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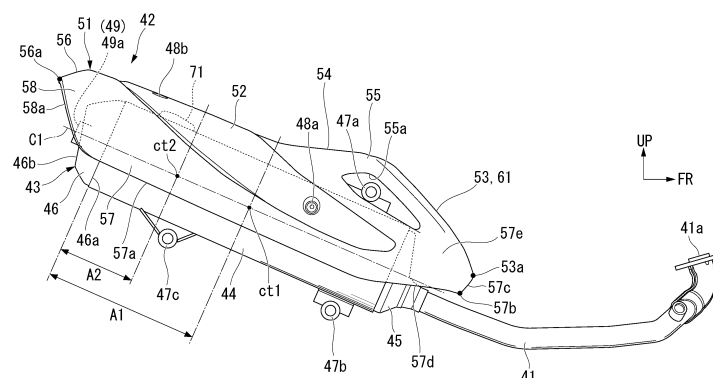
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(54) **SILENCER STRUCTURE FOR SADDLED VEHICLE**

(57) This silencer structure of a saddle-riding type vehicle includes a silencer (42) that performs silencing of exhaust gas discharged from an internal-combustion engine (E). The silencer (42) includes a silencer main body (43) which has an exhaust port (49a) at a rear end, and a cover member (51) which is attached to the silencer main body (43). The silencer (42) includes a projection

(71) which protrudes from an outer surface (43b) of the silencer main body (43) and generates a prescribed turbulence in head wind flowing along the outer surface (43b). The projection (71) is provided behind a central position (ct1) of the silencer (42) in a longitudinal direction of the silencer (42).

FIG. 5



Description

TECHNICAL FIELD

[0001] The present invention relates to a silencer structure of a saddle-riding type vehicle.

BACKGROUND ART

[0002] For example, Patent Document 1 discloses a constitution in which a muffler performing silencing of exhaust gas of an internal-combustion engine is disposed on a lateral side of a rear wheel of a motorcycle. In order to protect the muffler projecting outward in a vehicle width direction and to ensure heat dissipation, this constitution includes a first protector in a muffler front portion and includes a second protector having a narrower width than the first protector in a muffler rear portion.

RELATED ART DOCUMENT

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Unexamined Patent Application, First Publication No. 2009-264293

SUMMARY

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004] Incidentally, in mufflers projecting outward in a vehicle width direction, it is desired to sufficiently consider countermeasures against head wind. Regarding head wind countermeasures, in addition to reduction of air resistance, it is conceivable that entrainment of head wind into an exhaust port be curbed.

[0005] However, in the foregoing structure in the related art, no head wind countermeasures are described, and the foregoing problems remain.

[0006] Hence, an object of the present invention is to provide a silencer structure of a saddle-riding type vehicle in which air resistance around a silencer for silencing exhaust gas of an engine can be curbed and an influence on exhaust gas can be curbed.

MEANS FOR SOLVING THE PROBLEM

[0007] Regarding the solution to the foregoing problems, a first aspect of the present invention provides a silencer structure of a saddle-riding type vehicle (1) including a silencer (42) that performs silencing of exhaust gas discharged from an internal-combustion engine (E). The silencer (42) includes a projection (71) which protrudes from an outer surface (43b) thereof and generates a prescribed turbulence in head wind flowing along the outer surface (43b).

[0008] According to a second aspect of the present invention, in the foregoing first aspect, the silencer (42)

includes a silencer main body (43) and a cover member (51) which is attached to the silencer main body (43). The projection (71) is provided in at least one of the silencer main body (43) and the cover member (51).

[0009] According to a third aspect of the present invention, in the foregoing second aspect, the silencer main body (43) has an end cap (46) which is positioned at a rear end portion and an exhaust port (49a) which is disposed in the end cap (46) and emits exhaust gas to atmosphere. At least one of the cover member (51) and the end cap (46) extends rearward beyond the exhaust port (49a).

[0010] According to a fourth aspect of the present invention, in any one of the foregoing first to third aspects, the projection (71) is provided behind a central position (ctl) of the silencer (42) in a longitudinal direction of the silencer (42).

[0011] According to a fifth aspect of the present invention, in any one of the foregoing first to fourth aspects, the projection (71) has a projection longitudinal direction directed in a vehicle forward-rearward direction, and a dimension (Y1) in the projection longitudinal direction is larger than dimensions (X1, Z1) in a direction orthogonal to the projection longitudinal direction.

[0012] According to a sixth aspect of the present invention, in the foregoing fifth aspect, the projection (71) has a mountain shape having a protrusion apex portion (Zt) in a side view orthogonal to the projection longitudinal direction. A front side inclined portion ascending toward the protrusion apex portion (Zt) from a projection front end portion is provided on a front side of the projection (71) in the vehicle forward-rearward direction. A rear side inclined portion descending toward a projection rear end portion from the protrusion apex portion (Zt) is provided on a rear side of the projection (71) in the vehicle forward-rearward direction.

[0013] According to a seventh aspect of the present invention, in the foregoing sixth aspect, the front side inclined portion is longer than the rear side inclined portion in the projection longitudinal direction.

[0014] According to an eighth aspect of the present invention, in the foregoing sixth aspect, the rear side inclined portion is longer than the front side inclined portion in the projection longitudinal direction.

[0015] According to a ninth aspect of the present invention, in any one of the foregoing first to eighth aspects, a plurality of the projections (71) are disposed in an outer circumference of the silencer (42).

[0016] According to a tenth aspect of the present invention, in any one of the foregoing first to ninth aspects, the silencer (42) includes a silencer main body (43) and a cover member (51) which is attached to an outer side of the silencer main body (43). The projection (71) is provided in the cover member (51).

ADVANTAGE OF THE INVENTION

[0017] According to the first aspect of the present in-

vention, since a projection for generating a turbulence in head wind flowing along the outer surface is provided on the outer surface of the silencer, an effect of delaying separation of head wind from the outer surface of the silencer is achieved due to a prescribed turbulence generated behind the projection. For this reason, air resistance due to separation of head wind immediately behind the rear end of the silencer can be curbed. In addition, entrainment of head wind toward the exhaust port at the rear end of the silencer is curbed, and thus efficient gas discharging can be performed without hindering exhaust gas from the exhaust port.

[0018] According to the second aspect of the present invention, since a projection is provided in at least one of a muffler main body and a muffler cover, the degree of freedom in installation of the projection is enhanced, and thus control of an air flow according to the embodiment can be easily performed.

[0019] According to the third aspect of the present invention, due to the silencer structure of a type in which at least one of the cover member and the end cap extends rearward beyond the exhaust port and hides the exhaust port, appearance characteristics can be improved, and an influence of entrained wind from the rear ends of the cover member and the end cap on the exhaust port can be curbed.

[0020] According to the fourth aspect of the present invention, since the projection is provided at the rear half part of the silencer in the longitudinal direction, a turbulence of head wind generated due to the projection easily reaches a rear end position of the silencer, and thus entrainment of head wind at the rear end position of the silencer can be effectively curbed.

[0021] According to the fifth aspect of the present invention, since the dimension of the projection in a direction orthogonal to the projection longitudinal direction directed in the vehicle forward-rearward direction is smaller than the dimension in the projection longitudinal direction, air resistance of the projection can be reduced. In addition, since the dimension of the projection in the projection longitudinal direction directed in the vehicle forward-rearward direction is large, pressure change in head wind can become moderate and generation of wind noise can be curbed utilizing the length of the projection.

[0022] According to the sixth aspect of the present invention, since a front portion of the projection has the front side inclined portion which gradually ascends and a rear portion of the projection has the rear side inclined portion which gradually descends, air resistance of the projection can be further reduced, and pressure change in head wind can become moderate.

[0023] According to the seventh aspect of the present invention, since the front side inclined portion has a gentler slope shape than the rear side inclined portion, air resistance at the front portion of the projection can be further reduced, and an effect of generating a turbulence can be enhanced by making the rear side inclined portion steep.

[0024] According to the eighth aspect of the present invention, since the rear side inclined portion has a gentler slope shape than the front side inclined portion, air resistance at the rear portion of the projection can be further reduced, and a disturbance effect can be further improved by increasing the flow rate of head wind at the rear portion of the projection.

[0025] According to the ninth aspect of the present invention, since a plurality of projections for generating a turbulence in head wind are disposed in the outer circumference of the silencer, entrainment of head wind is curbed by generating a turbulence throughout the entire outer circumference of the silencer, and thus an influence on the exhaust efficiency can be further curbed.

[0026] According to the tenth aspect of the present invention, since a projection for generating a turbulence of head wind is provided on the outer surface of the cover member which is attached to the outer side of the silencer main body, an effect of delaying separation of head wind flowing on the outermost surface of the silencer is achieved. For this reason, entrainment of head wind at the rear end position of the silencer can be effectively curbed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

Fig. 1 is a right side view of a motorcycle according to an embodiment of the present invention.

Fig. 2 is a right side view of a part around a muffler of the foregoing motorcycle.

Fig. 3 is a top view of a part around a rear wheel of the foregoing motorcycle.

Fig. 4 is a perspective view of a part around the muffler of the foregoing motorcycle.

Fig. 5 is a right side view of the muffler and an exhaust pipe of the foregoing motorcycle.

Fig. 6 is a top view of the muffler and the exhaust pipe of the foregoing motorcycle.

Fig. 7 is a side view of a front portion of the muffler of the foregoing motorcycle.

Fig. 8 is a top view of the front portion of the muffler of the foregoing motorcycle.

Fig. 9 is a side view of a muffler main body of the foregoing muffler.

Fig. 10 is a top view of that in Fig. 9.

Fig. 11 is a rear view of that in Fig. 9.

Fig. 12(a) is a plan view of a projection for generating a turbulence provided in the foregoing muffler main body, and Fig. 12(b) is a side view of that in Fig. 12(a).

Fig. 13(a) is a plan view of the foregoing projection reversely directed in a forward-rearward direction, and Fig. 13(b) is a side view of that in Fig. 13(a).

Fig. 14(a) is an explanatory view of operation of a muffler which does not have the foregoing projection, and Fig. 14(b) is an explanatory view of operation of a muffler which is provided with the foregoing pro-

jection.

Fig. 15 is a side view of a modification example in which a projection for generating a turbulence is provided in a cover member of the foregoing muffler.

Fig. 16 is a top view of that in Fig. 15.

Fig. 17 is a rear view of that in Fig. 15.

Fig. 18 is a right side view of a motorcycle according to a second embodiment of the present invention.

Fig. 19 is a side view of a muffler of the motorcycle of the second embodiment.

Fig. 20 is a top view of that in Fig. 19.

Fig. 21 is a rear view of that in Fig. 19.

Fig. 22 is a right side view of a motorcycle according to a third embodiment of the present invention.

Fig. 23 is a side view of a muffler of the motorcycle of the third embodiment.

Fig. 24 is a top view of that in Fig. 23.

Fig. 25 is a rear view of that in Fig. 23.

DESCRIPTION OF THE EMBODIMENTS

[0028] Hereinafter, an embodiment of the present invention will be described with reference to the drawings. Unless otherwise specified in the following description, directions to the front, the rear, the left, the right, and the like are the same as directions in a vehicle, which will be described below. In addition, an arrow FR indicating a side in front of the vehicle, an arrow LH indicating the left side of the vehicle, and an arrow UP indicating a side above the vehicle are marked in suitable places in the diagrams used in the following description.

<Entirety of vehicle>

[0029] As illustrated in Fig. 1, a motorcycle (saddle-riding type vehicle) 1 of the present embodiment includes a head pipe 13 in a front end portion of a vehicle body frame F. Front forks 11 pivotally supporting a front wheel WF and a steering handlebar 12 are supported by the head pipe 13 in a steerable manner. A lower side of the front portion of a swing-type power unit (which will hereinafter be referred to as a power unit U) is supported by a lower portion of the vehicle body frame F in a vertically swingable manner. The motorcycle 1 is a unit swing-type saddle-riding type vehicle including the power unit U in which an engine (internal-combustion engine: motor) E and a rear wheel WR (driving wheel) integrally swing with respect to the vehicle body frame F (main body of the vehicle body).

[0030] Also with reference to Fig. 3, the power unit U is an integrated unit in which the engine E serving as a motor of the motorcycle 1 is disposed at the front portion, and a transmission M performing gear shifting with respect to an output of the engine E is disposed on the left side of a rear portion, respectively. An axle (rear wheel axle AR) of the rear wheel WR (driving wheel) is supported by the rear portion of the transmission M. For example, the lower side of the front portion of the power unit U is

supported by a support portion of the lower portion of the vehicle body frame F in a vertically swingable manner via a suspension link and the like. A rear end portion of the power unit U is supported by a rear end portion of the vehicle body frame F via a rear cushions 9 (cushioning device). A center line CL in Fig. 3 indicates the center of the vehicle body in a lateral direction.

[0031] As illustrated in Fig. 1, the vehicle body frame F includes a down frame 14 extending downward to the rear from the head pipe 13, a lower frame 15 extending rearward from a lower end portion of the down frame 14, and rear frames 16 extending upward to the rear from a rear end portion of the lower frame 15. Left and right steps 19 for a passenger are supported by front portions of the rear frames 16 via brackets (not illustrated). The left and right steps 19 for a passenger can turn between a usage state of protruding outward in a vehicle width direction substantially in a horizontal manner and a folded state of being inclined upward to the rear. The diagram illustrates the steps 19 in the folded state.

[0032] A part around the vehicle body frame F is covered with a vehicle body cover 27. A seat 28 having front and rear seat surfaces for occupants sitting thereon is supported above a rear portion of the vehicle body cover 27. The vehicle body cover 27 includes a pair of left and right step floors 29 on which a rider sitting on the seat 28 puts his/her feet, a front body FB which leads to a side in front of the step floors 29, and a rear body RB which leads to a side behind the step floors 29. A space above the step floors 29 and between the seat 28 and the steering handlebar 12 serves as a straddling space allowing an occupant to easily straddle the vehicle body.

[0033] The rear body RB has a front portion RB1 rising upward from the step floors 29 and a rear portion RB2 extending rearward from an upper end portion of the front portion RB1 and has substantially an L-shape in a side view. Behind the front portion RB1 and below the rear portion RB2 of the rear body RB, a wheel house WH accommodating the rear wheel WR in a swingable manner is defined by an inner cover (not illustrated) inside the rear body RB and a rear fender 31 extending downward to the rear from a lower surface of the rear portion RB2 of the rear body RB. In the diagrams, the reference sign 32 indicates a rear side cover forming left and right side surfaces of the rear body RB, and the reference sign 32a indicates a rear edge of the rear side cover 32 at the front portion RB1 of the rear body RB (which will hereinafter be referred to as a front portion rear edge of the rear body RB). The front portion rear edge 32a of the rear body RB is separated to a side in front of a wheel front end of the rear wheel WR (corresponding to the foremost end of the rear wheel WR) in a side view. Rear edges of the steps 19 in the folded state are disposed so as to overlap the front portion rear edge 32a of the rear body RB.

[0034] For example, the step floors 29 have a flat shape across a lateral width of a low floor portion of the vehicle body and form substantially a horizontal upper surface

(floor surface 29a) of the low floor portion. A constitution in which a center tunnel extending in a forward-rearward direction is provided at the center of the step floors 29 in the lateral direction may be adopted.

[0035] The motorcycle 1 is a scooter-type vehicle having the step floors 29 on which a rider puts his/her feet. The upper surface (footrest surface) 29a of the step floors 29 is slightly inclined upward to the rear in a side view. Lower surface rear portions 29b inclined upward to the rear with a steeper inclination than the upper surface 29a are formed in rear portions of the step floors 29 on the lower surface side.

<Power unit>

[0036] As illustrated in Figs. 1 to 3, the power unit U integrally includes the engine E at the front portion and a transmission case 35 accommodating the transmission M on the left side of the rear portion.

[0037] The engine E is a four-stroke single-cylinder engine in which a rotary center axis of a crankshaft (not illustrated) lies in the lateral direction (vehicle width direction) and a cylinder portion 22 protrudes forward from a front end portion of a crankcase 21 substantially in a horizontal manner (specifically, in a manner of being inclined slightly upward to the front).

[0038] A case main body 36 serving as a rear arm extending rearward after projecting to the left side is integrally formed in a left side portion of the crankcase 21. The case main body 36 opens outward in the vehicle width direction, and a case cover 37 is attached to this open part from the outer side in the vehicle width direction. The transmission case 35 accommodating the transmission M is constituted of the case main body 36 and the case cover 37.

[0039] The transmission M is a belt-type continuously variable transmission accommodated across the transmission case 35 in a length direction in a side view. The transmission M includes a driving pulley which is accommodated inside a front portion of the transmission case 35 and is disposed coaxially with the crankshaft, a driven pulley which is accommodated inside a rear portion of the transmission case 35, and an endless V-belt (transmission belt) which is wound across the driving pulley and the driven pulley (none of these is illustrated). The rear wheel WR is attached in an integrally rotatable manner to the rear wheel axle AR (output shaft) protruding to the right side of the rear portion of the transmission case 35.

[0040] A radiator 26 for cooling the engine E is disposed on the right side of the crankcase 21. Radiator covers 26a having an opening with a louver are mounted on left and right outer sides of the radiator 26.

[0041] A front end portion of an auxiliary arm 38 extending in the forward-rearward direction is fixed to the right side of the rear portion of the crankcase 21. The auxiliary arm 38 supports a right end portion of the rear wheel axle AR at the rear end portion. The auxiliary arm

38 constitutes a swing arm supporting the rear wheel WR together with the transmission case 35. Lower end portions of the pair of left and right rear cushions 9 are coupled to respective rear end portions of the transmission case 35 and the auxiliary arm 38. Upper end portions of the left and right rear cushions 9 are respectively coupled to rear end portions of the left and right rear frames 16. In the diagrams, the reference sign 39 indicates an inner fender which is attached to the power unit U in an integrally swingable manner and covers a front upper portion of the rear wheel WR, and the reference sign CA indicates a caliper which is supported above the rear portion of the auxiliary arm 38, respectively.

[0042] With reference to Fig. 3, a throttle body 24 (intake system component) is disposed above the cylinder portion 22 of the engine E. A front end portion of the throttle body 24 on a downstream side is connected to an upper portion of the cylinder portion 22 (an intake port of a cylinder head) with an insulator (not illustrated) therebetween. A rear end portion of the throttle body 24 on an upstream side is connected to an air cleaner 25 with a connection tube 25a therebetween. The connection tube 25a is curved to the left side behind the throttle body 24 in a plan view and is connected to a front end portion of the air cleaner 25 disposed above the transmission case 35. In the diagrams, the reference sign 25b indicates an element accommodated inside the air cleaner 25.

[0043] Hereinafter, a component leading from the air cleaner 25 to the intake port will be referred to as an intake component for intake to the engine E. An intake port 25c positioned on the uppermost stream side of the intake system component is disposed in an outer side portion of the air cleaner 25. The intake system component may include a carburetor.

[0044] An exhaust pipe 41 is connected to a lower portion of the cylinder portion 22 (an exhaust port of the cylinder head). The exhaust pipe 41 is bent rearward and extends below the cylinder portion 22, and it is curved upward to the rear and outward in the vehicle width direction and extends approximately at a position below the radiator 26. A rear end portion of the exhaust pipe 41 is connected to a front end portion of a muffler (silencer) 42 disposed on the right side of the rear wheel WR. The muffler 42 is disposed on a side opposite to the air cleaner 25 with the rear wheel WR sandwiched therebetween in the vehicle width direction. That is, the muffler 42 is disposed on the right side of the rear wheel WR, and the air cleaner 25 is disposed on the left side of the rear wheel WR.

<Muffler>

[0045] As illustrated in Figs. 5, 6, and 11, the muffler 42 includes a muffler main body (silencer main body) 43 having a cylindrical appearance, and a muffler cover (cover member) 51 covering a range from a part above the muffler main body 43 to the outer side in the vehicle width direction.

[0046] The muffler main body 43 linearly extends along a center axis C1 thereof and is mounted in the vehicle body in a posture inclined upward to the rear. For example, the muffler main body 43 is disposed with the center axis C1 parallel to a side surface of the vehicle body. Hereinafter, the forward-rearward direction along the axis C1 in a side view may be referred to as a muffler forward-rearward direction, and a vertical direction orthogonal to the axis C1 in a side view may be referred to as a muffler vertical direction. An arrow UP1 in Fig. 11 indicates an upper side viewed in a direction along the axis C1 (axis C1 direction) (an upper side in the muffler vertical direction).

[0047] The muffler main body 43 includes a tube body 44 lying along the center axis C1, a front cap 45 blocking a front end portion of the tube body 44, and an end cap 46 blocking a rear end portion of the tube body 44. For example, the tube body 44 has a double tube structure having inner and outer tubes. The front cap 45 has a tapered shape increasing in diameter toward the rear side and connects the exhaust pipe 41 to the front end portion. In the diagrams, the reference sign 41a indicates a base end portion in the exhaust pipe 41 connected to the engine E. The end cap 46 has a tapered shape decreasing in diameter toward the rear side, and a tail pipe 49 is disposed at the rear end portion. For example, the muffler main body 43 has a basic constitution in which an inner space of the tube body 44 is divided into a plurality of expansion chambers in the muffler forward-rearward direction and the plurality of expansion chambers suitably communicate with each other.

[0048] A front end 46a of the end cap 46 forms a circular opening along a plane orthogonal to the axis C1. A rear end of the tube body 44 is connected to the front end 46a of the end cap 46. A rear end 46b of the end cap 46 is inclined downward in a side view with respect to a plane orthogonal to the axis C1. For example, a recessed portion 46c having substantially a circular shape (a different shape in the diagrams) when viewed in the axis C1 direction is formed at the rear end 46b of the end cap 46. The recessed portion 46c has a bottom portion 46d having a flat surface shape orthogonal to the axis C1.

[0049] The tail pipe 49 is inserted through the bottom portion 46d of the recessed portion 46c. A rear end of the tail pipe 49 protrudes to a side behind the bottom portion 46d. The rear end of the tail pipe 49 protrudes rearward beyond the rear end 46b of the end cap 46. For example, the tail pipe 49 is constituted of a round pipe extending approximately coaxially with the axis C1. For example, the rear end of the tail pipe 49 is cut parallel to the rear end 46b of the end cap 46 or cut along a plane orthogonal to the axis C1. An opening of the rear end of this tail pipe 49 becomes an exhaust port 49a of the muffler 42. A constitution in which the rear end 46b of the end cap 46 extends rearward beyond the rear end (exhaust port 49a) of the tail pipe 49 may be adopted.

[0050] Also with reference to Figs. 9 and 10, three mounting brackets 47a, 47b, and 47c for attachment to

the auxiliary arm 38 and two cover brackets 48a and 48b for attachment of the muffler cover 51 are fixed to an outer circumference of the tube body 44. For example, each of the mounting brackets 47a, 47b, and 47c is fastened with the auxiliary arm 38 using a bolt lying in the vehicle width direction. For example, each of the cover brackets 48a and 48b fastens and fixes the muffler cover 51 using a screw lying in a radial direction of the muffler main body 43. For the sake of convenience of illustration, reference signs may be applied to the screws fastened to the cover brackets 48a and 48b.

[0051] The muffler main body 43 and the muffler 42 are attached to the power unit U in an integrally swingable manner by connecting the front end portions thereof to the exhaust pipe 41 and fastening the plurality of mounting brackets 47a, 47b, and 47c to the auxiliary arm 38. For example, the motorcycle 1 illustrated in Figs. 1 and 2 indicates a state of an empty vehicle 1G. In the illustrated state, the muffler 42 is in an inclined posture with the axis C1 lying upward to the rear.

<Muffler cover>

[0052] As illustrated in Figs. 5, 6, and 11, the muffler cover 51 has a length exceeding a front rear end of the muffler main body 43 and extends in the axis C1 direction. The muffler cover 51 covers a range from a part above the muffler main body 43 to the outer side in the vehicle width direction with an approximately regular gap therebetween.

[0053] An upper surface portion 52 in the muffler cover 51 covering the muffler main body 43 from above forms an inner edge 52a on the inner side in the vehicle width direction. The inner edge 52a extends approximately along the axis C1 (specifically, inclined so as to be positioned slightly inward in the vehicle width direction toward the rear side) in a plan view. The inner edge 52a is positioned inward in the vehicle width direction from the axis C1 in a plan view. In a part of the upper surface portion 52 overlapping a mounting bracket 47a, an inner hood portion 52b covering a part in the vicinity of the mounting bracket 47a from above protrudes inward in the vehicle width direction.

[0054] The upper surface portion 52 is inclined upward with respect to the axis C1 in a side view at a part forming the inner hood portion 52b and is inclined downward with respect to the axis C1 in front of the mounting bracket 47a. Hereinafter, in these inclined portions, the latter portion (the inclined portion in front of the mounting bracket 47a) will be referred to as a rearward ascending inclined portion 53, and the former portion (a part forming the inner hood portion 52b) will be referred to as a rearward descending inclined portion 54. A front end 53a of the rearward ascending inclined portion 53 is positioned in front of a front end of the muffler main body 43. The front end 53a of the rearward ascending inclined portion 53 is positioned above the axis C1 in a side view.

[0055] A straightening structure 61 for receiving head

wind and generating a prescribed flow rate is formed at an inner edge portion 53b on the inner side of the rearward ascending inclined portion 53 in the vehicle width direction. The straightening structure 61 functions as a canard causing a fast-flowing vortex flow to flow to the right side of the wheel house WH in which the rear wheel WR is disposed on a lower side behind the rear body RB and suctioning out air inside the wheel house WH using a negative pressure of the vortex flow. Accordingly, generation of a positive pressure inside the wheel house WH is curbed, and an influence on peripheral components due to a turbulence of air following the rear wheel WR is curbed.

[0056] A triangular opening portion 55a elongated in the forward-rearward direction along the bulge portion 55 in a side view is formed in a bulge portion 55 bulging due to both the inclined portions 53 and 54 in the upper surface portion 52. The opening portion 55a penetrates the inner side of the bulge portion 55 in the vehicle width direction and allows fastening work for the mounting bracket 47a from the outer side in the vehicle width direction.

[0057] Also with reference to Figs. 7 and 8, a rear end of the upper surface portion 52 is positioned behind the rear end portion (end cap 46) of the muffler main body 43 in the muffler forward-rearward direction. A rear end hood portion 56 inclined downward with respect to the axis C1 in a side view is formed at the rear end portion of the upper surface portion 52. In suitable places in the diagrams, an arrow FR1 indicating the forward side in the muffler forward-rearward direction along the axis C1 and the arrow UP1 indicating the upper side in the muffler vertical direction orthogonal to the axis C1 in a side view are marked.

[0058] A side surface portion 57 covering the muffler main body 43 from a lateral side in the muffler cover 51 forms a rearward ascending lower edge 57a along the axis C1 on the lower side. The lower edge 57a is positioned below the axis C1 in a side view.

[0059] A rear end of the lower edge 57a extends to a position overlapping the rear end portion (end cap 46) of the muffler main body 43 in a side view. A side surface inclined portion 58 inclined inward in the vehicle width direction with respect to the axis C1 in a plan view is formed at the rear end portion of the side surface portion 57. The side surface inclined portion 58 is formed in a manner of being connected to the rear end hood portion 56, and these make a rear end portion of the muffler cover 51 have a tapered shape decreasing in diameter. A rear end edge 58a of the side surface inclined portion 58 is inclined and extends upward from the rear end of the lower edge 57a in a side view so as to be positioned on the rear side toward the upper side with respect to the muffler vertical direction. The rear end edge 58a of the side surface inclined portion 58 leads to a rear end edge 56a of the rear end hood portion 56 of the upper surface portion 52. The rear end edge 56a of the upper surface portion 52 and the rear end edge 58a of the side surface

portion 57 form a connected rear end edge of the muffler cover 51.

[0060] With reference to Figs. 5 and 6, a front portion 57d of the lower edge 57a is curved upward behind a front end portion of the muffler main body 43 (front cap 45) in a side view and is curved inward in the vehicle width direction in a plan view. In accordance with the inward inclination of a front portion of the lower edge 57a in the vehicle width direction, a front portion 57e of the side surface portion 57 is inclined inward in the vehicle width direction in a plan view. A front end 57b of the lower edge 57a is positioned in front of the front end portion of the muffler main body 43. The front end 57b of the lower edge 57a is positioned above the axis C1 in a side view. A front end edge 57c extends upward and inward in the vehicle width direction from the front end 57b of the lower edge 57a. The front end edge 57c is inclined so as to be positioned on the front side toward the upper side with respect to the muffler vertical direction in a side view. The front end edge 57c is connected to the front end 53a of the rearward ascending inclined portion 53. The front end edge 57c is also a front end edge of the muffler cover 51.

[0061] With reference to Figs. 7 and 8, the rear end hood portion 56 of the muffler cover 51 projects rearward beyond the rear end 46b of the end cap 46 and the rear end (exhaust port 49a) of the tail pipe 49. The side surface inclined portion 58 of the muffler cover 51 is at a position overlapping the end cap 46 in a side view. An upper portion of the side surface inclined portion 58 is inclined and extends toward the rear end hood portion 56 in a side view. The exhaust port 49a is at a position overlapping the side surface inclined portion 58 in a side view. The rear end hood portion 56 and the side surface inclined portion 58 extend to a side behind the exhaust port 49a.

[0062] Head wind flowing along an outer surface of the side surface portion 57 of the muffler cover 51 flows along the side surface and then flows inward in the vehicle width direction along the side surface inclined portion 58. Thereafter, head wind is separated at the rear end edge 58a of the side surface inclined portion 58, and a vortex flow entrained into the exhaust port 49a side may be generated.

[0063] Head wind flowing along an outer surface of the upper surface portion of the cover flows along the rearward ascending upper surface with respect to the horizontal direction and then flows downward to the rear along the rearward descending rear end hood portion 56 with respect to the horizontal direction. Thereafter, head wind is separated at the rear end edge 56a of the rear end hood portion 56, and a vortex flow entrained into the exhaust port 49a side may be generated.

[0064] In the muffler 42 of the embodiment, a gap is provided between the muffler main body 43 and the muffler cover 51. Head wind invades this gap from the front end side of the muffler 42. This head wind flows along the outer surface of the muffler main body 43 and then blows rearward from a part around the end cap 46. A

projection 71 for disturbing head wind and generating a small turbulence is provided in the vicinity of the end cap 46 of the muffler main body 43.

<Muffler projection structure>

[0065] As illustrated in Figs. 5 to 8, the projection 71 protrudes upward from an upper surface (outer surface) 43b of the rear portion of the muffler main body 43 on the upper surface 43b. The projection 71 functions as a vortex flow generator for generating a prescribed turbulence (vortex flow) in head wind flowing along the outer surface 43b of the muffler main body 43. That is, since a small turbulence is intentionally generated by the projection 71, an air flow behind the rear end of the muffler main body 43 is controlled, and an effect such as reducing air resistance of the muffler 42 is achieved.

[0066] In the present embodiment, a small projection is provided on the outer surface of the muffler 42, and a small stable vortex (turbulence) is generated due to the principle of a turbulator. Accordingly, improvement in fuel efficiency and the like is achieved by curbing generation of a significantly unstable vortex and reducing air resistance around the muffler 42. The projection 71 reduces wind noise due to a generated turbulence and improves stability of the rear portion of the vehicle body. Since the projection 71 curbs (delays) separation of head wind, an influence of entrainment of head wind on the exhaust port 49a at the rear end of the muffler 42 is curbed, and the exhaust efficiency is favorably maintained.

[0067] With reference to Fig. 5, the projection 71 is provided behind a central position (in the embodiment, a central position of the tube body 44 having a uniform cross section) ct1 of the muffler 42 in a longitudinal direction. That is, the projection 71 is provided in a rear half region A1 of the muffler 42 in the longitudinal direction. More preferably, the projection 71 is provided behind a central position ct2 in the rear half region A1 of the muffler 42 in the longitudinal direction. That is, the projection 71 is provided in a region A2 corresponding to 1/4 from the rear end side of the muffler 42 in the longitudinal direction.

[0068] Similar to other brackets, the projection 71 is joined to an outer circumferential surface of the tube body 44 of the muffler main body 43 through welding. Unlike other brackets, the projection 71 does not support other components such as the muffler main body 43 and the muffler cover 51 and is independently provided on the outer surface of the muffler main body 43. For this reason, the projection 71 can facilitate optimal design for generating a prescribed turbulence in head wind flowing on the outer surface of the muffler main body 43. The projection 71 is not limited to a constitution in which it is welded to the muffler main body 43. The projection 71 may be fixed using means other than welding or may be integrally formed with the muffler main body 43.

[0069] Fig. 12(a) is a plan view of the projection 71 viewed from above in the muffler vertical direction, and

Fig. 12(b) is a side view of the projection 71 viewed in the vehicle width direction. Fig. 11 includes a form in which the projection 71 is viewed from behind in the muffler forward-rearward direction (axis C1 direction).

[0070] The projection 71 has an outer shape extending in a muffler longitudinal direction (axis C1 direction, arrow Y direction). In a plan view of Fig. 12(a), the projection 71 has a line-symmetrical outer shape with respect to the axis C1. In a rear view of Fig. 11, the projection 71 has a line-symmetrical outer shape with respect to a line R1 in a muffler radial direction parallel to the muffler vertical direction.

[0071] In the projection 71, a dimension (overall length) Y1 in the muffler longitudinal direction is larger than both a dimension (full width) X1 in a muffler width direction (arrow X direction) orthogonal to the muffler longitudinal direction in a plan view of Fig. 12(a) and a dimension (overall height) Z1 in the muffler radial direction (arrow Z direction) along the line R1 in the muffler radial direction in a rear view of Fig. 11. That is, the projection 71 has a projection longitudinal direction directed in the muffler longitudinal direction (axis C1 direction).

[0072] Hereinafter, a direction of the projection 71 directed in the muffler width direction in a plan view of Fig. 12(a) will be referred to as a projection width direction, and a direction of the projection 71 directed along the line R1 in the muffler radial direction in a rear view of Fig. 11 will be referred to as a projection height direction. The muffler longitudinal direction and the projection longitudinal direction are directed in the vehicle forward-rearward direction. In the present embodiment, "being directed in the vehicle forward-rearward direction" is not limited to a disposition parallel to the vehicle forward-rearward direction and includes a disposition inclined with respect to the vehicle forward-rearward direction within a prescribed angle (for example, 45°). The projection height direction corresponds to a direction perpendicular to a projection installation position on the outer surface of the muffler 42. For example, the projection installation position corresponds to a position of the center of gravity of a joint surface shape of the projection 71 with respect to the muffler 42.

[0073] The projection 71 is formed such that the full width X1 in the projection width direction orthogonal to the projection longitudinal direction is narrower than the overall length Y1 in the projection longitudinal direction. The projection 71 is formed such that the overall height Z1 in the projection height direction orthogonal to the projection longitudinal direction is shorter than the overall length Y1 in the projection longitudinal direction. Accordingly, air resistance of the projection 71 when head wind from a side in front of the vehicle is curbed.

[0074] In a plan view of Fig. 12(a), the projection 71 has a largest width portion Xm in the projection width direction in front of a central position Yc in the projection longitudinal direction. In a plan view of Fig. 12(a), the projection 71 has a pair of front portion side edges 72 which are inclined in front of the largest width portion Xm

so as to be positioned on the axis C1 side toward the front side. In a plan view of Fig. 12(a), a front end edge 73 lying between the front ends of the pair of front portion side edges 72 in the projection 71 has an arc shape projecting forward. For example, a locating hole 74 for positioning is formed at a position in the front end portion of the projection 71 separated above the outer surface of the muffler main body 43.

[0075] In a plan view of Fig. 12(a), the projection 71 has a pair of rear portion side edges 75 which are inclined behind the largest width portion Xm so as to be positioned on the axis C1 side toward the rear side. In a plan view of Fig. 12(a), a rear end edge 76 lying between the rear ends of the pair of rear portion side edges 75 in the projection 71 has an arc shape projecting rearward.

[0076] In a side view in Fig. 12(b), the projection 71 has a largest height portion Zm in the projection height direction in front of the central position Yc in the projection longitudinal direction. For example, the largest height portion Zm is positioned behind the largest width portion Xm, but it may be the same position as that of the largest width portion Xm in the forward-rearward direction. In the diagrams, the reference sign Zt indicates an upper end of the largest height portion Zm (which will hereinafter be referred to as a protrusion apex portion Zt). The projection 71 has a mountain shape having the protrusion apex portion Zt in a side view orthogonal to the projection longitudinal direction (in a side view viewed in the projection width direction).

[0077] In a side view in Fig. 12(b), in front of the protrusion apex portion Zt, the projection 71 has a first inclined portion 81 which is inclined so as to be positioned below toward the front side, and a first wall portion 83 which is steeply inclined and extends downward from a front end of the first inclined portion 81 via a first bent portion 82. The first inclined portion 81 corresponds to a front side inclined portion, and the first wall portion 83 corresponds to a projection front end portion.

[0078] In a side view in Fig. 12(b), behind the protrusion apex portion Zt, the projection 71 has a second inclined portions 84 which is inclined so as to be positioned below toward the rear side, and a second wall portion 86 which is steeply inclined and extends downward from a rear end of the second inclined portions 84 via a second bent portion 85. The second inclined portions 84 corresponds to a rear side inclined portion, and the second wall portion 86 corresponds to a projection rear end portion. The locating hole 74 is formed in the second bent portion 85.

[0079] In a rear view in Fig. 11, the projection 71 has substantially a trapezoidal shape. In a rear view in Fig. 11, the projection 71 has a pair of side wall portions 87 which are inclined so as to be positioned on the line R1 side in the muffler radial direction toward the upper side, and an upper wall portion 88 lying between the front ends of the pair of side wall portions 87.

[0080] In a side view in Fig. 12(b), the projection 71 has the first inclined portion 81 which serves as a forward descending front side inclined portion in front of the pro-

trusion apex portion Zt, and the second inclined portions 84 which serves as a rearward descending rear side inclined portion behind the protrusion apex portion Zt. The height of the projection 71 gradually increases in front of the protrusion apex portion Zt and gradually decreases behind the protrusion apex portion Zt. Accordingly, air resistance when the projection 71 receives head wind flowing along the outer surface of the muffler main body 43 is reduced. In addition, compression and expansion of head wind are alleviated, and thus generation of noise (wind noise) is curbed.

[0081] In the projection 71, the first inclined portion 81 serving as a front side inclined portion is formed to be longer than the second inclined portions 84 serving as a rear side inclined portion in the projection longitudinal direction. That is, a length L1 of the first inclined portion 81 in the projection longitudinal direction is longer than a length L2 of the second inclined portions 84 in the projection longitudinal direction. Accordingly, the projection 71 is formed such that the front side inclined portion has a gentler inclination than the rear side inclined portion. For this reason, air resistance in the front portion of the projection 71 is reduced, and a turbulence is likely to be generated at the rear portion of the projection 71.

[0082] In a plan view of Fig. 12(a), the width of the projection 71 gradually increases in front of the largest width portion Xm in the vicinity of the protrusion apex portion Zt and gradually decreases behind the largest width portion Xm. For this reason, air resistance is reduced, and generation of noise (wind noise) is curbed.

[0083] Fig. 13 illustrates a modification example of the projection 71 reversely directed in the forward-rearward direction.

[0084] In a projection 71' of this modification example, the first inclined portion 81 serving as a rear side inclined portion is formed to be longer than the second inclined portions 84 serving as a front side inclined portion in the projection longitudinal direction. Accordingly, the projection 71' is formed such that the rear side inclined portion has a gentler inclination than the front side inclined portion. For this reason, the projection 71' has a nearly streamlined shape so that separation of head wind which has passed through the protrusion apex portion Zt at the rear portion of the projection 71' is curbed and the flow rate of head wind increases at the rear portion of the projection 71'. Thus, a disturbance effect of head wind is improved.

[0085] As illustrated in Fig. 11, a plurality of projections 71 (including the projections 71', the same applies hereinafter) may be provided in the outer circumference of the muffler 42. In Fig. 11, a projection 71 is provided at an upper portion of the muffler 42, and another projection 71 (indicated by a two-dot dashed line) is also provided obliquely below the muffler 42, for example. The projections 71 are not limited to being provided at a part covered with the muffler cover 51 and may also be provided at a position avoiding the muffler cover 51. The projections 71 are not limited to being provided at a rear portion of

the muffler 42 and may also be provided at a front portion of the muffler 42.

<Operation>

[0086] Next, operation of the projection 71 of the present embodiment will be described with reference to Fig. 14.

[0087] With reference to a comparative example in Fig. 14(a), when the motorcycle 1 travels, if head wind flows around the muffler 42, a negative pressure is generated below the rear portion and behind the rear end of the muffler 42. Head wind which has flowed on the upper surface side and the side surface side in the muffler 42 is suctioned due to the negative pressure below the rear portion and behind the rear end of the muffler 42, is bent along the outer surface of the muffler 42, and flows so as to go around parts below the rear portion and behind the rear end of the muffler 42. At this time, since head wind is separated from the outer surface of the muffler 42, air resistance is caused around the muffler 42.

[0088] Behind the rear end of the muffler 42, a part of head wind W1 flowing along each of the outer surfaces of the muffler cover 51 and the muffler main body 43 becomes entrained wind W2 turning back to the exhaust port 49a side. Since the rear end hood portion 56 and the side surface inclined portion 58 extend to a side behind the exhaust port 49a, even if head wind flowing on the outer surface of the muffler cover 51 is entrained into the exhaust port 49a side, there is little influence on exhaust gas from the exhaust port 49a. Since head wind flowing on the outer surface of the muffler main body 43 is entrained into the exhaust port 49a side immediately after passing by the rear end 46b of the end cap 46, it may affect exhaust gas from the exhaust port 49a. This influence is reduced by increasing the rearward protrusion amount of the tail pipe 49 and providing the projection 71 for generating a turbulence at the rear portion of the muffler 42.

[0089] With reference to Fig. 14(b), in the rearward ascending muffler 42, since the head wind W1 particularly hits the upper surface side, there is a large amount of air. Since the projection 71 is provided on the upper surface side of this muffler main body 43, the following effects are exhibited. That is, since the projection 71 is provided in a flow of the head wind W1 on the upper surface side of the muffler main body 43, a small turbulence (vortex flow) W3 is generated in head wind. A turbulence is caused in a boundary layer of head wind on the upper surface side of the muffler main body 43 and separation of an air flow at the rear end of the muffler main body 43 is delayed by causing this turbulence W3 to flow to a side behind the rear end of the muffler main body 43. Accordingly, generation of a large vortex immediately after head wind passes through the rear end of the muffler main body 43 is curbed, and generation of an air flow turning back to the exhaust port 49a side (entrained wind) is curbed. Therefore, air resistance of the

muffler 42 is reduced, and an influence on the exhaust efficiency can be inhibited.

[0090] As described above, regarding a silencer structure of a saddle-riding type vehicle according to the foregoing embodiment, in the silencer structure of the motorcycle 1 including the muffler 42 that performs silencing of exhaust gas discharged from the engine E, the muffler 42 includes the projection 71 protruding from the outer surface 43b thereof and generating a prescribed turbulence in head wind flowing along the outer surface 43b.

[0091] According to this constitution, since the projection 71 for generating a turbulence in head wind flowing along the outer surface is provided on the outer surface of the muffler 42, an effect of delaying separation of head wind from the outer surface of the muffler 42 is achieved due to a prescribed turbulence generated behind the projection 71. For this reason, air resistance due to separation of head wind immediately behind the rear end of the muffler 42 can be curbed. In addition, entrainment of head wind toward the exhaust port 49a at the rear end of the muffler 42 is curbed, and thus efficient gas discharging can be performed without hindering exhaust gas from the exhaust port 49a.

[0092] In the foregoing silencer structure of a saddle-riding type vehicle, the muffler 42 includes the muffler main body 43 and the muffler cover 51 which is attached to the muffler main body 43. The projection 71 is provided in at least one of the muffler main body 43 and the muffler cover 51 (in the foregoing embodiment, the muffler main body 43).

[0093] According to this constitution, since the projection 71 is provided in at least one of the muffler main body 43 and the muffler cover 51, the degree of freedom in installation of the projection 71 is enhanced, and thus control of an air flow can be easily performed.

[0094] In the foregoing silencer structure of a saddle-riding type vehicle, the exhaust port 49a emitting exhaust gas to the atmosphere is provided at the rear end of the muffler main body 43, and the muffler cover 51 extends rearward beyond the exhaust port 49a.

[0095] According to this constitution, due to the silencer structure of a type in which the muffler cover 51 extends rearward beyond the exhaust port 49a and hides the exhaust port 49a, appearance characteristics can be improved, and an influence of entrained wind from the rear end of the muffler cover 51 on the exhaust port 49a can be curbed. When the end cap 46 has a constitution extending rearward beyond the exhaust port 49a, an influence of entrained wind from the rear end of the muffler main body 43 on the exhaust port 49a can be curbed.

[0096] In the foregoing silencer structure of a saddle-riding type vehicle, the projection 71 is provided behind the central position ct1 of the muffler 42 in the longitudinal direction of the muffler 42.

[0097] According to this constitution, since the projection 71 is provided at the rear half part of the muffler 42 in the longitudinal direction, a turbulence of head wind generated due to the projection 71 easily reaches a rear

end position of the muffler 42, and thus entrainment of head wind at the rear end position of the muffler 42 can be effectively curbed.

[0098] In the foregoing silencer structure of a saddle-riding type vehicle, the projection 71 has the projection longitudinal direction directed in the vehicle forward-rearward direction, and the dimension (overall length Y1) in the projection longitudinal direction is larger than the dimensions (full width X1, overall height Z1) in a direction orthogonal to the projection longitudinal direction.

[0099] According to this constitution, since the dimension of the projection 71 in a direction orthogonal to the projection longitudinal direction directed in the vehicle forward-rearward direction is smaller than the dimension in the projection longitudinal direction, air resistance of the projection 71 can be reduced. In addition, since the dimension of the projection 71 in the projection longitudinal direction directed in the vehicle forward-rearward direction is large, pressure change in head wind can become moderate and generation of wind noise can be curbed utilizing the length of the projection 71.

[0100] In the foregoing silencer structure of a saddle-riding type vehicle, the projection 71 has a mountain shape having the protrusion apex portion Zt in a side view orthogonal to the projection longitudinal direction. A front side inclined portion ascending toward the protrusion apex portion Zt from the projection front end portion is provided on the front side of the projection 71 in the vehicle forward-rearward direction. A rear side inclined portion descending toward the projection rear end portion from the protrusion apex portion Zt is provided on the rear side of the projection 71 in the vehicle forward-rearward direction.

[0101] According to this constitution, since the front portion of the projection 71 has the front side inclined portion which gradually ascends and the rear portion of the projection 71 has the rear side inclined portion which gradually descends, air resistance of the projection 71 can be further reduced, and pressure change in head wind can become moderate.

[0102] In the foregoing silencer structure of a saddle-riding type vehicle, when the front side inclined portion is longer than the rear side inclined portion in the projection longitudinal direction, since the front side inclined portion has a gentler slope shape than the rear side inclined portion, air resistance at the front portion of the projection 71 can be further reduced, and an effect of generating a turbulence can be enhanced by making the inclination of the rear side inclined portion steep.

[0103] In the foregoing silencer structure of a saddle-riding type vehicle, when the rear side inclined portion is longer than the front side inclined portion in the projection longitudinal direction, since the rear side inclined portion has a gentler slope shape than the front side inclined portion, air resistance at the rear portion of the projection 71 can be further reduced, and a disturbance effect of head wind can be further improved by increasing the flow rate of head wind at the rear portion of the projection 71.

[0104] In the foregoing silencer structure of a saddle-riding type vehicle, a plurality of projections 71 may be disposed in the outer circumference of the muffler 42.

[0105] In this case, since a plurality of projections 71 for generating a turbulence in head wind are disposed in the outer circumference of the muffler 42, entrainment of head wind is curbed by generating a turbulence throughout the entire outer circumference of the muffler 42, and thus an influence on the exhaust efficiency can be further curbed.

<Modification example>

[0106] With reference to Figs. 15 to 17, a modification example of the present embodiment will be described. This modification example particularly differs from the foregoing embodiment in that the projection 71 for generating a turbulence in head wind is provided on the outer surface of the muffler cover 51 instead of the muffler main body 43. For the rest, the same reference signs are applied to constitutions which are the same as the foregoing embodiment, and detailed description thereof will be omitted.

[0107] The projection 71 protruding upward from an upper surface (outer surface) 51b of the rear portion of the muffler cover 51 is provided on the upper surface 51b. Similar to the projection 71 of the first embodiment, the projection 71 functions as a vortex flow generator for generating a prescribed turbulence (vortex flow) in head wind flowing along the outer surface 51b of the muffler main body 43. That is, since a small turbulence is intentionally generated by the projection 71, an air flow behind the rear end of the muffler cover 51 is controlled, and an effect such as reducing air resistance of the muffler 42 is achieved. In addition, since the projection 71 curbs (delays) separation of head wind, an influence of entrainment of head wind on the exhaust port 49a at the rear end of the muffler 42 is curbed, and the exhaust efficiency is favorably maintained.

[0108] In the silencer structure of a saddle-riding type vehicle in the foregoing modification example, the muffler 42 includes the muffler main body 43 and the muffler cover 51 which is attached to the outer side of the muffler main body 43. The projection 71 is provided in the muffler cover 51.

[0109] According to this constitution, since the projection 71 for generating a turbulence of head wind is provided on the outer surface of the muffler cover 51 which is attached to the outer side of the muffler main body 43, an effect of delaying separation of head wind flowing on the outermost surface of the muffler 42 is achieved. For this reason, entrainment of head wind at the rear end position of the muffler 42 can be effectively curbed.

[0110] In the muffler cover 51 of the embodiment, the rear end portion extends to a side behind the exhaust port 49a, but effects similar to those above can be achieved even with a constitution in which the muffler cover 51 terminates in front of the exhaust port 49a. Par-

ticularly, when there is no effect of curbing entrainment due to the rear end portion of the muffler cover 51 extending to a side behind the exhaust port 49a, an effect of providing the projection 71 for generating a turbulence is significant. For example, the projection 71 is integrally formed on the upper surface of the muffler cover 51, but it is not limited thereto, and a separate component may be fixed by bonding, screwing, or the like.

<Second embodiment>

[0111] Next, a second embodiment of the present invention will be described with reference to Figs. 18 to 21.

[0112] This embodiment particularly differs from the first embodiment in that it is applied to a sport-type motorcycle having a knee grip portion in front of a seat and having bar-type steps on both sides of a vehicle body, instead of a scooter-type vehicle having step floors and a straddling space. For the rest, the same reference signs are applied to constitutions which are the same as the foregoing embodiment, and detailed description thereof will be omitted.

<Entirety of vehicle>

[0113] As illustrated in Fig. 18, a vehicle body frame F2 of a motorcycle 101 of the second embodiment includes a head pipe 113 which is positioned at the front end portion, a pair of left and right main frames 114 which extends downward to the rear from the head pipe 113, and a pair of left and right pivot frames 115 which extends downward from the rear end portion of the left and right main frames 114. The front wheel WF of the motorcycle 101, a pair of left and right front forks 11, and the steering handlebar 12 are supported by the head pipe 113 in a steerable manner. The front end portion of a swing arm 117 is supported by the left and right pivot frames 115 in a vertically swingable manner. The rear wheel WR of the motorcycle 101 is supported by the rear end portion of the swing arm 117. The front end portion of a seat frame 116 is coupled to the rear portions of the left and right main frames 114.

[0114] A fuel tank 133 is supported above the left and right main frames 114. A seat 128 on which an occupant sits is supported behind the fuel tank 133 and above the seat frame 116. The fuel tank 133 constitutes a knee grip portion in front of the seat 128. A pair of left and right steps 118 on which an occupant puts his/her feet are supported by the left and right pivot frames 115.

[0115] The vehicle body of the motorcycle 101 is covered with a vehicle body cover 127. The vehicle body cover 127 includes a front cowl FC2 which covers the front portion of the vehicle body, a lower cowl LC which leads to a part below the front cowl FC2 and covers the lower portion of the vehicle body, and a rear cowl RC2 which covers the rear portion of the seat frame 116.

[0116] An engine (internal-combustion engine: motor) E of the motorcycle 101 is supported below the left and

right main frames 114. An exhaust pipe 141 extending from a cylinder of the engine E is disposed on the inner side of the front cowl FC2 and the lower cowl LC. The exhaust pipe 141 is inclined upward to the rear and extends from the right side of the rear portion of the lower cowl LC and is connected to a front end portion of a muffler (silencer) 142 which is disposed on the right side of the rear wheel WR.

[0117] Also with reference to Figs. 19 to 21, the muffler 142 includes a muffler main body (silencer main body) 143 extending with a prescribed cross-sectional shape. In the present embodiment, a muffler cover (cover member) for covering the outer side of the muffler main body 143 is not provided, but a constitution including a muffler cover may be adopted. For example, in the diagrams, a line C2 indicates a center axis passing through a position of the center of gravity in the cross-sectional shape in the muffler main body 143.

[0118] The muffler main body 143 linearly extends along the center axis C2 thereof and is mounted in the vehicle body in a posture inclined upward to the rear. For example, the muffler main body 143 is disposed with the center axis C2 parallel to the side surface of the vehicle body. Hereinafter, the forward-rearward direction along the axis C2 in a side view will be referred to as a muffler forward-rearward direction, and the vertical direction orthogonal to the axis C2 in a side view will be referred to as a muffler vertical direction. An arrow FR2 indicating a side in front in the muffler forward-rearward direction along the axis C2, and an arrow UP2 indicating a side above in the muffler vertical direction orthogonal to the axis C2 in a side view are marked in suitable places in the diagrams.

[0119] The muffler main body 143 includes a tube body 144 lying along the center axis C2, a front cap 145 blocking the front end portion of the tube body 144, and an end cap 146 blocking the rear end portion of the tube body 144. When viewed in the axis C2 direction, the tube body 144 has a different cross-sectional shape in which a substantially polygonal-shaped upper portion and a substantially V-shaped lower portion are combined. When viewed in the axis C2 direction, the tube body 144 forms a chamfered portion having a flat surface shape inclined downward on the outer side of the lower portion in the vehicle width direction, thereby securing a bank angle for the motorcycle 101. The front cap 145 has a tapered shape increasing in diameter toward the rear side and connects the exhaust pipe 141 to the front end portion. The end cap 146 has a tapered shape decreasing in diameter toward the rear side, and a tail pipe 149 is disposed at the rear end portion.

[0120] Along a plane orthogonal to the axis C2, a front end 146a of the end cap 146 forms an opening having different shape similar to that of the tube body 144. The rear end of the tube body 144 is connected to the front end 146a of the end cap 146. A rear end 146b of the end cap 146 is slightly inclined downward in a side view with respect to a plane orthogonal to the axis C2. For example,

a recessed portion 146c having a different shape which is smaller than the tube body 144 by one size when viewed in the axis C2 direction is formed at the rear end 146b of the end cap 146. The recessed portion 146c has a bottom portion 146d having a flat surface shape orthogonal to the axis C2. The tail pipe 149 is inserted through the bottom portion 146d. The rear end of the tail pipe 149 is disposed inside the recessed portion 146c. The rear end of this tail pipe 149 becomes an exhaust port 149a of the muffler 142. The rear end 146b of the end cap 146 extends rearward beyond the rear end of the tail pipe 149 (exhaust port 149a).

<Muffler projection structure>

[0121] As illustrated in Figs. 18 to 21, the projection 71 protruding upward from an upper surface (outer surface) 143b of the rear portion of the muffler main body 143 is provided on the upper surface 143b. Similar to the projection 71 of the first embodiment, the projection 71 functions as a vortex flow generator for generating a prescribed turbulence (vortex flow) in head wind flowing along the outer surface 143b of the muffler main body 143. That is, since a small turbulence is intentionally generated by the projection 71, an air flow behind the rear end of the muffler main body 143 is controlled, and an effect such as reducing air resistance of the muffler 142 is achieved. In addition, since the projection 71 curbs (delays) separation of head wind, an influence of entrainment of head wind on the exhaust port 149a at the rear end of the muffler 142 is curbed, and the exhaust efficiency is favorably maintained.

[0122] The projection 71 is provided behind a central position of the muffler 142 (in the embodiment, a central position of the tube body 144 having a uniform cross section) of the muffler 142 in the longitudinal direction. That is, the projection 71 is provided in the rear half region of the muffler 142 in the longitudinal direction. More preferably, the projection 71 is provided behind a central position in the rear half region of the muffler 142 in the longitudinal direction. That is, the projection 71 is provided in a region corresponding to 1/4 from the rear end side of the muffler 142 in the longitudinal direction.

[0123] The projection 71 is joined to the outer circumferential surface of the tube body 144 of the muffler main body 143 through welding. The projection 71 does not support other components such as the muffler main body 143 and the muffler cover and is independently provided on the outer surface of the muffler main body 143. For this reason, the projection 71 can facilitate optimal design for generating a prescribed turbulence in head wind flowing on the outer surface of the muffler main body 143. The projection 71 is not limited to a constitution in which it is welded to the muffler main body 143. The projection 71 may be fixed using means other than welding or may be integrally formed with the muffler main body 143.

[0124] The projection 71 in Figs. 19 and 20 has a constitution having the first inclined portion 81 which serves

as a forward descending front side inclined portion in front of the protrusion apex portion Zt, and the second inclined portions 84 which serves as a rearward descending rear side inclined portion behind the protrusion apex portion Zt. However, similar to the modification example in Fig. 13, the projection 71 may be reversely directed in the forward-rearward direction. A plurality of projections 71 may be provided in the outer circumference of the muffler 142. When the muffler 142 includes a muffler cover, the projection 71 may be provided in the muffler cover. The projection 71 is not limited to being provided at the rear portion of the muffler 142 and may be provided at the front portion of the muffler 142.

[0125] As described above, also in the silencer structure of a saddle-riding type vehicle according to the second embodiment, since the projection 71 for generating a turbulence in head wind flowing along the outer surface is provided on the outer surface of the muffler 142, an effect of delaying separation of head wind from the outer surface of the muffler 142 is achieved due to a prescribed turbulence generated behind the projection 71. For this reason, air resistance due to separation of head wind immediately behind the rear end of the muffler 142 can be curbed. In addition, entrainment of head wind toward the exhaust port 149a at the rear end of the muffler 142 is curbed, and thus efficient gas discharging can be performed without hindering exhaust gas from the exhaust port 149a.

<Third embodiment>

[0126] Next, a third embodiment of the present invention will be described with reference to Figs. 22 to 25.

[0127] This embodiment particularly differs from the first embodiment in that it is applied to a business-type motorcycle in which an engine is supported by a vehicle body, instead of a scooter-type vehicle having a swing unit. For the rest, the same reference signs are applied to constitutions which are the same as the foregoing embodiment, and detailed description thereof will be omitted.

<Entirety of vehicle>

[0128] As illustrated in Fig. 22, a motorcycle (saddle-riding type vehicle) 201 of the third embodiment includes a so-called underbone-type vehicle body frame F3, thereby improving the ease of straddling the vehicle body and lowering the center of gravity of the vehicle.

[0129] The vehicle body frame F3 includes a head pipe 213 which is positioned at the front end portion, a main frame 214 which extends downward to the rear from the head pipe 213, and a pivot frame 215 which extends downward from the rear end portion of the main frame 214. The front wheel WF of the motorcycle 201, a pair of left and right front forks 11, and the steering handlebar 12 are supported by the head pipe 213 in a steerable manner. The front end portion of a swing arm 217 is sup-

ported by the pivot frame 215 in a vertically swingable manner. The rear wheel WR of the motorcycle 201 is supported by the rear end portion of the swing arm 217. The front end portion of a seat frame 216 is coupled to the rear portion of the main frame 214. The pair of left and right rear cushions 9 are disposed between the seat frame 216 and the swing arm 217.

[0130] The vehicle body of the motorcycle 201 is covered with a vehicle body cover 227. The vehicle body cover 227 includes a front body cover FC3 which covers a part around the head pipe 213 and a part around the front portion of the main frame 214, and a rear body cover RC3 which covers a part around the rear portion of the main frame 214 and a part around the seat frame 216. Left and right leg shields LS projecting outward in the lateral direction are formed on left and right side portions of the front body cover FC3. A seat 228 for an occupant sitting thereon is supported above the rear body cover RC3.

[0131] An engine E (motor) of the motorcycle 201 is supported below the main frame 214. Steps 218 on which an occupant puts his/her feet are disposed on both left and right sides of the engine E. An exhaust pipe 241 extending from the cylinder of the engine E extends rearward on a lower right side of the engine E. The exhaust pipe 241 is connected to a front end portion of a muffler (silencer) 242 which is disposed on the right side of the rear wheel WR in the vicinity of the rear end of the engine E.

[0132] Also with reference to Figs. 23 to 25, the muffler 242 includes a muffler main body (silencer main body) 243 extending with a circular cross-sectional shape. In the present embodiment, a muffler cover (cover member) for covering the outer side of the muffler main body 243 is not provided, but a constitution including a muffler cover may be adopted. In the diagrams, a line C3 indicates a center axis in the muffler main body 243.

[0133] The muffler main body 243 linearly extends along the center axis C3 thereof and is mounted in the vehicle body in a posture slightly inclined upward to the rear. For example, the muffler main body 243 is disposed with the center axis C3 parallel to the side surface of the vehicle body. Hereinafter, the forward-rearward direction along the axis C3 in a side view will be referred to as a muffler forward-rearward direction, and the vertical direction orthogonal to the axis C3 in a side view will be referred to as a muffler vertical direction. An arrow FR3 indicating a side in front in the muffler forward-rearward direction along the axis C3, and an arrow UP3 indicating a side above in the muffler vertical direction orthogonal to the axis C3 in a side view are marked in suitable places in the diagrams.

[0134] The muffler main body 243 includes a tube body 244 lying along the center axis C3, a front cap 245 blocking the front end portion of the tube body 244, and an end cap 246 blocking the rear end portion of the tube body 244. The tube body 244 has a circular cross-sectional shape when viewed in the axis C3 direction and

has a moderately tapered shape increasing in diameter toward the rear side. The front cap 245 has a tapered shape increasing in diameter toward the rear side and connects the exhaust pipe 241 to the front end portion.

5 The end cap 246 has a tapered shape decreasing in diameter toward the rear side, and a tail pipe 249 is disposed at the rear end portion.

[0135] Along a plane orthogonal to the axis C3, a front end 246a of the end cap 246 forms a circular opening similar to that of the tube body 244. The rear end of the tube body 244 is connected to the front end 246a of the end cap 246. A rear end 246b of the end cap 246 forms a circular opening which is smaller than the front end 246a by one size along a plane orthogonal to the axis C3. A recessed portion 246c having a circular shape when viewed in the axis C3 direction is formed at the rear end 246b of the end cap 246. The recessed portion 246c has a bottom portion 246d having a flat surface shape orthogonal to the axis C3. The tail pipe 249 is inserted through the bottom portion 246d. The rear end of the tail pipe 249 slightly protrudes rearward beyond the rear end 246b of the end cap 246. The rear end of this tail pipe 249 becomes an exhaust port 249a of the muffler 242. A constitution in which the rear end 246b of the end cap 246 extends rearward beyond the rear end (exhaust port 249a) of the tail pipe 249 may be adopted.

<Muffler projection structure>

30 **[0136]** As illustrated in Figs. 22 to 25, the projection 71 protruding upward from an upper surface (outer surface) 243b of the rear portion of the muffler main body 243 is provided on the upper surface 243b. Similar to the projection 71 of the first embodiment, the projection 71 functions as a vortex flow generator for generating a prescribed turbulence (vortex flow) in head wind flowing along the outer surface 243b of the muffler main body 243. That is, since a small turbulence is intentionally generated by the projection 71, an air flow behind the rear end of the muffler main body 243 is controlled, and an effect such as reducing air resistance of the muffler 242 is achieved. In addition, since the projection 71 curbs (delays) separation of head wind, an influence of entrainment of head wind on the exhaust port 249a at the rear end of the muffler 242 is curbed, and the exhaust efficiency is favorably maintained.

[0137] The projection 71 is provided behind a central position of the muffler 242 (in the embodiment, a central position of the tube body 244 having a uniform cross section) of the muffler 242 in the longitudinal direction. That is, the projection 71 is provided in the rear half region of the muffler 242 in the longitudinal direction. More preferably, the projection 71 is provided behind a central position in the rear half region of the muffler 242 in the longitudinal direction. That is, the projection 71 is provided in a region corresponding to 1/4 from the rear end side of the muffler 242 in the longitudinal direction.

[0138] The projection 71 is joined to the outer circum-

ferential surface of the tube body 244 of the muffler main body 243 through welding. The projection 71 does not support other components such as the muffler main body 243 and the muffler cover and is independently provided on the outer surface of the muffler main body 243. For this reason, the projection 71 can facilitate optimal design for generating a turbulence in head wind flowing on the outer surface of the muffler main body 243. The projection 71 is not limited to a constitution in which it is welded to the muffler main body 243. The projection 71 may be fixed using means other than welding or may be integrally formed with the muffler main body 243.

[0139] The projection 71 in Figs. 23 and 24 has a constitution having the first inclined portion 81 which serves as a forward descending front side inclined portion in front of the protrusion apex portion Zt, and the second inclined portions 84 which serves as a rearward descending rear side inclined portion behind the protrusion apex portion Zt. However, similar to the modification example in Fig. 13, the projection 71 may be reversely directed in the forward-rearward direction. A plurality of projections 71 may be provided in the outer circumference of the muffler 242. When the muffler 242 includes a muffler cover, the projection 71 may be provided in the muffler cover. The projection 71 is not limited to being provided at the rear portion of the muffler 242 and may be provided at the front portion of the muffler 242.

[0140] As described above, also in the silencer structure of a saddle-riding type vehicle according to the third embodiment, since the projection 71 for generating a turbulence in head wind flowing along the outer surface is provided on the outer surface of the muffler 242, an effect of delaying separation of head wind from the outer surface of the muffler 242 is achieved due to a prescribed turbulence generated behind the projection 71. For this reason, air resistance due to separation of head wind immediately behind the rear end of the muffler 242 can be curbed. In addition, entrainment of head wind toward the exhaust port 249a at the rear end of the muffler 242 is curbed, and thus efficient gas discharging can be performed without hindering exhaust gas from the exhaust port 249a.

[0141] The present invention is not limited to the foregoing embodiments. For example, the projection 71 may be provided in both the silencer main body and the cover member. When the saddle-riding type vehicle includes two silencers branching out on the left and right sides, the projection 71 may be provided in both the silencers.

[0142] The saddle-riding type vehicle includes all types of vehicles in which a rider rides the vehicle in a manner of straddling a vehicle body and includes not only motorcycles (including motorized bicycles and scooter-type vehicles) but also vehicles having three wheels (including vehicles having two front wheels and one rear wheel in addition to vehicles having one front wheel and two rear wheels) or four wheels.

[0143] Further, the constitutions in the foregoing embodiments are examples of the present invention, and

various changes can be made within a range not departing from the gist of the present invention, such as replacing the constituent elements of the embodiments with known constituent elements.

BRIEF DESCRIPTION OF THE REFERENCE SYMBOLS

[0144]

1:	Motorcycle (saddle-riding type vehicle)
E:	Engine (internal-combustion engine)
42:	Muffler (silencer)
43:	Muffler main body (silencer main body)
Ct1:	Central position
43b:	Upper surface, outer surface
46:	End cap
49a:	Exhaust port
51:	Muffler cover (cover member)
71:	Projection
Y1:	Dimension in projection longitudinal direction
X1, Z1:	Dimension in direction orthogonal to projection longitudinal direction
Zt:	Protrusion apex portion

Claims

1. A silencer structure of a saddle-riding type vehicle (1) comprising:
 - a silencer (42) that performs silencing of exhaust gas discharged from an internal-combustion engine (E),
 - wherein the silencer (42) comprises a projection (71) which protrudes from an outer surface (43b) thereof and generates a prescribed turbulence in head wind flowing along the outer surface (43b).
2. The silencer structure of a saddle-riding type vehicle according to claim 1,
 - wherein the silencer (42) comprises a silencer main body (43) and a cover member (51) which is attached to the silencer main body (43), and wherein the projection (71) is provided in at least one of the silencer main body (43) and the cover member (51).
3. The silencer structure of a saddle-riding type vehicle according to claim 2,
 - wherein the silencer main body (43) has an end cap (46) which is positioned at a rear end portion and an exhaust port (49a) which is disposed in the end cap (46) and emits exhaust gas to atmosphere, and

wherein at least one of the cover member (51) and the end cap (46) extends rearward beyond the exhaust port (49a).

4. The silencer structure of a saddle-riding type vehicle according to any one of claims 1 to 3, wherein the projection (71) is provided behind a central position (ctl) of the silencer (42) in a longitudinal direction of the silencer (42). 5
10
5. The silencer structure of a saddle-riding type vehicle according to any one of claims 1 to 4, wherein the projection (71) has a projection longitudinal direction directed in a vehicle forward-rearward direction, and a dimension (Y1) in the projection longitudinal direction is larger than dimensions (X1, Z1) in a direction orthogonal to the projection longitudinal direction. 15
6. The silencer structure of a saddle-riding type vehicle according to claim 5, 20

wherein the projection (71) has a mountain shape having a protrusion apex portion (Zt) in a side view orthogonal to the projection longitudinal direction, 25

wherein a front side inclined portion ascending toward the protrusion apex portion (Zt) from a projection front end portion is provided on a front side of the projection (71) in the vehicle forward-rearward direction, and 30

wherein a rear side inclined portion descending toward a projection rear end portion from the protrusion apex portion (Zt) is provided on a rear side of the projection (71) in the vehicle forward-rearward direction. 35
7. The silencer structure of a saddle-riding type vehicle according to claim 6, wherein the front side inclined portion is longer than the rear side inclined portion in the projection longitudinal direction. 40
8. The silencer structure of a saddle-riding type vehicle according to claim 6, wherein the rear side inclined portion is longer than the front side inclined portion in the projection longitudinal direction. 45
9. The silencer structure of a saddle-riding type vehicle according to any one of claims 1 to 8, wherein a plurality of the projections (71) are disposed in an outer circumference of the silencer (42). 50
10. The silencer structure of a saddle-riding type vehicle according to any one of claims 1 to 9, 55

wherein the silencer (42) comprises a silencer

main body (43) and a cover member (51) which is attached to an outer side of the silencer main body (43), and wherein the projection (71) is provided in the cover member (51).

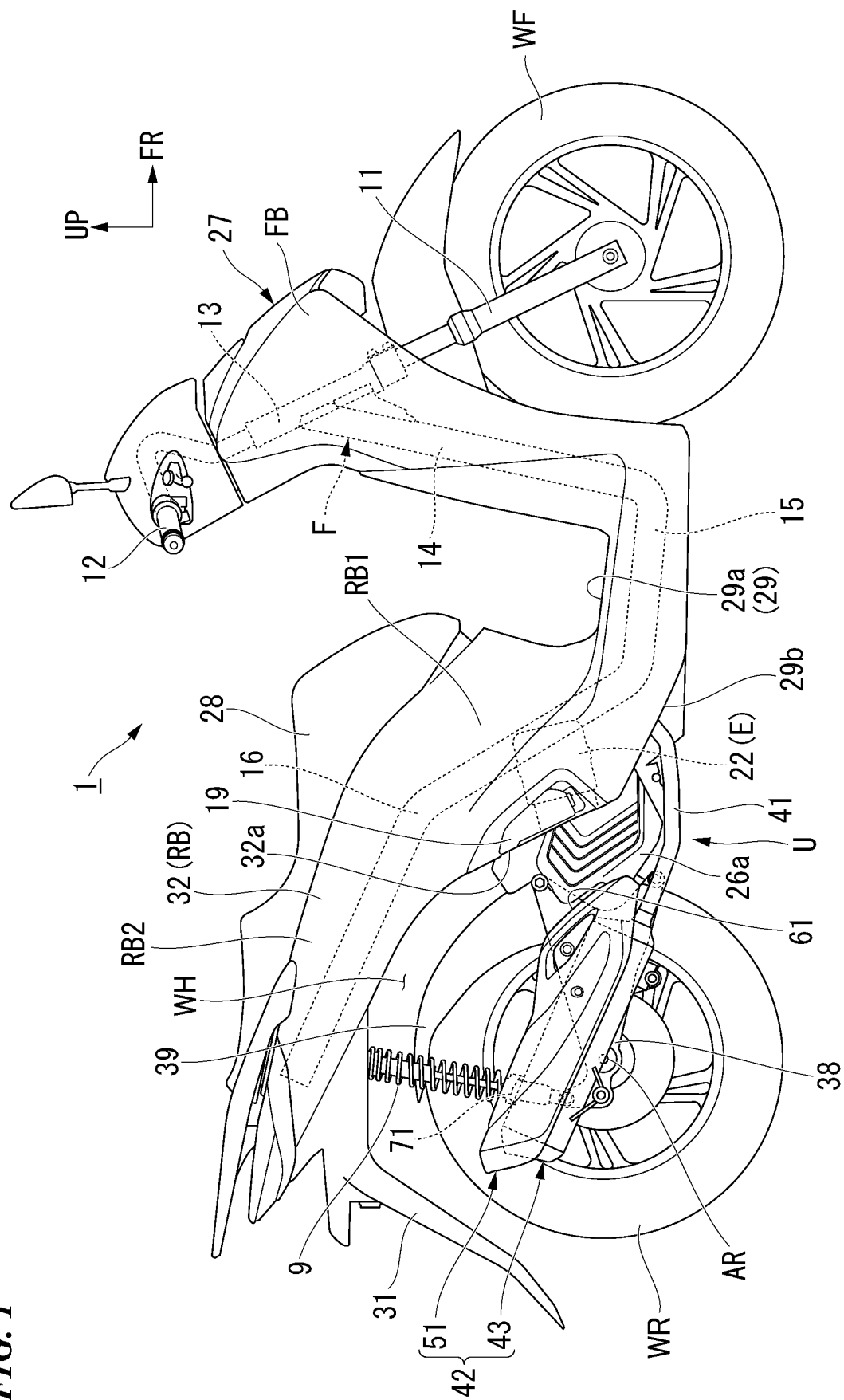


FIG. 1

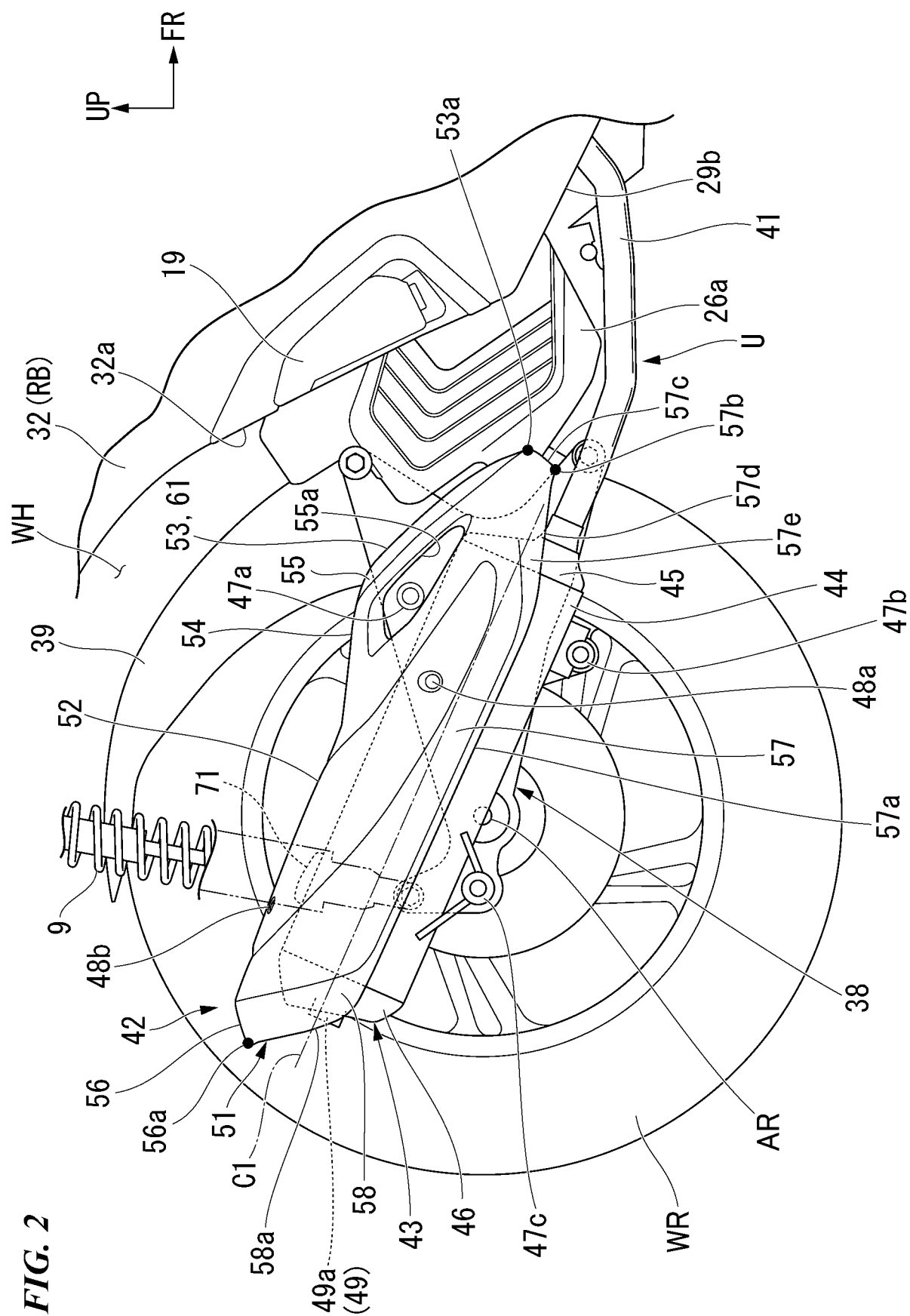
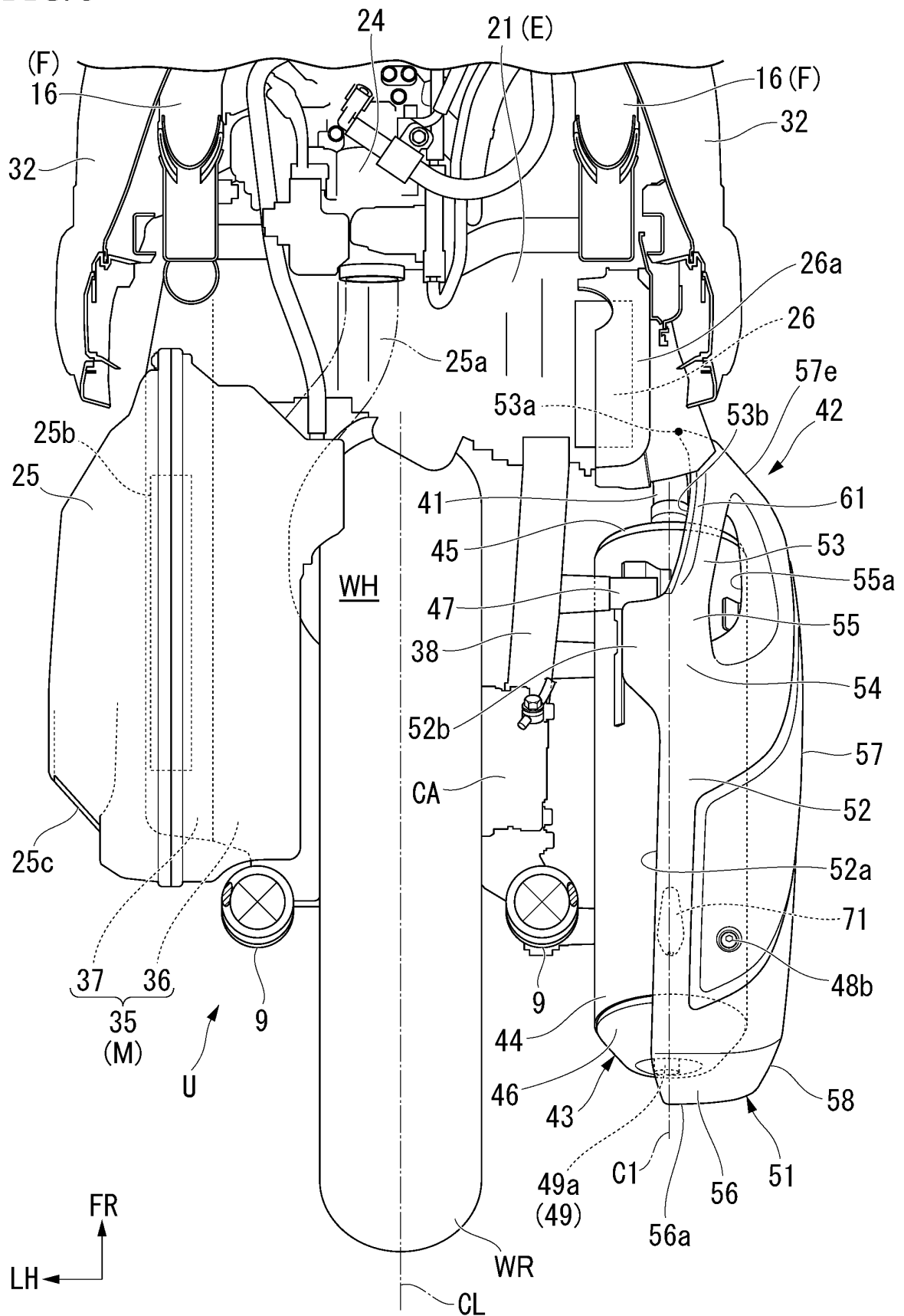


FIG. 3



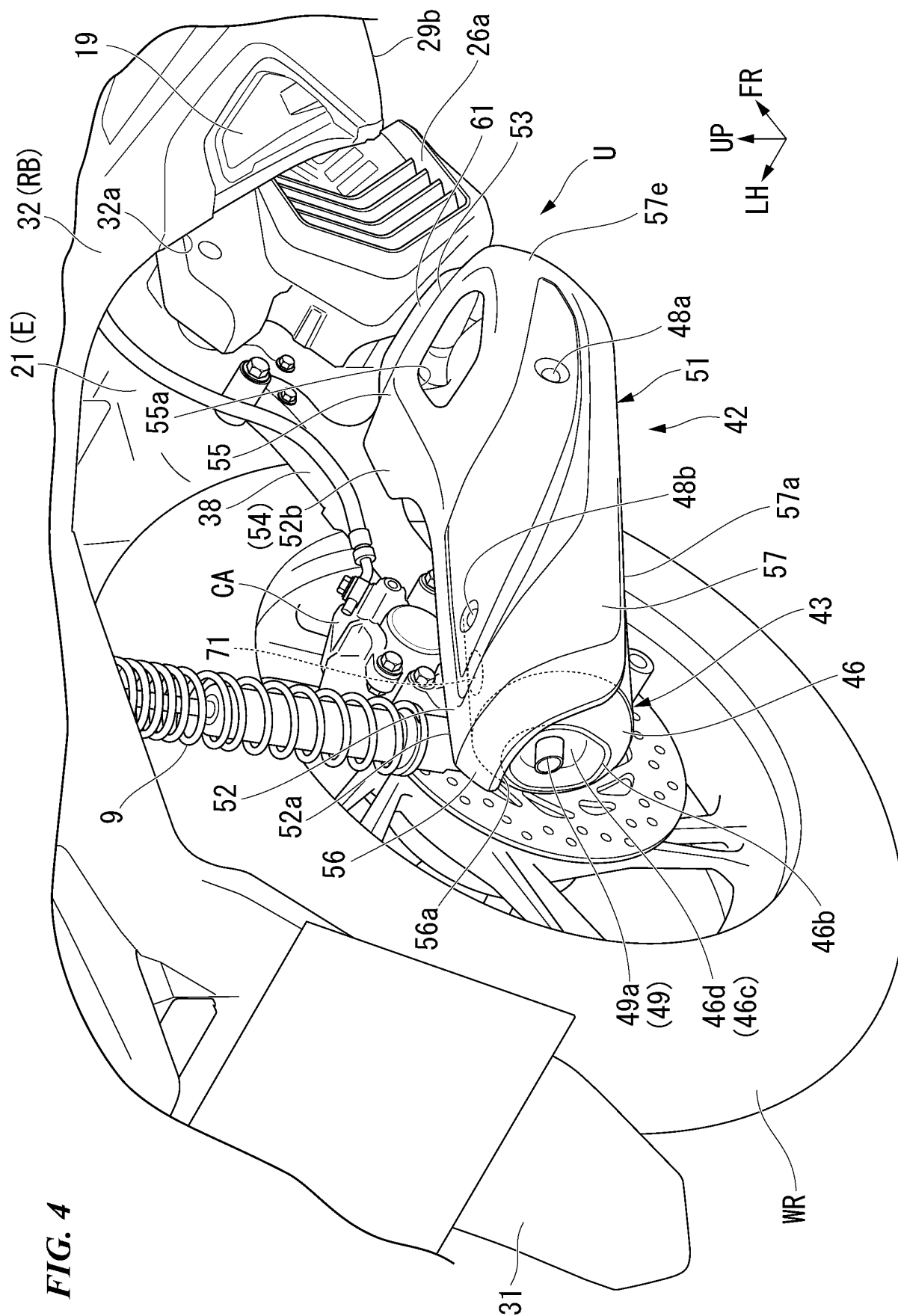


FIG. 4

FIG. 5

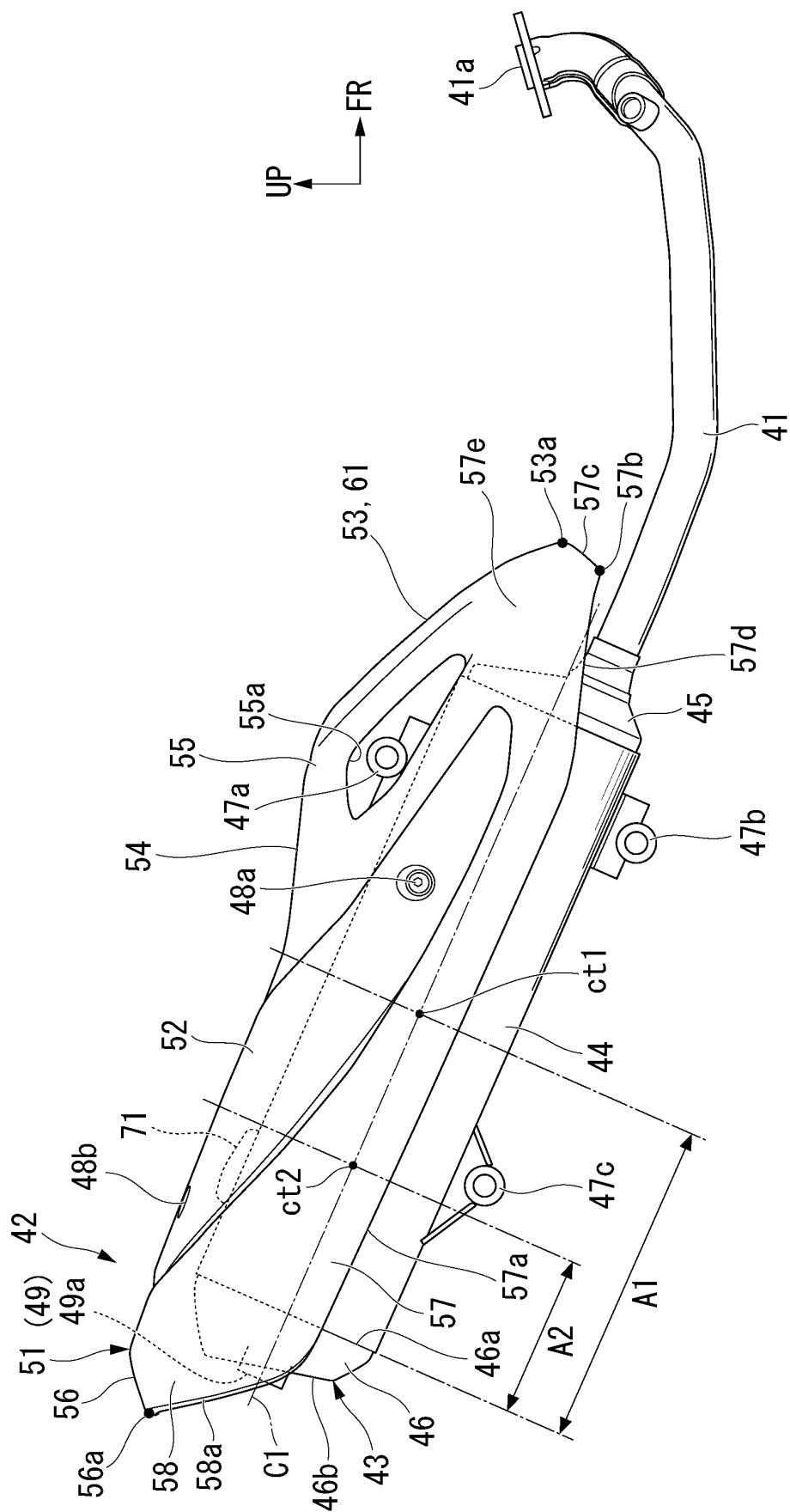


FIG. 6

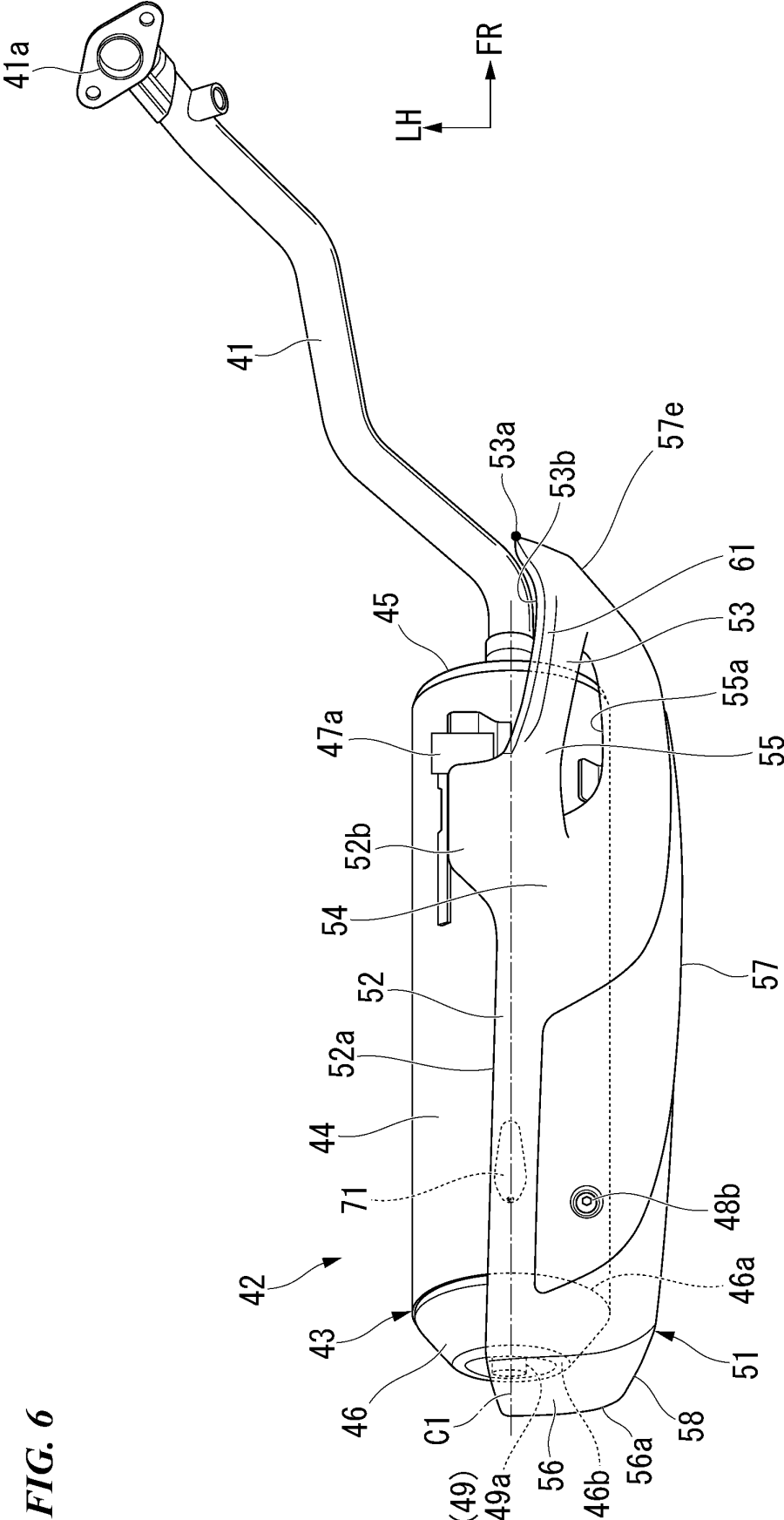
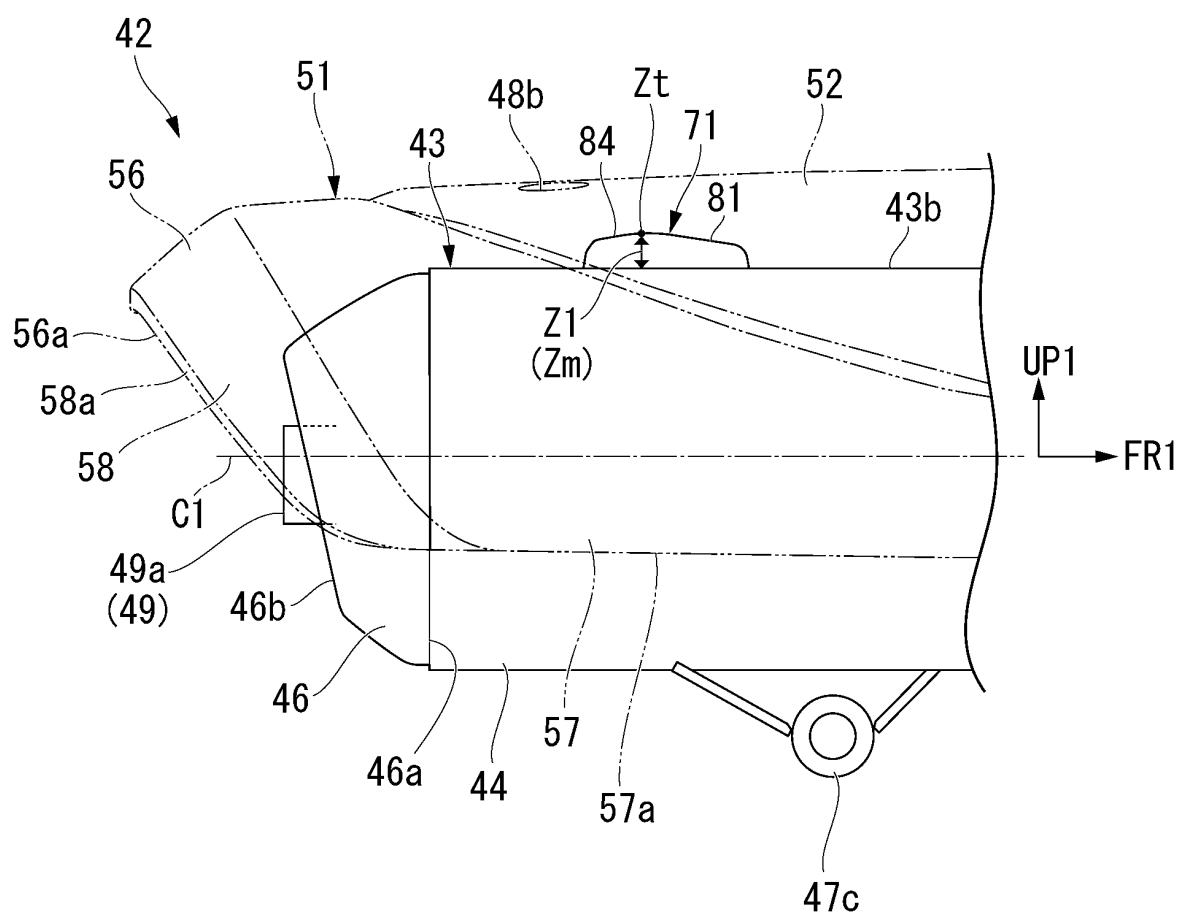
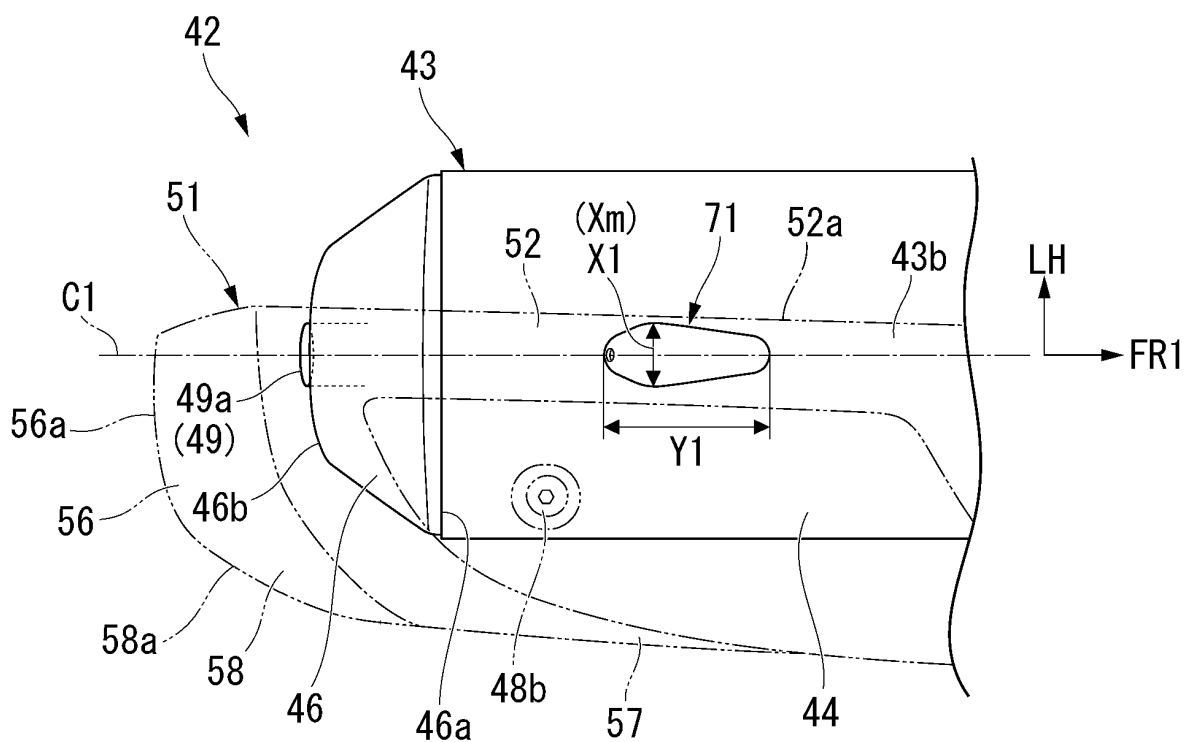


FIG. 7**FIG. 8**

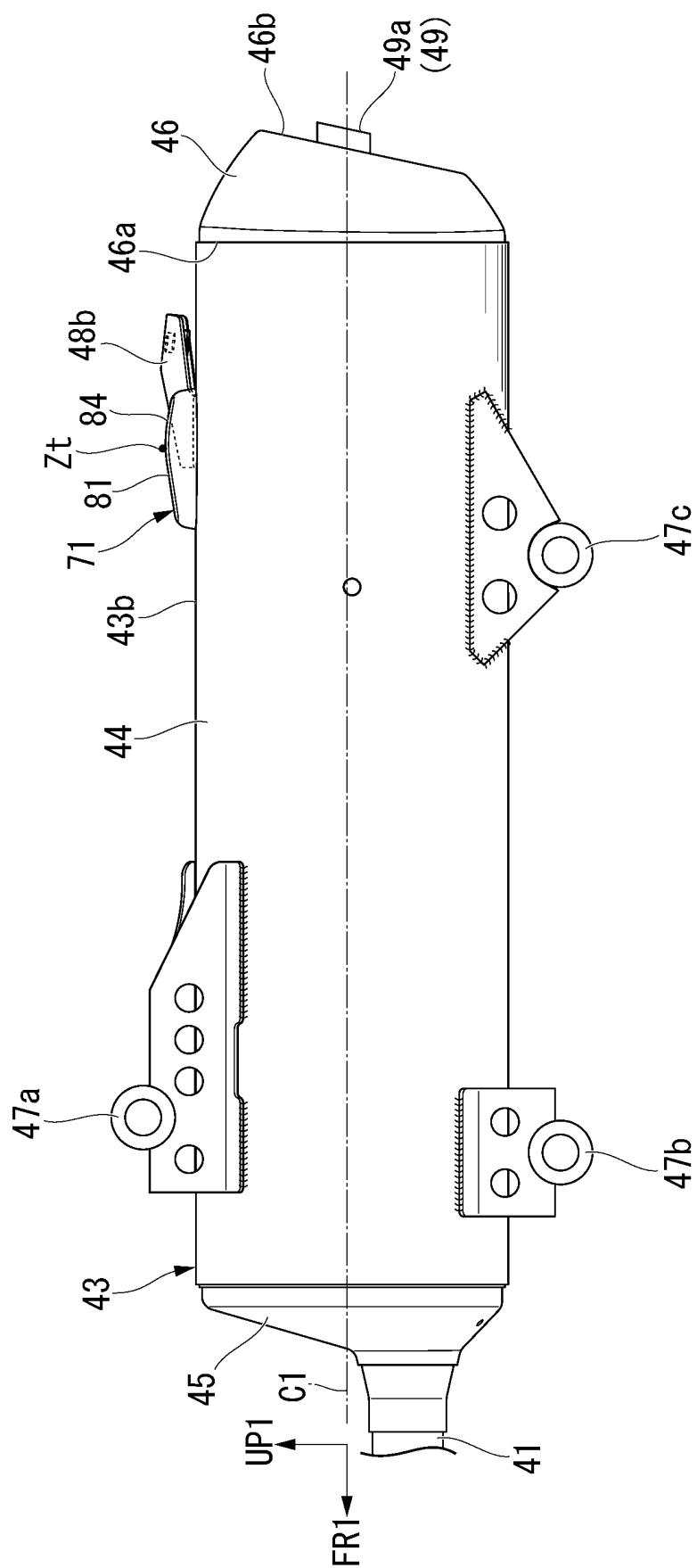


FIG. 9

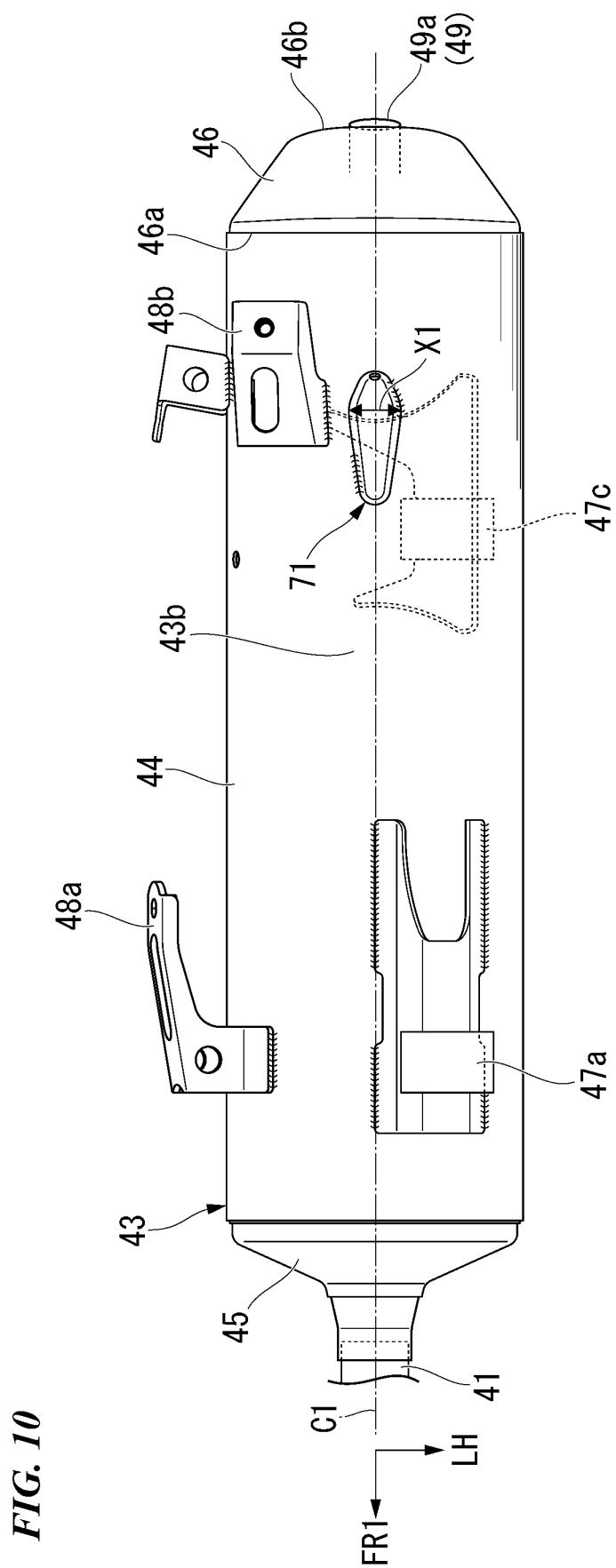


FIG. 10

FIG. 11

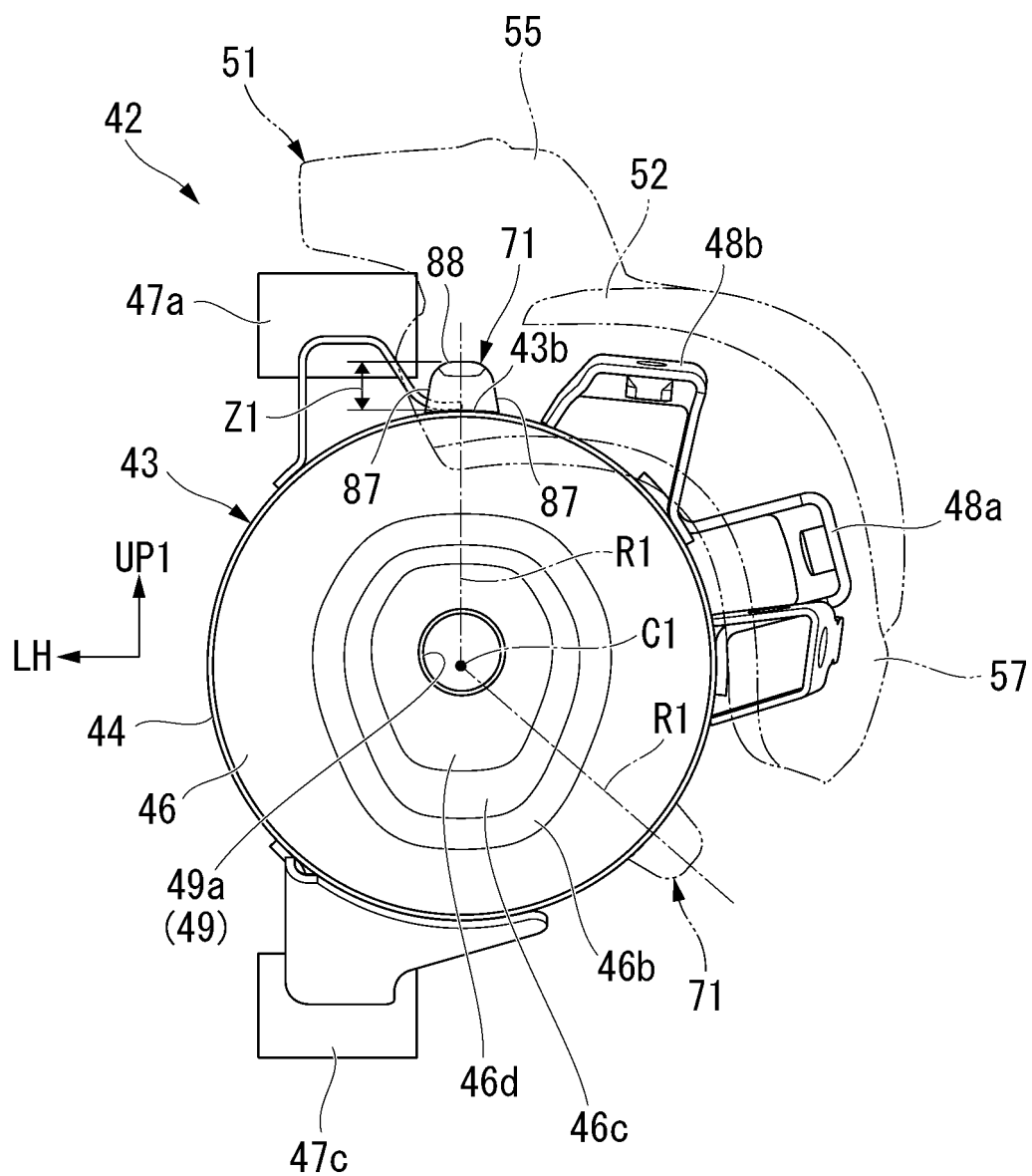
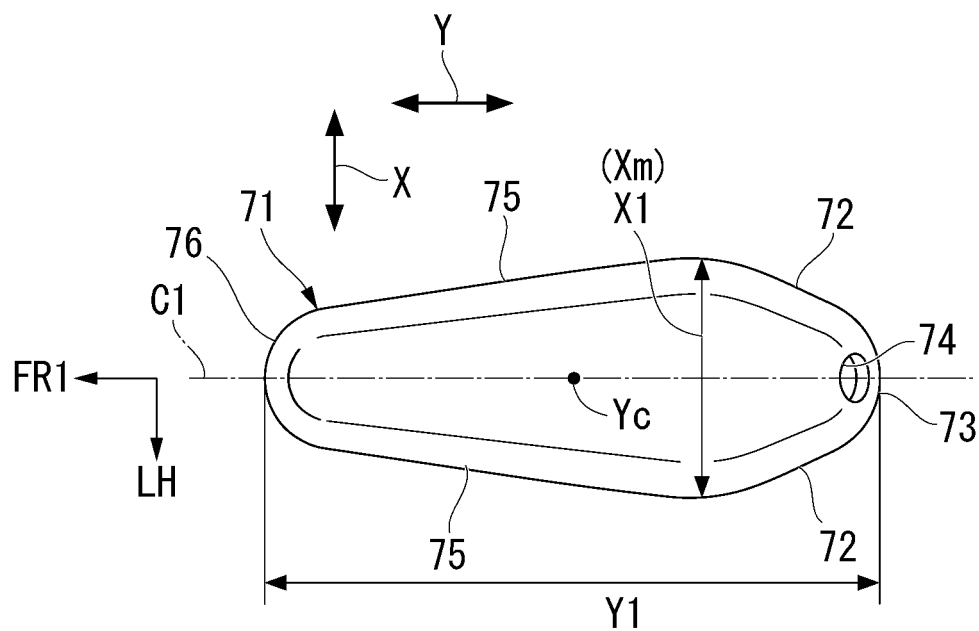


FIG. 12

(a)



(b)

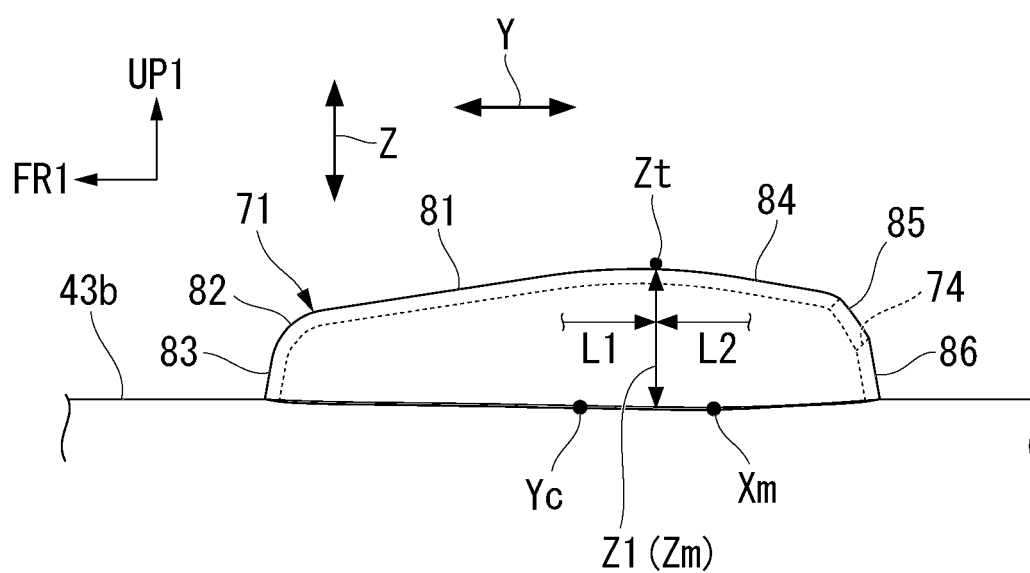


FIG. 13

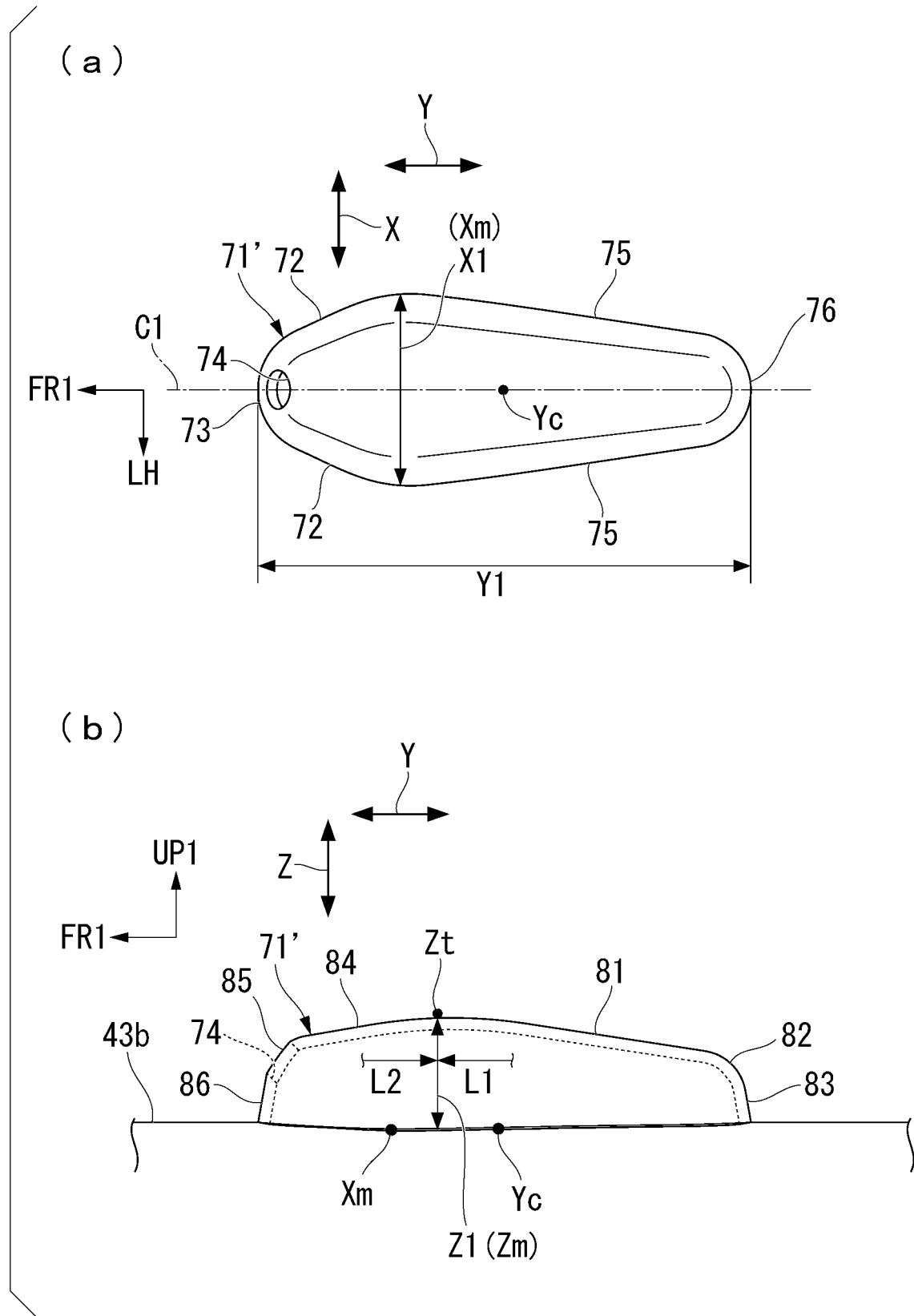


FIG. 14

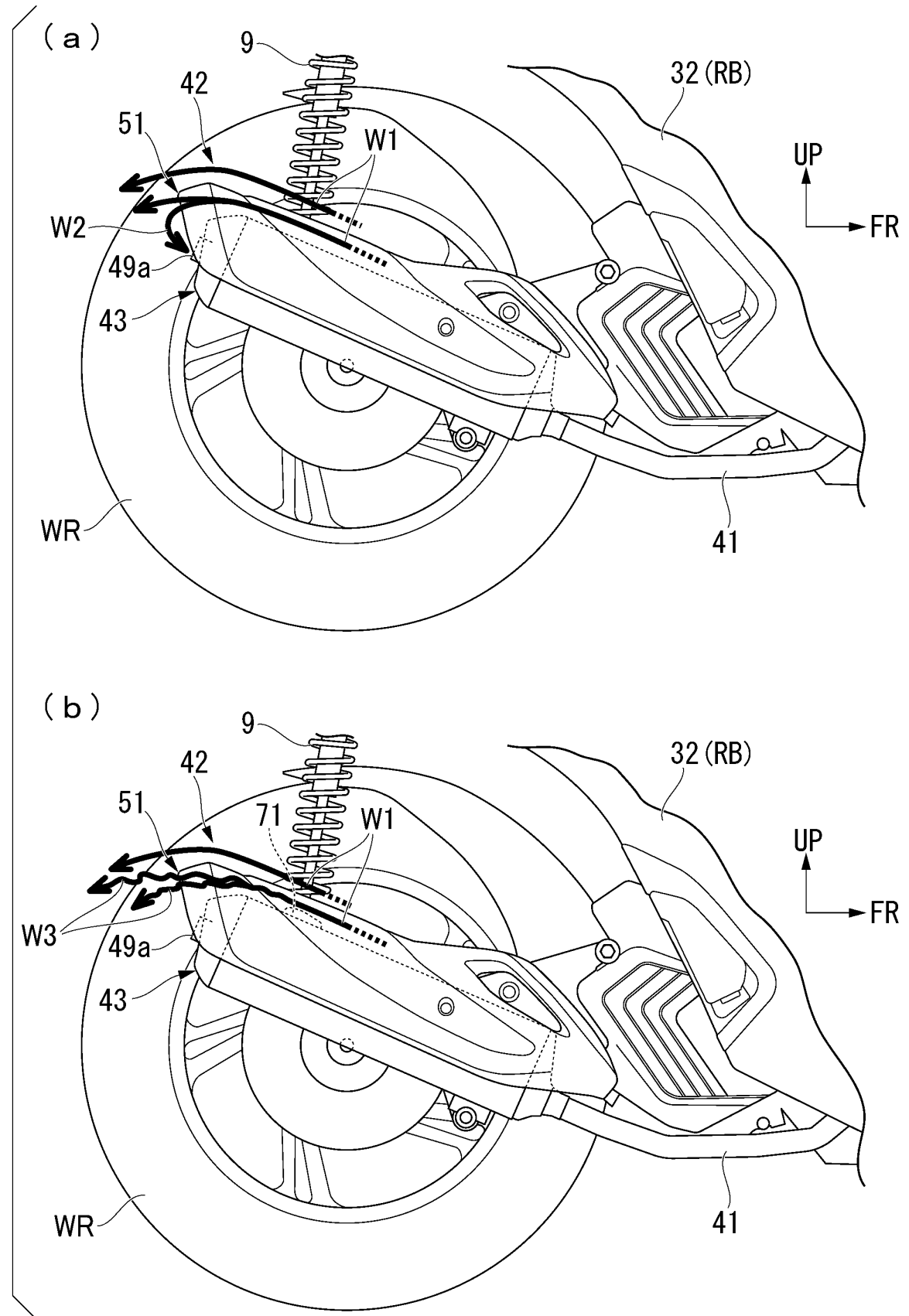


FIG. 15

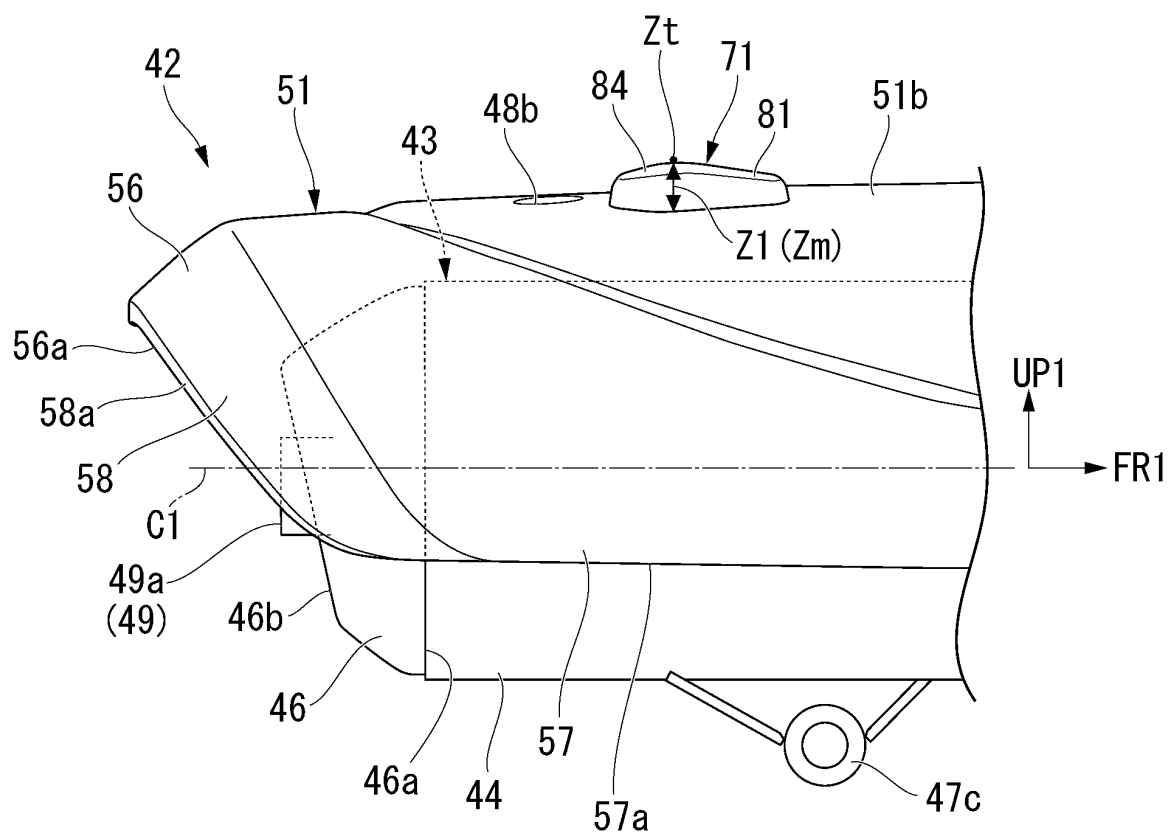


FIG. 16

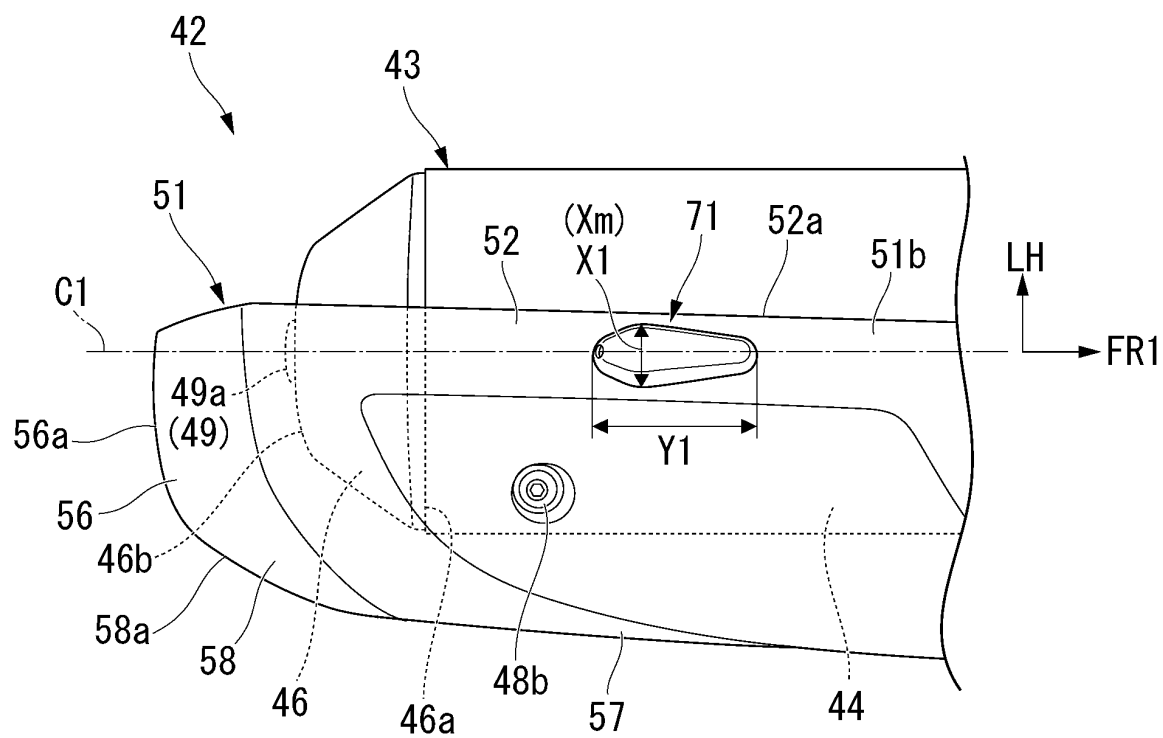


FIG. 17

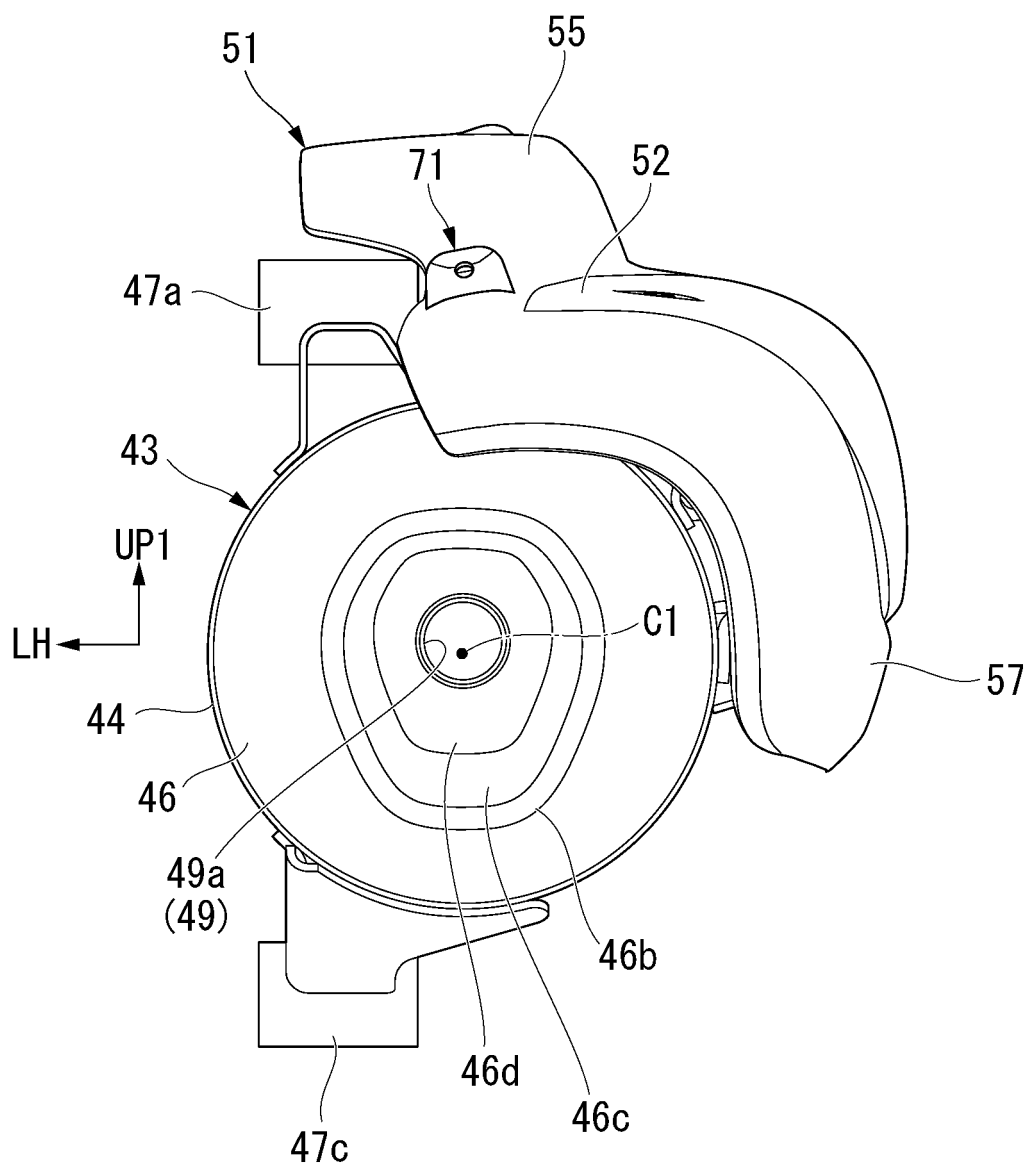
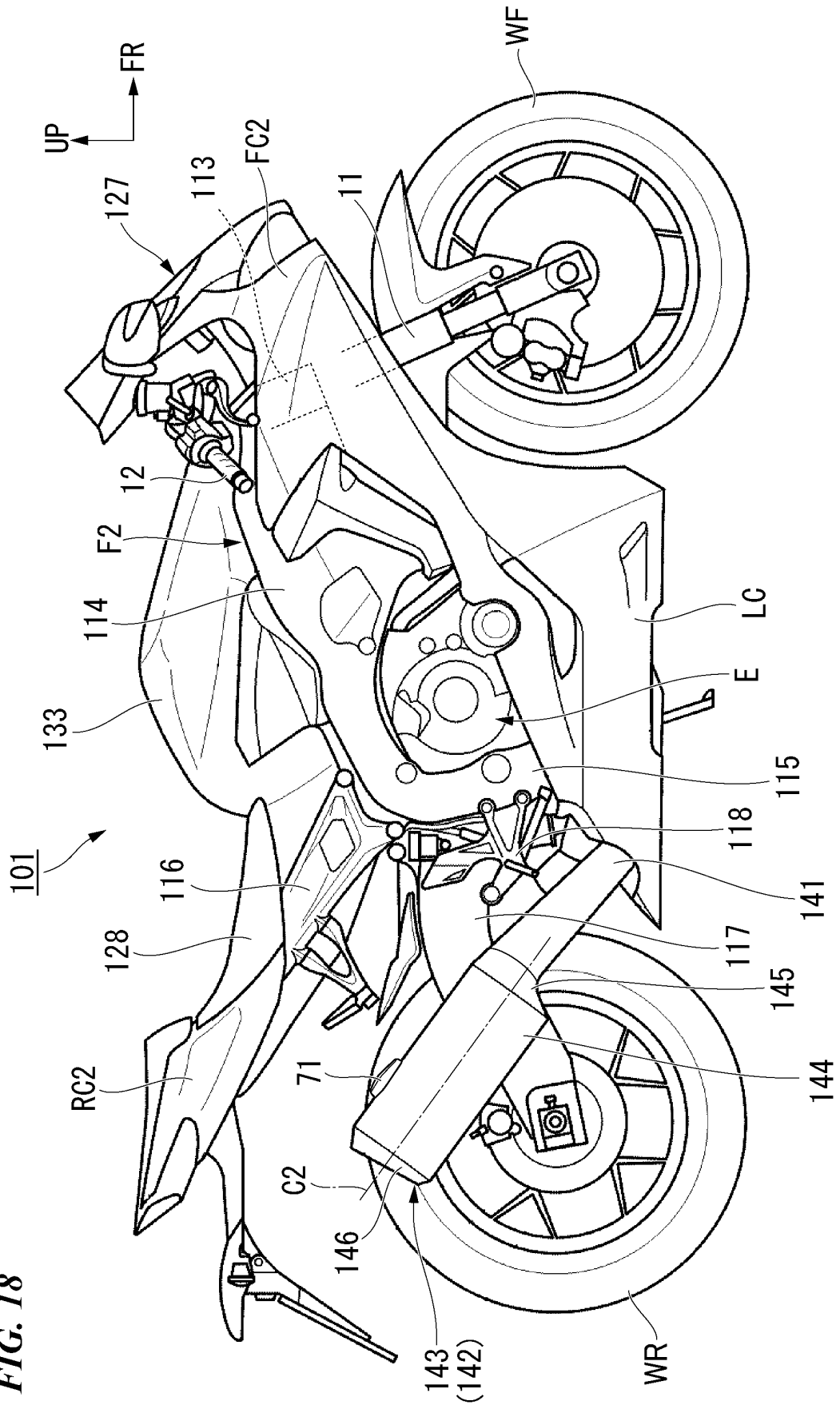


FIG. 18



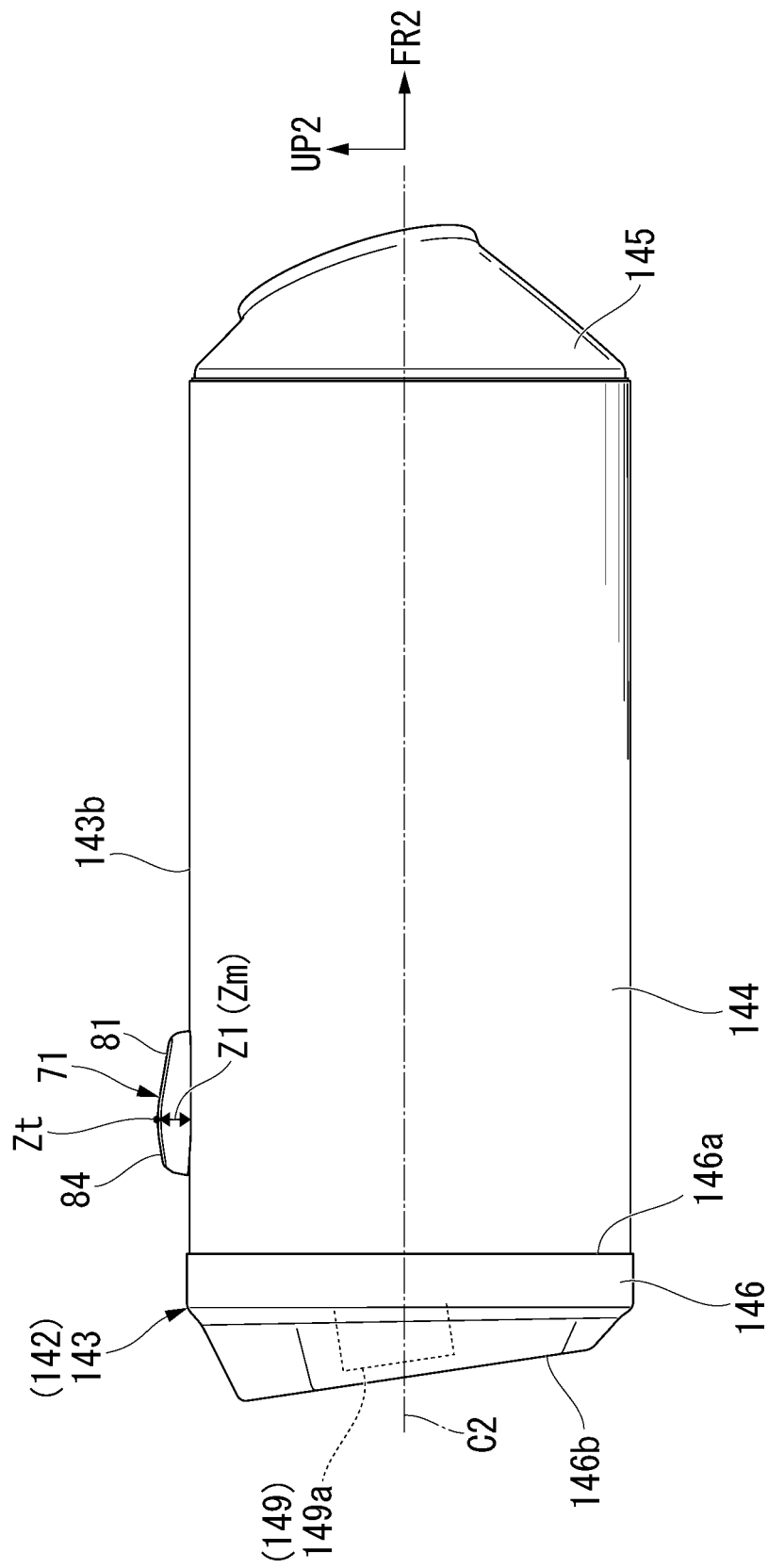


FIG. 19

FIG. 20

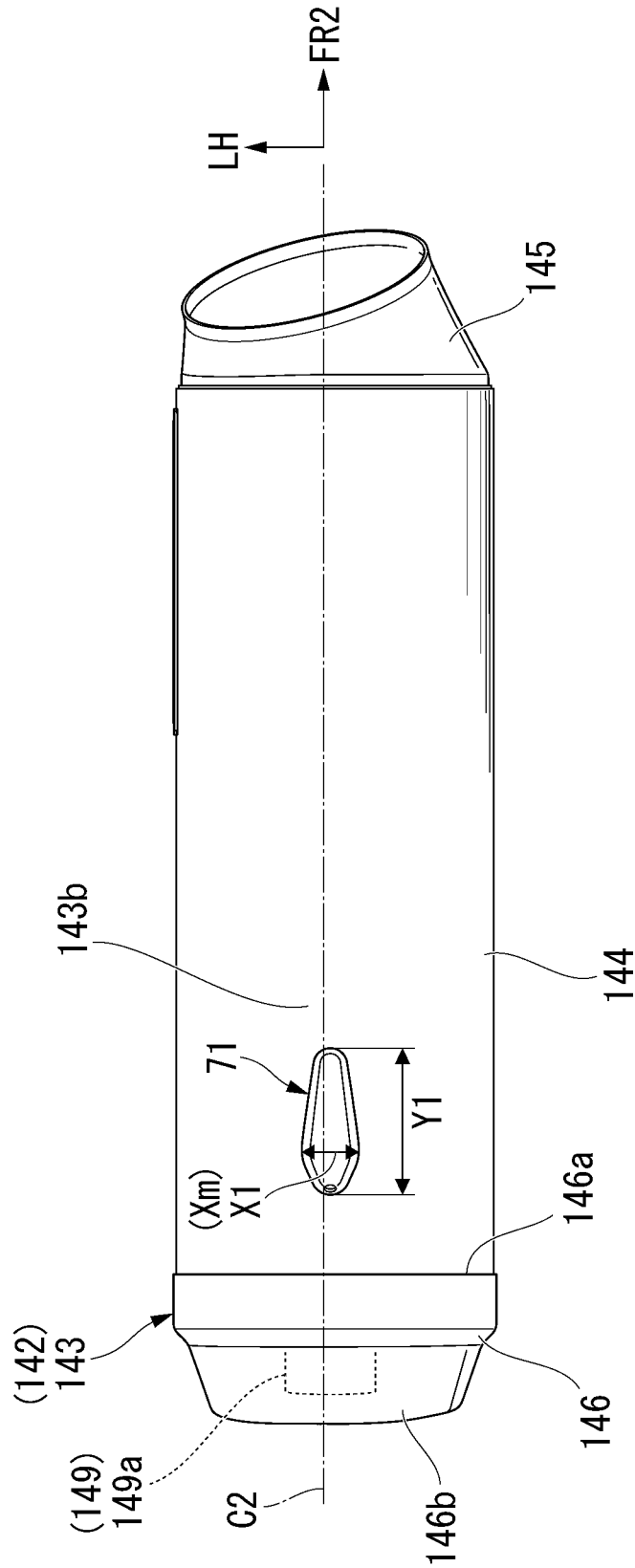


FIG. 21

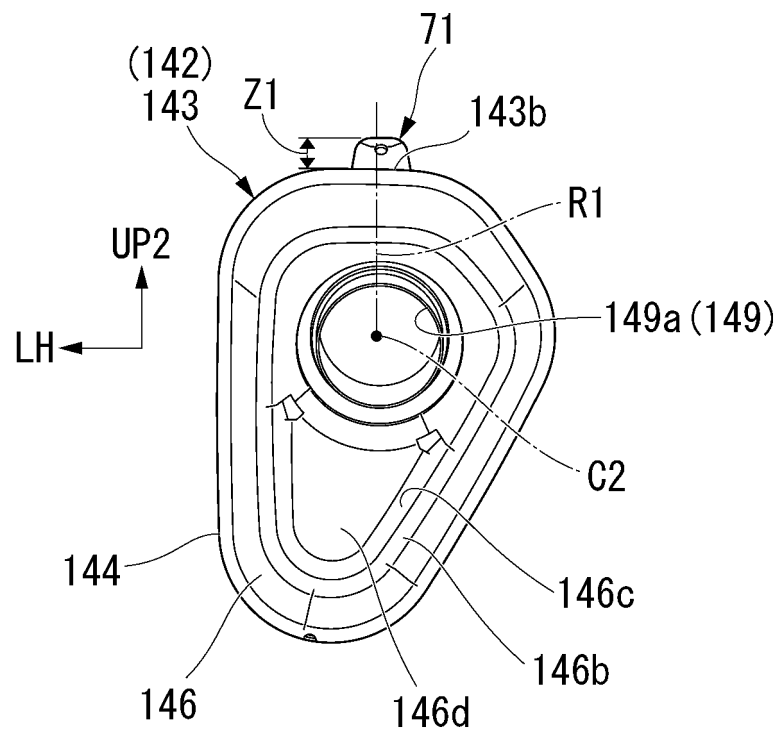


FIG. 22

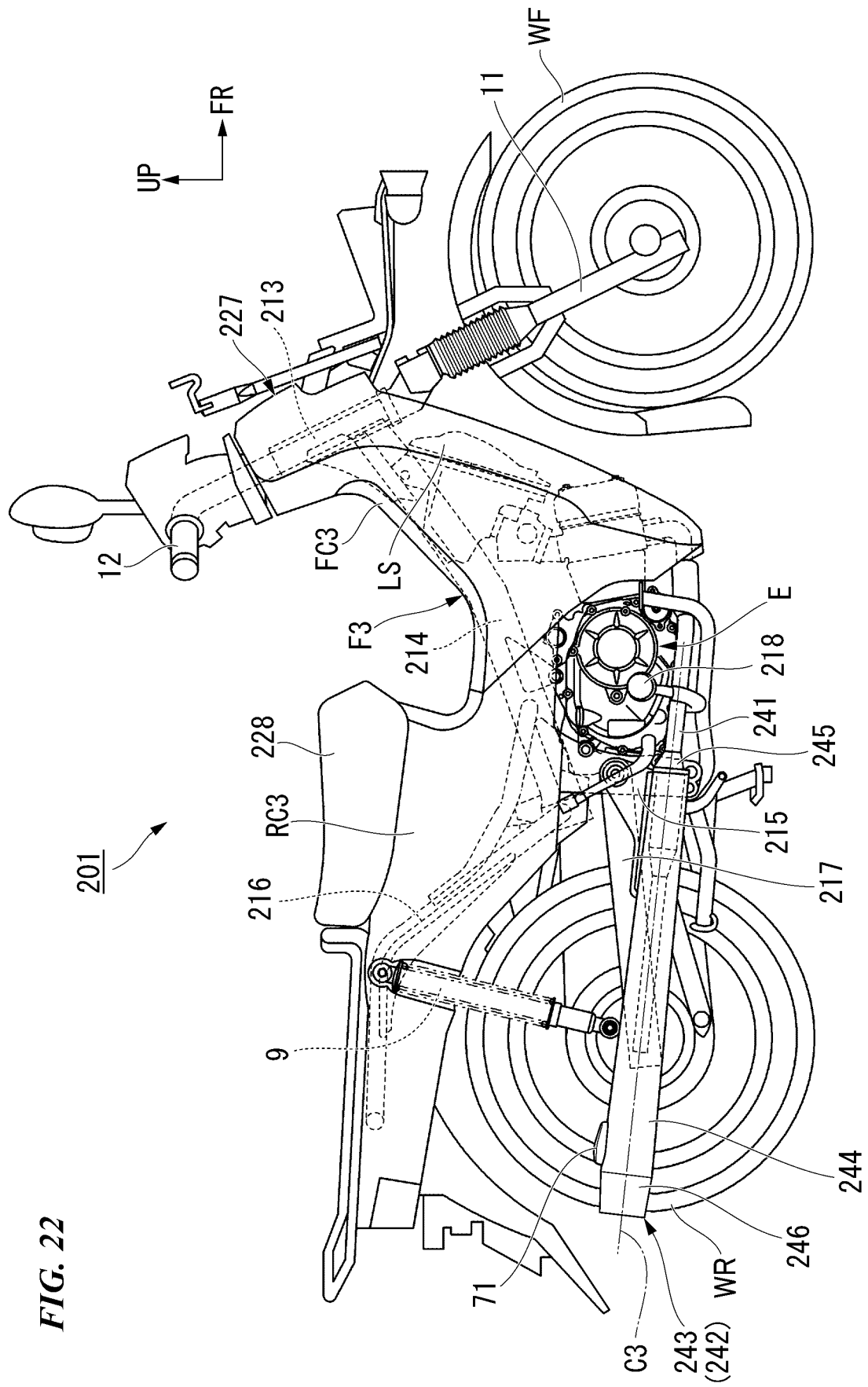


FIG. 23

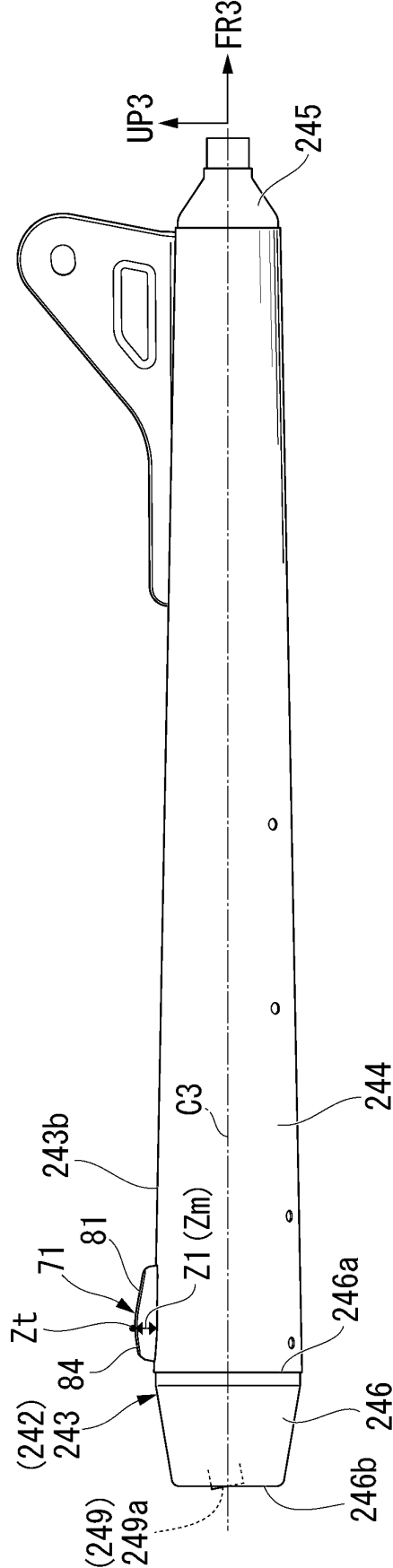


FIG. 24

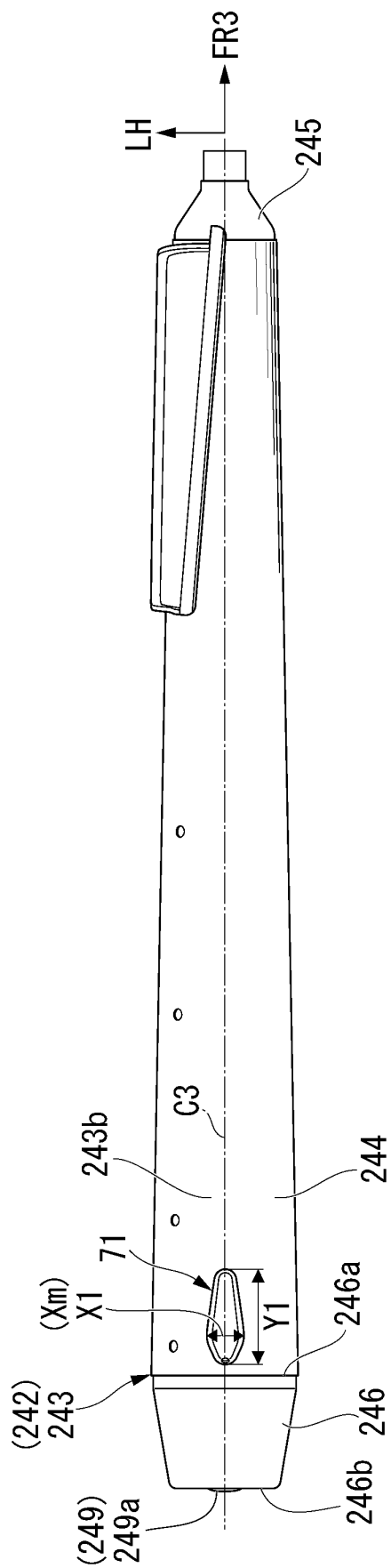
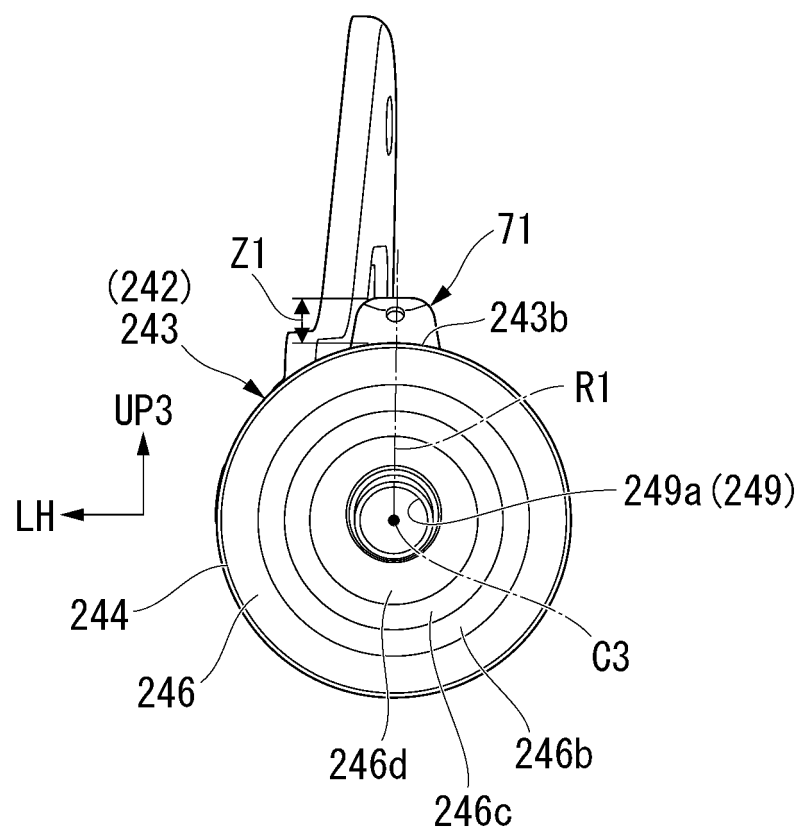


FIG. 25



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/006501

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A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F01N1/08 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

15

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. F01N1/08

20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2012-241639 A (HONDA MOTOR CO., LTD.) 10 December 2012, paragraphs [0032], [0038], [0039], fig. 5, 7, 10, 11, 13 (Family: none)	1-5, 9-10 6-8
Y A	JP 2006-77609 A (KANTO AUTO WORKS LTD.) 23 March 2006, paragraph [0006], fig. 10 (Family: none)	1-5, 9-10 6-8
Y A	JP 7-259531 A (CALSONIC CORP.) 09 October 1995, paragraphs [0019], [0021], [0027], [0030], fig. 5 (Family: none)	5 1-4, 6-10

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☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

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Date of the actual completion of the international search
22.03.2019

Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/006501

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 85049/1975 (Laid-open No. 846/1977) (HONDA MOTOR CO., LTD.) 06 January 1977, page 1, line 10 to page 2, line 8, fig. 2 (Family: none)	5 1-4, 6-10
A	JP 2006-17046 A (HONDA MOTOR CO., LTD.) 19 January 2006, paragraphs [0022]-[0036], fig. 3, 6, 8 & US 2006/0000668 A1, paragraphs [0045]-[0062], fig. 3, 6, 8 & EP 1612378 A2	1-10
A	JP 2005-155551 A (TOYOTA MOTOR CORPORATION) 16 June 2005, paragraphs [0020]-[0025], fig. 2, 4 & US 2005/0115764 A1, paragraphs [0021]-[0027], fig. 2, 4 & DE 102004057014 A1	1-10

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2009264293 A [0003]