaner case **17** and forward relative to the rear end of the air cleaner case **17.**

[0075] In FIG **5,** the straight line **17uL** is a horizontal line passing through an upper end **17u** of the connection port **17a** of the air cleaner case **17.** The straight line **17dL** is a horizontal line passing through a lower end **17d** of the connection port **17a** of the air cleaner case **17.** At least a portion of the fuel injector **12** is located downward relative to the upper end **17u** of the connection port **17a** of the air cleaner case **17** and upward relative to the lower end **17d** of the connection port **17a.**

[0076] In FIG **5,** the phantom line denoted by reference sign **19d** represents the rotation path of the crank pin **19.** That is, the crank pin **19** revolves around the center of the crankshaft **1** as the crankshaft **1** rotates, and the phantom line **19d** represents the path of the portion of

the crank pin **19** that is farthest away from the center of the crankshaft **1.** The straight line **19fL** is a vertical line passing through a front end **19f** of the rotation path **19d** of the crank pin **19.** The straight line **19rL** is a vertical line passing through a rear end **19r** of the rotation path **19d** of the crank pin **19.** At least a portion of the connection port **17a** of the air cleaner case **17,** at least a portion of the throttle valve **11** and at least a portion of the motor **13** are located rearward relative to the front end **19f** of the rotation path **19d** of the crank pin **19** and forward relative to the rear end **19r** of the rotation path **19d.**

[0077] In FIG **5,** the straight line **L3** is a straight line that passes through the center **13c** of the motor **13** and is parallel to the cylinder axial line **4c,** as the vehicle is seen from the side. The straight line **L3** that passes through the center **13c** of the motor **13** and is parallel to the cylinder axial line **4c** overlaps with the air cleaner case **17,** as the vehicle is seen from the side.

[0078] The motorcycle **50** is configured as described above. Next, various effects of the motorcycle **50** according to the present embodiment will be described.

[0079] With the motorcycle **50** according to the present embodiment, as shown in FIG. **3,** the cylinder body **3** and the cylinder head **5** of the engine **15** extend forward and upward from the crankcase **2,** and the intake pipe **10** extends upward from the cylinder head **5.** Therefore, there is no margin of space forward of a portion of the intake pipe **10** that is close to the cylinder head **5.** There is only a small V-shaped space between the intake pipe **10** and the cylinder head **5,** as the vehicle is seen from the side.

[0080] However, in the present embodiment, the motor **13,** which is conventionally arranged forward of the intake pipe **10,** is arranged rearward of the intake pipe **10.** Therefore, the motor **13** is arranged at a portion of the intake pipe **10** that is close to the cylinder head **5.**

[0081] In the present embodiment, the fuel injector **12,** which is conventionally arranged rearward of the intake pipe **10,** is arranged forward of the intake pipe **10.** This realizes a compact arrangement of the fuel injector **12,** wherein the fuel injector **12** and the motor **13** do not interfere with each other.

[0082] Furthermore, according to the present embodiment, at least a portion of the fuel injector **12** and at least a portion of the throttle valve **11** are arranged downward relative to the upper end **13a** of the motor **13** and upward relative to the lower end **13b** of the motor **13,** as shown in FIG **6.** The overall dimension in the up-down direction of the motor **13,** the fuel injector **12** and the throttle valve **11** is small. Therefore, it is possible to reduce the size of the engine **15,** and hence to reduce the size of the motorcycle **50.**

[0083] According to the present embodiment, since the motor **13** is arranged at a portion of the intake pipe **10** that is close to the cylinder head **5,** the throttle valve **11** is arranged at a position close to the cylinder head **5** without elongating the power transmission path between the motor **13** and the throttle valve **11.** Therefore, it is possible to shorten the distance between the throttle valve **11** and the intake port **6.** Thus, it is possible to reduce the size of the engine **15** and also enhance the responsiveness of the power of the engine **15** in response to changes in the opening of the throttle valve **11,** and it is possible to improve the performance of the engine **15.**

[0084] Furthermore, according to the present embodiment, at least a portion of the intake cam **8** is arranged downward relative to the upper end **13a** of the motor **13** and upward relative to the lower end **13b.** Therefore, since it is possible to suppress the overall dimension in the up-down direction of the motor **13,** the fuel injector **12,** the throttle valve **11** and the cylinder head **5** (specifically, a portion of the cylinder head **5** where the intake cam **8** is provided), it is possible to further reduce the size of the engine **15.**

[0085] Without particular limitation thereto, according to the present embodiment, the center of rotation **8c** of the intake cam **8,** the injection port **12a** of the fuel injector **12** and the center of rotation **11c** of the throttle valve **11** are arranged downward relative to the upper end **13a** of the motor **13** and upward relative to the lower end **13b** of the motor **13.** Thus, it is possible to further reduce the size of the engine **15.**

[0086] According to the present embodiment, the fuel injector **12** and the throttle valve **11** are arranged rearward relative to the front end **8f** of the rotation path of the intake cam **8** and forward relative to the rear end **13r** of the motor **13.** Without particular limitation thereto, the fuel injector **12** and the throttle valve **11** are arranged rearward relative to the center of rotation **8c** of the intake cam **8** and forward relative to the center **13c** of the motor **13.** The fuel injector **12** and the throttle valve **11** are arranged rearward relative to the center of rotation **8c** of the intake cam **8** and forward relative to the center of rotation **1c** of the crankshaft **1.** According to the present embodiment, the overall dimension in the front-rear direction of the motor **13,** the throttle valve **11,** the fuel injector **12** and the intake cam **8** is small. Therefore, it is possible to further reduce the size of the engine **15.**

[0087] According to the present embodiment, the injection port **12a** of the fuel injector **12,** the center **11c** of the throttle valve **11** and the center **13c** of the motor **13** are arranged between the first line **L1,** which passes through the center of rotation **8c** of the intake cam **8** and is perpendicular to the cylinder axial line **4c,** and the second line **L2,** which passes through the center **6c** of the intake port **6** and is perpendicular to the cylinder axial line **4c,** as the vehicle is seen from the side. Without particular limitation thereto, the injection port **12a** of the fuel injector **12,** the entirety of the throttle valve **11** and the entirety of the motor **13** are arranged between the first line **L1** and the second line **L2,** as the vehicle is seen from the side. According to the present embodiment, it is possible to suppress the overall dimension of the motor **13,** the throttle valve **11,** the fuel injector **12** and the intake cam **8** for the direction along the cylinder axial line **4c.** Thus, it is possible to further reduce the size of the engine

15.

[0088] According to the present embodiment, the center line **10c** of the intake pipe **10** is located rearward relative to the center of rotation **8c** of the intake cam **8** and forward relative to the rear end **13r** of the motor **13,** as shown in FIG **3.** According to the present embodiment, the dimension of the intake pipe **10** in the front-rear direction is small. Thus, it is possible to further reduce the size of the engine **15.**

[0089] According to the present embodiment, the angle $\theta 1$ formed between the cylinder axial line **4c** and the horizontal line **PL** is 45 degrees or more, as the vehicle is seen from the side, as shown in FIG **5.** With the motorcycle **50,** since the inclination of the cylinder **4** is large, there is a small space between the cylinder body **3** and the cylinder head **5** and the intake pipe **10.** Therefore, the aforementioned effects, e.g., being able to arrange the motor **13** at a portion of the intake pipe **10** that is close to the cylinder head **5,** are particularly pronounced.

[0090] According to the present embodiment, the angle $\theta 2$ formed between the axial line **12c** of the fuel injector **12** and the horizontal line **PL** is greater than the angle $\theta 1$ formed between the cylinder axial line **4c** and the horizontal line **PL** (see FIG **5**), as the vehicle is seen from the side, as shown in FIG **6.** The fuel injector **12** is arranged in an attitude that is more along the vertical direction. Therefore, the dimension in the front-rear direction of the fuel injector **12** is small. Thus, the fuel injector **12** is arranged in a compact arrangement in a V-shaped small space between the cylinder head **5** and the intake pipe **10.**

[0091] According to the present embodiment, at least a portion of the fuel injector **12** is arranged forward of the intake pipe **10,** and at least a portion of the motor **13** is arranged rearward of the intake pipe **10.** Thus, the side frame **27** is arranged sideward of the intake pipe **10** without being interfered by the fuel injector **12** and the motor **13.** According to the present embodiment, at least a portion of the throttle valve **11,** at least a portion of the fuel injector **12** and at least a portion of the motor **13** overlap with the side frame **27,** as the vehicle is seen from the side (see FIG **3**), and arranged in a compact arrangement sideward of the side frame **27.** The overall dimension in the up-down direction of the throttle valve **11,** the fuel injector **12,** the motor **13** and the side frame **27** is small. Therefore, it is possible to reduce the size of the motorcycle **50.**

[0092] Now, in the present embodiment, since the fuel injector **12** is arranged forward of the intake pipe **10,** the fuel hose **16** that connects the fuel tank **14,** which is arranged rearward of the intake pipe **10,** with the fuel injector **12** needs to be extended to a position rearward of the intake pipe **10** to a position forward of the intake pipe **10.** However, according to the present embodiment, the fuel hose **16** extends from the fuel tank **14** toward the fuel injector **12** through the side of the intake pipe **10.** Since the motor **13** is arranged rearward of the intake pipe **10,** it is possible to easily avoid the interference between the fuel hose **16** and the motor **13.**

[0093] According to the present embodiment, at least a portion of the connection port **17a** of the air cleaner case **17,** at least a portion of the throttle valve **11** and at least a portion of the motor **13** are located rearward relative to the front end **19f** of the rotation path **19d** of the crank pin **19** and forward relative to the rear end **19r,** as shown in FIG **5.** The overall dimension in the front-rear direction of the connection port **17a** of the air cleaner case **17,** the throttle valve **11** and the motor **13** is small. Therefore, it is possible to reduce the size of the motorcycle **50.**

[0094] According to the present embodiment, at least a portion of the fuel injector **12** is located downward relative to the upper end **17u** of the connection port **17a** of the air cleaner case **17** and upward relative to the lower end **17d** of the connection port **17a.** The distance in the up-down direction between the connection port **17a** of the air cleaner case **17** and the fuel injector **12** is short. Therefore, it is possible to reduce the size of the motorcycle **50.**

[0095] According to the present embodiment, the straight line **L3,** which passes through the center **13c** of the motor **13** and is parallel to the cylinder axial line **4c,** overlaps with the air cleaner case **17,** as the vehicle is seen from the side. The motor **13** is arranged close to the air cleaner case **17.** Since the motor **13** and the air cleaner case **17** are arranged in a compact arrangement, it is possible to reduce the size of the motorcycle **50.**

[0096] According to the present embodiment, the fuel injector **12** is a slant injector of which the injection direction **12s** is inclined from the axial line **12c** of the fuel injector **12** toward the intake port **6,** as shown in FIG **6.** The fuel injector **12** is arranged so that the straight line extending from the injection port **12a** to the injection direction **12s** crosses the umbrella portion **42** of the intake valve **7.** Therefore, it is possible to effectively inject the fuel toward the intake port **6.**

[0097] While one embodiment has been described above, the embodiment is merely illustrative, and various other embodiments are possible.

[0098] The internal combustion engine may be a multi-cylinder internal combustion engine including a plurality of cylinders **4** or may be a single-cylinder internal combustion engine including only one cylinder **4.** The internal combustion engine may be a water-cooled internal combustion engine or may be an air-cooled internal combustion engine.

[0099] The side frame **27** does not always need to overlap with at least a portion of the throttle valve **11,** at least a portion of the fuel injector **12** and at least a portion of the motor **13,** as the vehicle is seen from the side.

[0100] The fuel injector **12** does not need to be a slant injector. The straight line extending in the injection direction **12s** of the fuel injector **12** does not need to cross the umbrella portion **42** of the intake valve **7.**

[0101] A straddled vehicle refers to a vehicle that is straddled by a passenger. While a motorcycle is an ex-

ample of a straddled vehicle, a straddled vehicle is not limited to a motorcycle. A straddled vehicle may include an auto tricycle, an ATV (All Terrain Vehicle), and the like, as well as a motorcycle.

REFERENCE SIGNS LIST

[0102]

1	Crankshaft
2	Crankcase
3	Cylinder body
4	Cylinder
5	Cylinder head
6	Intake port
7	Intake valve
8	Intake cam
9	Intake port
10	Intake pipe
11	Throttle valve
12	Fuel injector
12a	Injection port
13	Motor
14	Fuel tank
15	Internal combustion engine
16	Fuel hose
17	Air cleaner case
17a	Connection port
18	Piston
19	Crank pin
20	Connecting rod
22	Vehicle frame
27	Side frame
42	Umbrella portion
43	Stem
50	Motorcycle (straddled vehicle)

Claims

1. A straddled vehicle comprising an internal combustion engine **(15),** the internal combustion engine **(15)** comprising:

a crankcase **(2)** that rotatably supports a crankshaft **(1)** extending in a vehicle width direction;
a cylinder body **(3)** extending forward and upward from the crankcase **(2);**
a cylinder **(4)** formed inside the cylinder body **(3);**
a cylinder head **(5)** connected to the cylinder body **(3);**
an intake port **(6)** that is formed inside the cylinder head **(5)** and has an opening facing toward an inside of the cylinder **(4);**
an intake valve **(7)** that is supported on the cylinder head **(5)** and opens/closes the intake port **(6);**
an intake cam **(8)** that is rotatably supported on the cylinder head **(5)** and actuates the intake valve **(7);**
an intake passage **(9)** that is formed inside the cylinder head **(5)** and is connected to the intake port **(7);**
an intake pipe **(10)** that is connected to the cylinder head **(5),** extends upward from the cylinder head **(5)** and is connected to the intake passage **(9);**
a throttle valve **(11)** that is arranged inside the intake pipe **(10);**
a fuel injector **(12)** that has an injection port **(12a)** arranged between the throttle valve **(11)** and the intake port **(6);** and
a motor **(13)** that is linked to the throttle valve **(11)** and actuates the throttle valve **(11),** wherein:

at least a portion of the fuel injector **(12)** is arranged forward of the intake pipe **(10);**
at least a portion of the motor **(13)** is arranged rearward of the intake pipe **(10);** and
at least a portion of the fuel injector **(12)** and at least a portion of the throttle valve **(11)** are arranged downward relative to an upper end **(13a)** of the motor **(13)** and upward relative to a lower end **(13b)** of the motor **(13).**

2. The straddled vehicle according to claim 1, wherein at least a portion of the intake cam **(8)** is arranged downward relative to the upper end **(13a)** of the motor **(13)** and upward relative to the lower end **(13b)** of the motor **(13).**

3. The straddled vehicle according to claim 1 or 2, wherein a center of rotation **(8c)** of the intake cam **(8),** the injection port **(12a)** of the fuel injector **(12)** and a center of rotation **(11c)** of the throttle valve **(11)** are arranged downward relative to the upper end **(13a)** of the motor **(13)** and upward relative to the lower end **(13b)** of the motor **(13).**

4. The straddled vehicle according to any one of claims 1 to 3,
wherein the fuel injector **(12)** and the throttle valve **(11)** are arranged rearward relative to a front end **(8f)** of a rotation path **(8d)** of the intake cam **(8)** and forward relative to a rear end **(13r)** of the motor **(13);** and/or
wherein the fuel injector **(12)** and the throttle valve **(11)** are arranged rearward relative to the center of rotation **(8c)** of the intake cam **(8)** and forward relative to a center **(13c)** of the motor **(13);** and/or
wherein the fuel injector **(12)** and the throttle valve **(11)** are arranged rearward relative to the center of rotation **(8c)** of the intake cam **(8)** and forward relative to a center of rotation **(1c)** of the crankshaft **(1).**

5. The straddled vehicle according to any one of claims 1 to 4, wherein where a first line **(L1)** is defined as a straight line that passes through a center of rotation **(8c)** of the intake cam **(8)** and is perpendicular to an axial line **(4c)** of the cylinder **(4)** and a second line **(L2)** as a straight line that passes through a center **(6c)** of the intake port **(6)** and is perpendicular to the axial line **(4c)** of the cylinder **(4),** the injection port **(12a)** of the fuel injector **(12),** a center **(11c)** of the throttle valve **(11)** and a center **(13c)** of the motor **(13)** are arranged between the first line **(L1)** and the second line **(L2),** as the vehicle is seen from the side.

6. The straddled vehicle according to any one of claims 1 to 5, wherein the injection port **(12a)** of the fuel injector **(12),** an entirety of the throttle valve **(11)** and an entirety of the motor **(13)** are arranged between the first line **(L1)** and the second line **(L2),** as the vehicle is seen from the side.

7. The straddled vehicle according to any one of claims 1 to 6, wherein a center line **(10c)** of the intake pipe **(10)** is located rearward relative to a center of rotation **(8c)** of the intake cam **(8)** and forward relative to a rear end **(13r)** of the motor **(13).**

8. The straddled vehicle according to any one of claims 1 to 7,
wherein an angle **(θ1)** formed between an axial line **(4c)** of the cylinder **(4)** and a horizontal line **(PL)** is 45 degrees or more, as the vehicle is seen from the side; and/or
wherein an angle **(θ2)** formed between an axial line **(12c)** of the fuel injector **(12)** and a horizontal line **(PL)** is greater than an angle **(θ1)** formed between an axial line **(4c)** of the cylinder **(4)** and the horizontal line **(PL),** as the vehicle is seen from the side.

9. The straddled vehicle according to any one of claims 1 to 8, comprising:

a vehicle frame **(22)** that supports the internal combustion engine **(15),**
wherein the vehicle frame **(22)** includes a side frame **(27)** that overlaps with at least a portion of the throttle valve **(11),** at least a portion of the fuel injector **(12)** and at least a portion of the motor **(13),** as the vehicle is seen from the side.

10. The straddled vehicle according to any one of claims 1 to 9, comprising:

a fuel tank **(14)** arranged rearward relative to the intake pipe **(10);** and
a fuel hose **(16)** connected to the fuel tank **(14)** and the fuel injector **(12),**
wherein a portion of the fuel hose **(16)** is arranged sideward of the intake pipe **(10).**

11. The straddled vehicle according to any one of claims 1 to 10, comprising an air cleaner case **(17)** including a connection port **(17a)** to which the intake pipe **(10)** is connected.

12. The straddled vehicle according to claim 11, wherein:

the internal combustion engine **(15)** includes:

a piston **(18)** arranged in the cylinder **(4);**
a crank pin **(19)** provided on the crankshaft **(1);** and
a connecting rod **(20)** linked to the piston **(18)** and the crank pin **(19),**

wherein at least a portion of the connection port **(17a)** of the air cleaner case **(17),** at least a portion of the throttle valve **(11)** and at least a portion of the motor **(13)** are located rearward relative to a front end **(19f)** of a rotation path **(19d)** of the crank pin **(19)** and forward relative to a rear end **(19r)** of the rotation path **(19d)** of the crank pin **(19).**

13. The straddled vehicle according to claim 11 or 12, wherein at least a portion of the fuel injector **(12)** is located downward relative to an upper end **(17u)** of the connection port **(17a)** of the air cleaner case **(17)** and upward relative to a lower end **(17d)** of the connection port **(17a);** and/or
wherein a straight line **(L3)** that passes through a center **(13c)** of the motor **(13)** and is parallel to an axial line **(4c)** of the cylinder **(4)** overlaps with the air cleaner case **(17),** as the vehicle is seen from the side.

14. The straddled vehicle according to any one of claims 1 to 13, wherein the fuel injector **(12)** is a slant injector of which an injection direction **(12s)** is inclined from an axial line **(12c)** of the fuel injector **(12)** toward the intake port **(6).**

15. The straddled vehicle according to claim 14, wherein:

the intake valve **(7)** is implemented as a poppet valve including an umbrella portion **(42)** that covers the intake port **(6)** and a rod-shaped stem **(43)** that extends from the umbrella portion **(42);** and
the fuel injector **(12)** is arranged so that a straight line that extends in the injection direction **(12s)** from the injection port **(12a)** crosses the umbrella portion **(42).**

FIG.1

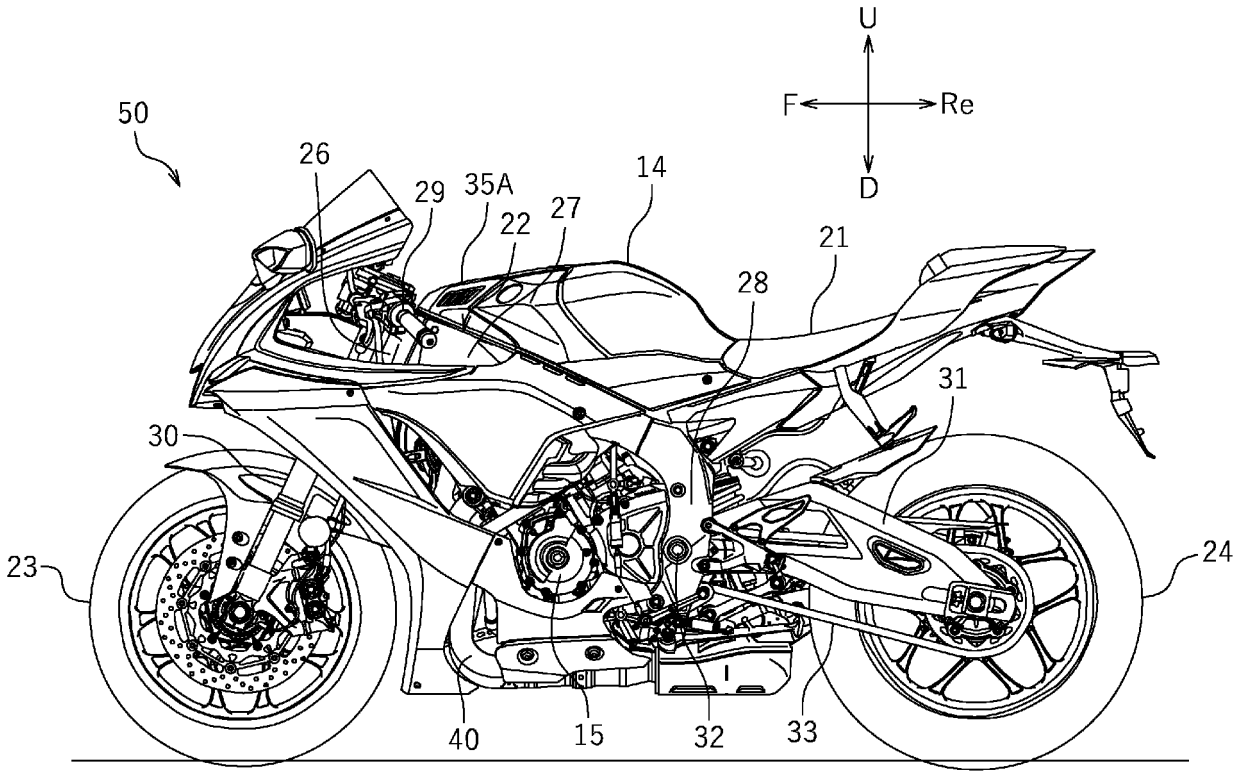


FIG.2

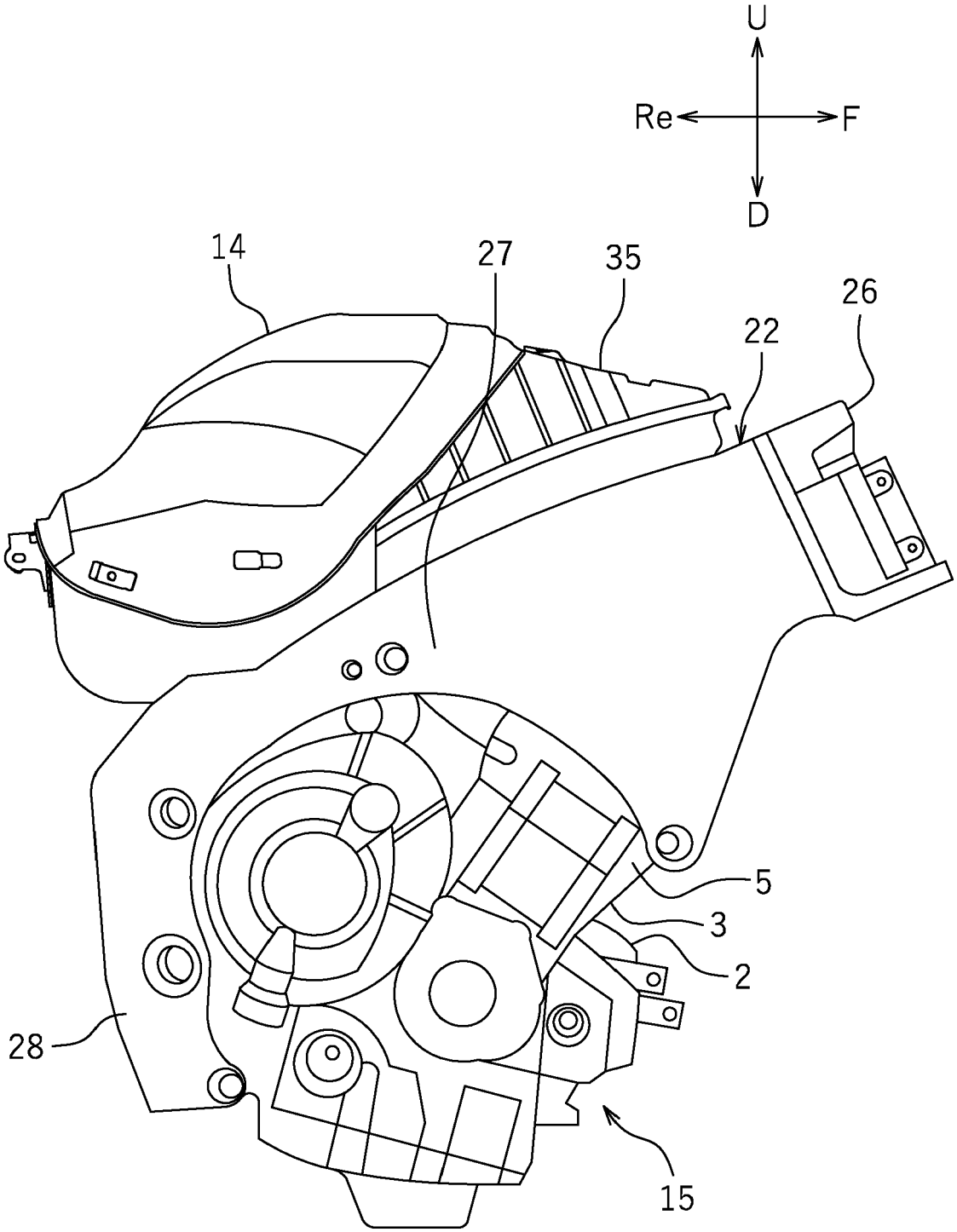
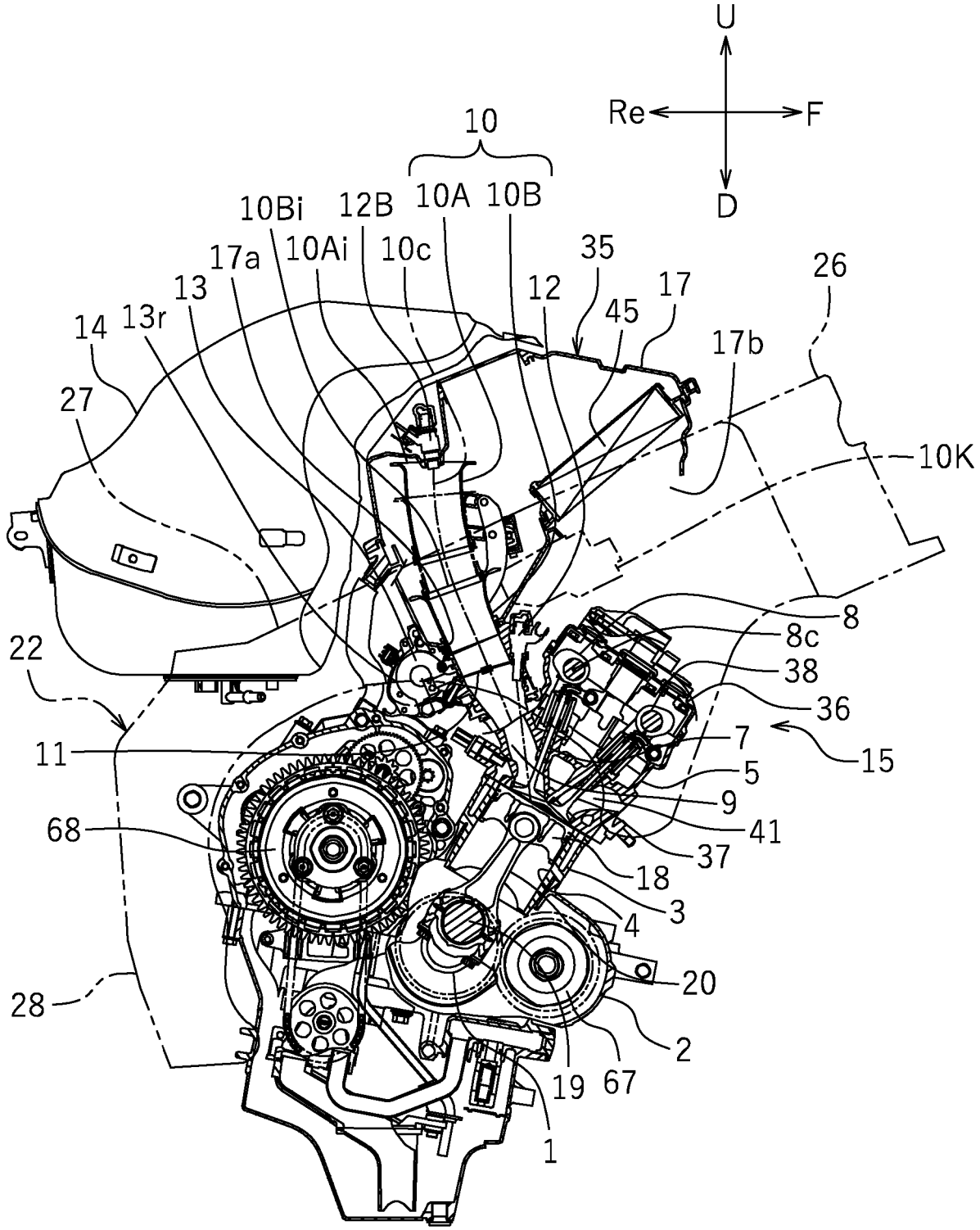


FIG.3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45
17b
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8
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8c
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67
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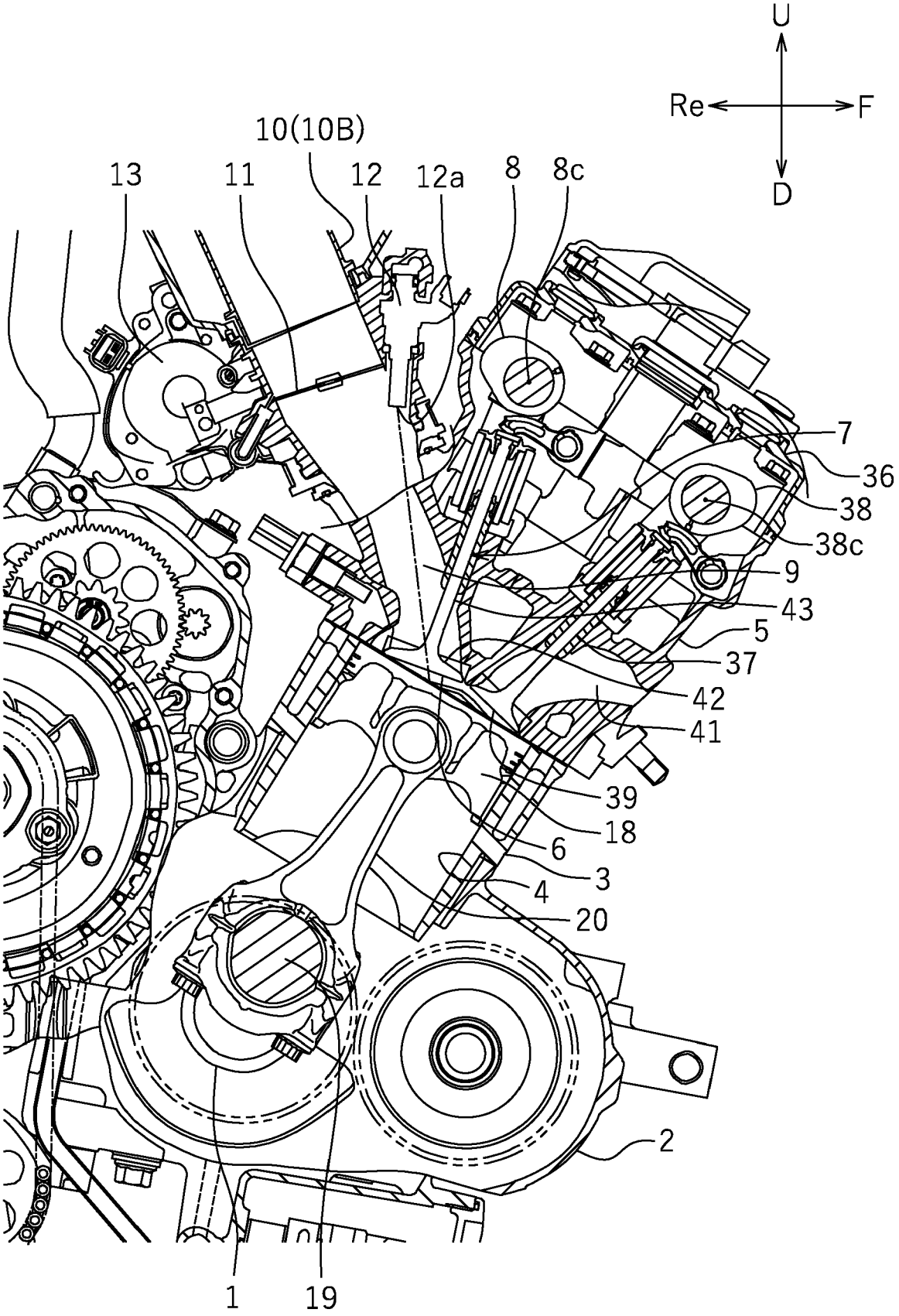
FIG.4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11
12
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8
8c
7
36
38
38c
9
43
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37
42
41
39
18
6
3
4
20
2
1
19

FIG.5

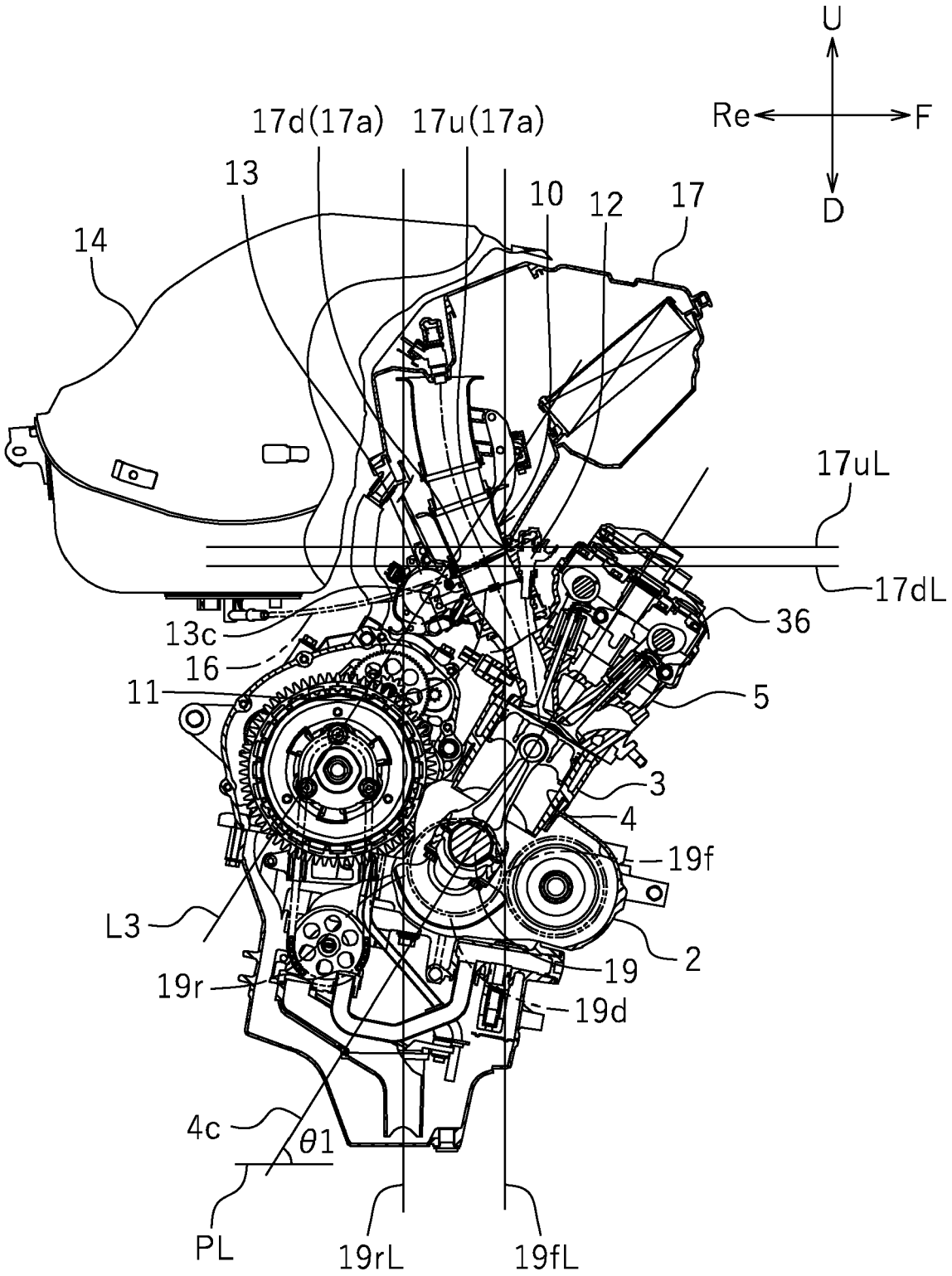
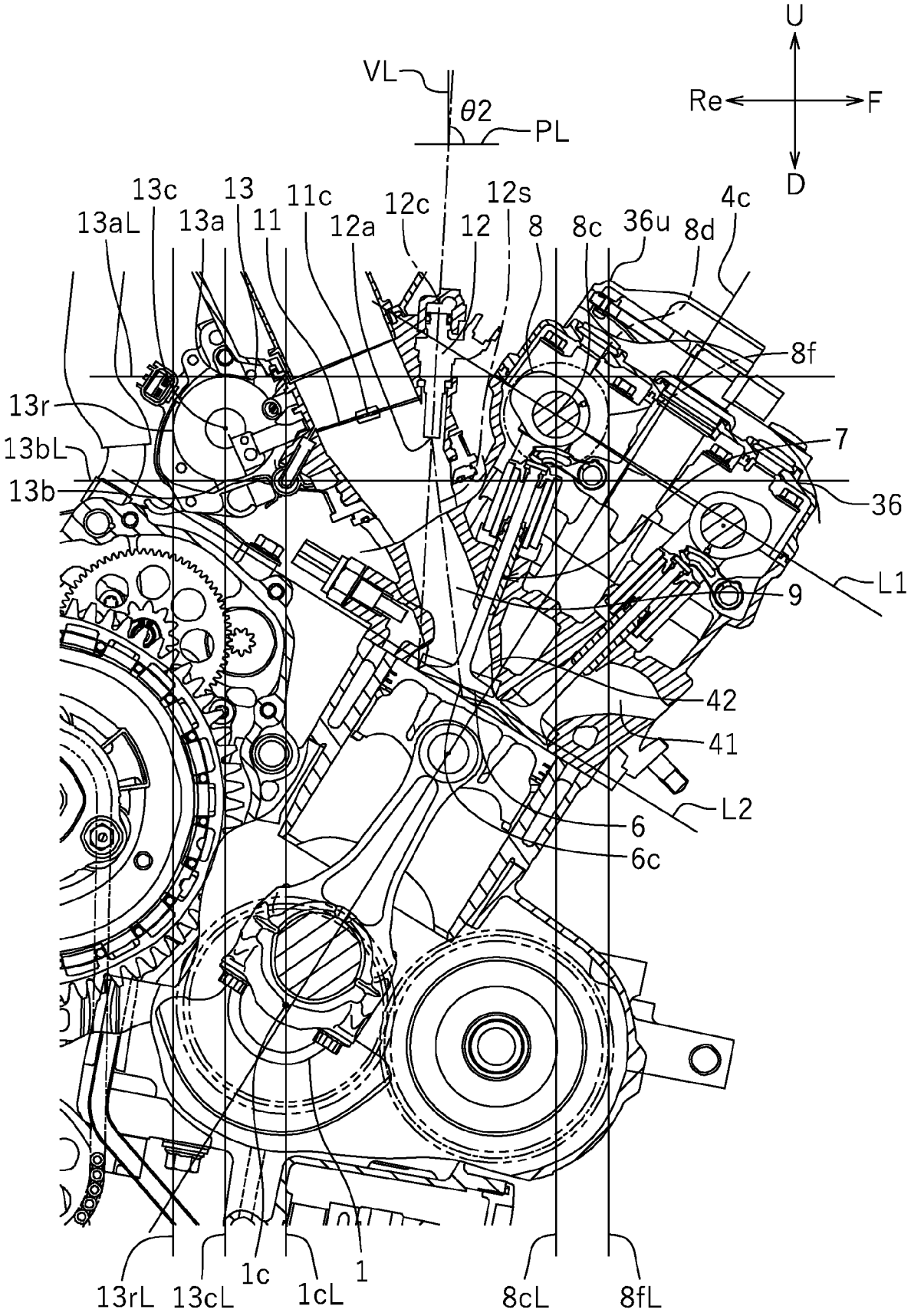

U
Re
F
D
17d(17a)
17u(17a)
13
10
12
17
14
17uL
17dL
36
13c
16
11
5
3
4
19f
L3
2
19
19r
19d
4c
θ1
PL
19rL
19fL

FIG.6


U
Re
F
D
VL
θ2
PL
13c
13
11c
12c
12s
4c
13aL
13a
11
12a
12
8
8c
36u
8d
8f
13r
13bL
13b
7
36
L1
9
42
41
L2
6
6c
13rL
13cL
1c
1cL
1
8cL
8fL

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Application Number
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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	JP 2011 149277 A (HONDA MOTOR CO LTD) 4 August 2011 (2011-08-04) * figures 1-10 * -----	1 2-15	INV. F02M61/14 F02M69/04
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F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 October 2020	Morales Gonzalez, M

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