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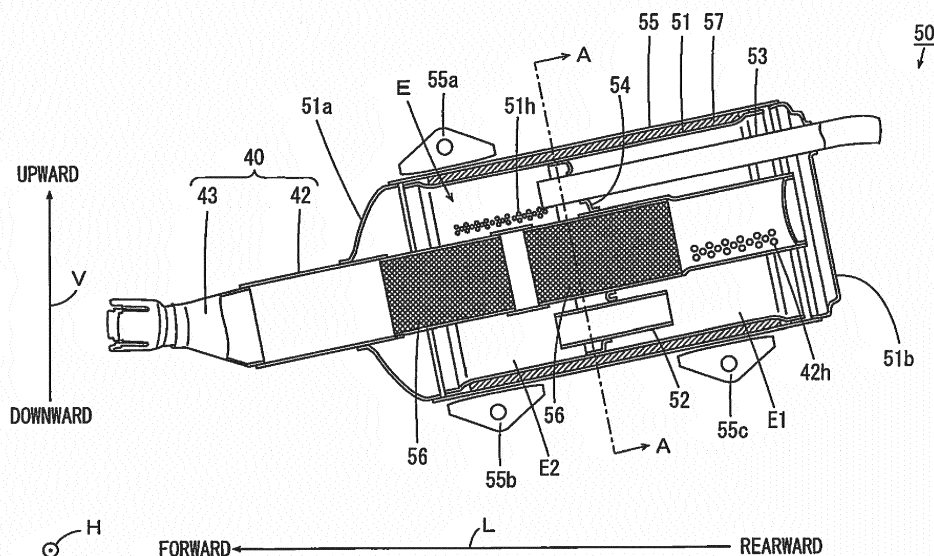
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(54) **STRADDLED VEHICLE**

(57) An upstream expansion chamber E1 and a downstream expansion chamber E2 are provided in an outer pipe 51. An exhaust pipe 40 extends to the upstream expansion chamber E1 through the downstream expansion chamber E2. An inner pipe 52 leads an exhaust gas from the upstream expansion chamber E1 to the downstream expansion chamber E2. An inner pipe 53 allows an exhaust gas to pass through the upstream expansion chamber E1 from the downstream expansion chamber E2 and be led to the outside of the outer pipe 51. In a vehicle side view, the inner pipes 52, 53 are

respectively arranged at a position further downward than the exhaust pipe 40 and a position further upward than the exhaust pipe 40. The outer pipe 51 is provided to incline such that a rear end is higher than a front end, and inclines to pass through a position further upward than an axle of a rear wheel. In a cross section orthogonal to a direction in which the outer pipe 51 extends, a dimension of the outer pipe 51 in a width direction is smaller than a dimension of the outer pipe 51 in a top-and-bottom direction.

**FIG. 6**



## Description

**[0001]** The present invention relates to a straddled vehicle including a silencer.

**[0002]** A silencer (a muffler device) is provided in a motorcycle in order to reduce the exhaust sound caused by the discharge of an exhaust gas from an engine (see JP 9-13942 A, for example). The muffler device (hereinafter referred to as the silencer) described in JP 9-13942 A includes a cylindrical main body. In the cylindrical main body, first, third and second expansion chambers are provided in this order from the front towards the rear. The exhaust gas discharged from the engine passes through an exhaust pipe and is led to the inside of the cylindrical main body from the front.

**[0003]** In the cylindrical main body, the exhaust gas flows along the exhaust pipe to the second expansion chamber at the rear, then makes a U-turn to be led to the first expansion chamber, and expands in the first expansion chamber. The exhaust gas that has expanded in the first expansion chamber is led to the second expansion chamber by a first coupling pipe and expands in the second expansion chamber. The exhaust gas that has expanded in the second expansion chamber is led to the third expansion chamber by a second coupling pipe and expands in the third expansion chamber. The exhaust gas that has expanded in the third expansion chamber is discharged to the air through a tail pipe.

**[0004]** In a unit swing type engine, the silencer swings together with the swing of the engine. In particular, when the motorcycle banks at a curve or the like, the silencer deviates downward due to swing characteristics of the engine and a suspension. In the case where the motorcycle banks while largely accelerating or largely decelerating, this tendency is more sufficiently increased. Therefore, it is desired that a bank angle of the motorcycle is increased.

**[0005]** The silencer described in JP 9-13942 A is fixed to incline with respect to a vehicle main body such that a rear end is located at a position further upward than a front end. The inventors of the present application have considered that it is possible to increase the bank angle of the motorcycle by allowing the silencer to incline. On the other hand, in the case where the silencer inclines, the size of the motorcycle is increased in a width direction due to the overlap of the silencer with a portion projecting in the width direction of the vehicle main body. For a straddled vehicle such as the motorcycle, an increase in dimension in the width direction is not desired. In this manner, an increase in bank angle and inhibition of an increase in dimension in the width direction are conflicting requirements.

**[0006]** It is an object of the present invention to provide a straddled vehicle that includes a silencer capable of inhibiting an increase in dimension in a width direction while being capable of increasing a bank angle.

**[0007]** A straddled vehicle according to one aspect of the present invention includes a body frame, a unit swing

type engine swingably attached to the body frame, a swingarm swingably provided at the engine, a drive wheel rotated by motive power of the engine, an exhaust pipe connected to a cylinder head of the engine, and a silencer that is connected to the exhaust pipe and has an expansion chamber inside, wherein the engine includes a crankcase that is configured to store a crankshaft and a belt case that is configured to store a transmission mechanism, an oil storage that is configured to store oil is formed in a lower portion in the crankcase, a light-transmitting window portion through which a height of a liquid surface of the oil stored in the oil storage is viewable is provided at an outer surface of the crankcase, the exhaust pipe is configured to overlap with the crankcase in a vehicle side view, the window portion is arranged at a position further downward than the exhaust pipe, the silencer includes an outer pipe, a separator that is arranged in the outer pipe and is configured to section the expansion chamber into an upstream expansion chamber and a downstream expansion chamber, and a plurality of inner pipes that are configured to penetrate the separator and connect the upstream expansion chamber to the downstream expansion chamber, the upstream expansion chamber is arranged at a position further rearward than the downstream expansion chamber in the vehicle side view, the exhaust pipe, in the outer pipe, is configured to pass through the downstream expansion chamber, is configured to penetrate the separator and is configured to extend to the upstream expansion chamber, the plurality of inner pipes include a first inner pipe that, in the outer pipe, is configured to penetrate the separator and is configured to lead an exhaust gas from the upstream expansion chamber to the downstream expansion chamber, and a second inner pipe that, in the outer pipe, is configured to penetrate the separator, allows an exhaust gas to pass through the upstream expansion chamber from the downstream expansion chamber and be led to outside of the outer pipe, and is configured to project from a rear end of the outer pipe, the first inner pipe is arranged at a position further upward or further downward than the exhaust pipe in the vehicle side view, the second inner pipe, in the vehicle side view, is arranged to be opposite to the first inner pipe with the exhaust pipe sandwiched therebetween, the drive wheel is supported between the belt case and the swingarm, the swingarm is located between the outer pipe and the drive wheel in a vehicle plan view, the outer pipe is configured to extend in a vehicle front-and-rear direction in the vehicle plan view, is configured to overlap with the swingarm in the vehicle side view, is configured to incline such that a rear end of the outer pipe is higher than a front end, and is configured to incline to pass through a position further upward than an axle of the drive wheel, and a dimension of the outer pipe in a width direction is smaller than a dimension of the outer pipe in a top-and-bottom direction in a cross section orthogonal to a direction in which the outer pipe extends.

**[0008]** In this straddled vehicle, the unit swing type en-

gine is swingably attached to the body frame. Further, the swingarm is swingably provided at the engine. The drive wheel is supported between the belt case of the engine and the swingarm. The swingarm is located between the outer pipe of the silencer and the drive wheel in the vehicle plan view. The drive wheel is rotated by motive power of the engine. The cylinder head of the engine and the silencer are connected to each other by the exhaust pipe.

**[0009]** The expansion chamber in the outer pipe is sectioned into the upstream expansion chamber and the downstream expansion chamber by the separator. The upstream expansion chamber is located at a position further rearward than the downstream expansion chamber in the vehicle side view. In the outer pipe, the exhaust pipe passes through the downstream expansion chamber, penetrates the separator and extends to the upstream expansion chamber. In the outer pipe, the first inner pipe penetrates the separator. The second inner pipe penetrates the separator from the downstream expansion chamber in the outer pipe, passes through the upstream expansion chamber and projects from the rear end of the outer pipe.

**[0010]** In this configuration, the exhaust gas from the engine is led to the upstream expansion chamber in the outer pipe through the exhaust pipe and expands in the upstream expansion chamber. The exhaust gas that has expanded in the upstream expansion chamber is led to the downstream expansion chamber through the first inner pipe and expands in the downstream expansion chamber. The exhaust gas that has expanded in the downstream expansion chamber passes through the second inner pipe and is discharged to the outside from the rear end of the outer pipe.

**[0011]** The first inner pipe is arranged at a position further upward or further downward than the exhaust pipe in the vehicle side view, and the second inner pipe is arranged to be opposite to the first pipe with the exhaust pipe sandwiched therebetween in the vehicle side view. Due to such arrangement, a dimension of the outer pipe in the width direction can be reduced to be sufficiently smaller than a dimension in the top-and-bottom direction. Therefore, even in the configuration in which the outer pipe overlaps with the swingarm due to the inclination of the outer pipe with the rear end of the outer pipe located at a position higher than the front end, an increase in dimension of the straddled vehicle including the silencer in the width direction is inhibited. As a result, the bank angle of the straddled vehicle can be increased, and an increase in dimension of the straddled vehicle in the width direction can be inhibited.

**[0012]** Further, in the vehicle side view, the outer pipe overlaps with the swingarm, inclines such that the rear end of the outer pipe is located at a position higher than the front end, and inclines to pass through a position further upward than the axle of the drive wheel. Therefore, the outer pipe does not overlap with the axle of the drive wheel in the vehicle side view. Thus, the rider can easily

perform the daily inspection for checking a state of the axle of the drive wheel from the side surface of the vehicle.

**[0013]** Further, because the exhaust pipe is arranged at a sufficiently high position to overlap with the crankcase in the vehicle side view, the window portion can be arranged at a position further downward than the exhaust pipe not to overlap with the exhaust pipe. Thus, the rider can check a remaining amount of the oil by viewing a height of a liquid surface of the oil through the window portion. Further, because the rider can check the remaining amount of the oil from the window portion, it is not necessary that the crankcase is configured to enable the attachment of a bar-shape oil level gauge to the crankcase. Further, it is not necessary to ensure a space for enabling attachment and detachment of the oil level gauge in an upper portion of the crankcase. Thus, the space can be effectively utilized.

**[0014]** The straddled vehicle may further include a storage box provided at a position further upward than the engine, wherein an oil filling port through which the oil storage is filled with oil may be formed at the crankcase, and the oil filling port may be arranged to overlap with the storage box in the vehicle plan view. In this case, the size of the storage box provided at a position further upward than the engine can be increased.

**[0015]** A rear portion of the second inner pipe may be curved in the vehicle plan view such that a rear end opening of the second inner pipe is directed obliquely outward. In this configuration, even in the case where the rear end opening of the second inner pipe is located near the license plate in a rear portion of the vehicle due to the inclination of the outer pipe, contamination of the license plate caused by an exhaust gas discharged from the second inner pipe can be prevented. Further, because an exhaust gas is not blowing at the license plate, generation of an abnormal noise caused by vibration of the license plate can be prevented.

**[0016]** Inclination of a center axis of the rear portion of the second inner pipe with respect to the vehicle front-and-rear direction may be 30 degrees or less in the vehicle plan view. In this case, an exhaust gas can be prevented from being discharged sideward from the second inner pipe of the silencer.

**[0017]** A catalytic converter may be provided inside of the outer pipe. In this case, the exhaust gas discharged from the outer pipe can be cleaned. Further, the catalytic converter is provided in the outer pipe located at the downstream of the exhaust pipe, thereby not coming into contact with an excessively high temperature exhaust gas. Thus, the catalytic converter can be prevented from melting.

**[0018]** The outer pipe may be oblong or elliptical in a cross section orthogonal to a direction in which the outer pipe extends. In this case, the outer pipe can be easily manufactured while a dimension of the outer pipe in the width direction is reduced to be smaller than a dimension of the outer pipe in the top-and-down direction.

**[0019]** The second inner pipe may be arranged at a position further upward than a center of the outer pipe in the top-and-bottom direction. In this case, an entrance of foreign objects stirred up from the ground surface due to the travel of the straddled vehicle into the outer pipe from the second inner pipe can be prevented.

**[0020]** The second inner pipe may be arranged at a position further upward than the first inner pipe. In this case, the second inner pipe can be easily arranged at a position further upward than the center of the outer pipe in the top-and-bottom direction.

**[0021]** An inner diameter of the exhaust pipe, in the outer pipe, may be larger than an inner diameter of the first inner pipe and an inner diameter of the second inner pipe. In this case, an increase in size of the outer pipe in the top-and-bottom direction can be prevented.

**[0022]** An inner diameter of the second inner pipe may be smaller than an inner diameter of the first inner pipe. In this configuration, because the inner diameter of the second inner pipe is small, even in the case where the second inner pipe is arranged to pass through the upstream expansion chamber, a reduction in volume of the upstream expansion chamber can be prevented.

**[0023]** The exhaust pipe may have a first portion having a first inner diameter and a second portion having a second diameter, the first portion of the exhaust pipe may be connected to an exhaust port of the cylinder head, the second portion of the exhaust pipe may penetrate the separator from the upstream expansion chamber, may pass through the downstream expansion chamber and may project from a front portion of the outer pipe by a predetermined distance, and the second inner diameter may be larger than the first inner diameter. In this configuration, the strength of the second portion of the exhaust pipe can be improved. Thus, even in the case where the outer pipe is arranged to incline, the outer pipe can be firmly supported by the second portion of the exhaust pipe.

**[0024]** An upper end at a rear end of the silencer may be located at a position further upward than an upper end of a head cover of the cylinder head. In this case, because the rear end of the silencer inclines sufficiently upward, the bank angle of the straddled vehicle can be more sufficiently increased. Further, the exhaust path for the exhaust gas can be more sufficiently lengthened.

**[0025]** A lower end of the silencer may be located at a position further upward than a lower end of the crankcase and further rearward than a rear end of the crankcase in the vehicle side view. In this case, because the silencer is located sufficiently upwardly, the bank angle of the straddled vehicle can be more sufficiently increased.

**[0026]** A lower end of the exhaust pipe may be located at a position further upward than a lower end of the crankcase in the vehicle side view. In this case, because the exhaust pipe is located sufficiently upwardly, the bank angle of the straddled vehicle can be more sufficiently increased.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

### [0027]

Fig. 1 is a schematic side view showing a schematic configuration of a motorcycle according to one embodiment;

Fig. 2 is a diagram mainly showing a body frame of the motorcycle of Fig. 1;

Fig. 3 is a schematic enlarged plan view showing a schematic configuration of an engine and its periphery;

Fig. 4 is a schematic plan view showing a schematic configuration of the motorcycle of Fig. 1;

Fig. 5 is a plan view of a silencer;

Fig. 6 is a partial longitudinal cross sectional view of the silencer of Fig. 5;

Fig. 7 is a rear end view of the silencer of Fig. 5;

Fig. 8 is a cross sectional view taken along the line A-A of the silencer of Fig. 7; and

Fig. 9 is a diagram for explaining a detailed positional relationship between an exhaust pipe and the silencer.

**[0028]** A straddle vehicle according to one embodiment will be described below with reference to the drawings. In the following description, a motorcycle will be described as one example of the straddled vehicle. Further, in the following description, an upstream position and a downstream position are defined with reference to a flow of an exhaust gas.

### (1) Configuration of Motorcycle

**[0029]** Fig. 1 is a schematic side view showing a schematic configuration of the motorcycle according to the one embodiment. As shown in Fig. 1, the motorcycle 100 includes a swingarm 1, a storage box 2, a seat 3, a body frame 10 (Fig. 2, described below), a unit swing type engine 30, an exhaust pipe 40, a silencer 50 and a rear wheel 60.

**[0030]** In Fig. 1 and subsequent given diagrams, arrows suitably indicate a front-and-rear direction L, a width direction H and a top-and-bottom direction V of the motorcycle 100. A direction in which an arrow is directed in the front-and-rear direction L is referred to as forward, and its opposite direction is referred to as rearward. A direction in which an arrow is directed in the width direction H is referred to as leftward, and its opposite direction is referred to as rightward. A direction in which an arrow is directed in the top-and-bottom direction V is referred to as upward, and its opposite direction is referred to as downward.

**[0031]** Fig. 2 is a diagram mainly showing the body frame 10 of the motorcycle 100 of Fig. 1. In Fig. 2, dotted lines indicate the body frame 10. As shown in Fig. 2, the body frame 10 includes a main frame 11, a rear frame

12 and a head pipe 13. The main frame 11 extends obliquely rearward and downward from the head pipe 13 and further extends substantially horizontally. The rear frame 12 extends obliquely rearward and upward from a rear end of the main frame 11.

**[0032]** A steering shaft 21 is inserted into the head pipe 13 to be swingable in a left-and-right direction. A handle 23 is attached to an upper end of the steering shaft 21. A pair of fork pipes 22 is connected to the respective left and right of the steering shaft 21. A front wheel 24 is rotatably supported between lower portions of the pair of fork pipes 22.

**[0033]** The unit swing type engine 30 is provided at a position further downward than the main frame 11 and the rear frame 12. The storage box 2 (see Fig. 1) capable of storing personal belongings of a rider is provided at a position further upward than the engine 30. The storage box 2 is supported by the main frame 11 and the rear frame 12. The seat 3 is provided at a position further upward than the storage box 2. The seat 3 is also used as a lid of the storage box 2.

**[0034]** Fig. 3 is a schematic enlarged plan view showing a schematic configuration of the engine 30 and its periphery. Fig. 4 is a schematic plan view showing a schematic configuration of the motorcycle 100 of Fig. 1. In Fig. 4, one-dot and dash lines indicate portions except for the engine 30 and constituent elements of its periphery.

**[0035]** As shown in Fig. 3, the engine 30 includes a cylinder unit 31 and a unit case 32. The cylinder unit 31 is provided to extend obliquely forward and upward from a front portion of the unit case 32. The cylinder unit 31 is constituted by a cylinder body 31 a, a cylinder head 31 b and a head cover 31c. At the cylinder head 31 b, an exhaust port 31 p is formed.

**[0036]** In the present embodiment, as shown in Fig. 4, the unit case 32 has a configuration in which a crankcase 32a that stores a crankshaft and a belt case 32b that stores a transmission mechanism are integrally formed. The belt case 32b extends rearward from a left portion of the crankcase 32a. In the example of Fig. 4, a thick two-dots and dash line indicates a boundary portion between the crankcase 32a and the belt case 32b.

**[0037]** The crankcase 32a is swingably supported by the rear frame 12 of Fig. 2. The swingarm 1 is provided to extend rearward from a right rear portion of the crankcase 32a. The rear wheel 60 is rotatably held by a rear end of the belt case 32b and a rear end of the swingarm 1. The rear wheel 60 is rotated by a rotational force of the engine 30.

**[0038]** As shown in Fig. 3, the silencer 50 is attached to a right side surface of the swingarm 1 while inclining to pass through a position further upward than an axle 61 of the rear wheel 60 including a coupling member such as a bolt. In this case, because the silencer 50 does not overlap with the axle 61 of the rear wheel 60 in a vehicle side view, the rider can easily perform daily inspection for checking a state of the axle 61 from a side surface of

the vehicle.

**[0039]** The exhaust pipe 40 is constituted by an upstream pipe 41, a downstream pipe 42 and a tapered pipe 43. An inner diameter of the downstream pipe 42 is larger than an inner diameter of the upstream pipe 41. The tapered pipe 43 is formed in a tapered shape such that its inner diameter is gradually increased from an upstream position towards a downstream position. The upstream pipe 41 is connected to the exhaust port 31 p of the cylinder head 31b. The downstream pipe 42 is attached to the silencer 50. The tapered pipe 43 connects the upstream pipe 41 to the downstream pipe 42. The exhaust pipe 40 is arranged to extend rearward while overlapping with the crankcase 32a in the vehicle side view. An exhaust gas from the exhaust port 31 p is discharged to the outside through the exhaust pipe 40 and the silencer 50.

**[0040]** An oil storage 33 that stores oil is formed in a lower portion in the crankcase 32a. Further, an oil filling port 33a is formed at the crankcase 32a. The oil storage 33 can be filled with oil through the oil filling port 33a. A light-transmitting window portion 33b is provided at an outer surface of the crankcase 32a to overlap with a liquid surface of the oil stored in the oil storage 33.

**[0041]** Because the exhaust pipe 40 is arranged at a sufficiently high position to overlap with the crankcase 32a in the vehicle side view, the window portion 33b can be arranged at a position further downward than the exhaust pipe 40 not to overlap with the exhaust pipe 40. The window portion 33b is arranged at a position further downward than the exhaust pipe 40 not to overlap with the exhaust pipe 40 in the vehicle side view. The rider can check a remaining amount of the oil by viewing a height of the liquid surface of the oil stored in the oil storage 33 through the window portion 33b.

**[0042]** In this configuration, it is not necessary that the crankcase 32a is configured to enable the attachment of a bar-shape oil level gauge for checking a remaining amount of the oil to the crankcase 32a. Further, it is not necessary to ensure a space for enabling the attachment and detachment of the oil level gauge in an upper portion of the crankcase 32a. Then, in a vehicle plan view, as shown in Fig. 4, the oil filling port 33a is arranged to overlap with the storage box 2. Thus, the oil filling port 33a can be provided at the crankcase 32a while the storage box 2 is largely maintained.

## (2) Configuration of Silencer

**[0043]** Fig. 5 is a plan view of the silencer 50. Fig. 6 is a partial longitudinal cross sectional view of the silencer 50 of Fig. 5. Fig. 7 is a rear end view of the silencer 50 of Fig. 5. Fig. 8 is a cross sectional view taken along the line A-A of the silencer 50 of Fig. 7. As shown in Fig. 6, the silencer 50 includes an outer pipe 51, two inner pipes 52, 53, a separator 54 and a cover member 55.

**[0044]** The outer pipe 51 extends in the front-and-rear direction L in the vehicle plan view. A front portion of the

outer pipe 51 is closed by a bowl-shaped closing member 51 a, and a rear portion of the outer pipe 51 is closed by a flat closing member 51 b. The outer pipe 51 is elliptical in a cross section orthogonal to a direction in which the outer pipe 51 extends (see Fig. 8). An expansion chamber E is formed in the outer pipe 51. The inner pipe 52 and the separator 54 are provided in the outer pipe 51. Further, part of the downstream pipe 42 of the exhaust pipe 40 and part of the inner pipe 53 are provided in the outer pipe 51.

**[0045]** The separator 54 is arranged to section the expansion chamber E in the outer pipe 51 into an upstream expansion chamber E1 and a downstream expansion chamber E2. The upstream expansion chamber E1 is located at a position further rearward than the downstream expansion chamber E2 in the vehicle side view. The downstream pipe 42 is arranged to penetrate the closing member 51a that closes the front portion of the outer pipe 51. In the outer pipe 51, the downstream pipe 42 passes through the downstream expansion chamber E2, penetrates the separator 54 and extends to the upstream expansion chamber E1. The downstream end of the downstream pipe 42 is closed.

**[0046]** A catalytic converter 56 for cleaning an exhaust gas is provided inside of the downstream pipe 42 in the outer pipe 51. In the present embodiment, two catalytic converters 56 are arranged in the front-and-rear direction L. In a region of the downstream pipe 42 located in the upstream expansion chamber E1, a plurality of holes 42h that penetrate an inner peripheral surface and an outer peripheral surface are formed in the entire periphery. In Fig. 6, only part of holes 42h is drawn. The plurality of holes 42h are punched holes, for example. In the present embodiment, a shape of each hole 42h is a circle. Thus, the inside of the downstream pipe 42 and the upstream expansion chamber E1 communicate with each other.

**[0047]** The inner pipe 52 is arranged to penetrate the separator 54 and connect the upstream expansion chamber E1 to the downstream expansion chamber E2. The inner pipe 53 is arranged to penetrate the separator 54 from the downstream expansion chamber E2 in the outer pipe 51, passes through the upstream expansion chamber E1 and projects from the closing member 51 b at a rear portion of the outer pipe 51 (see Fig. 7). In the present embodiment, a rear portion of the inner pipe 53 is curved such that a rear end opening of the inner pipe 53 is directed obliquely outward.

**[0048]** In the vehicle plan view, an inclination angle  $\theta$  of a center axis of a rear portion of the inner pipe 53 with respect to the front-and-rear direction L (see Fig. 5) is preferably larger than 0 degree and 30 degrees or less. With this inclination angle  $\theta$ , even in the case where the rear end opening of the inner pipe 53 is located near a license plate in a rear portion of the vehicle, contamination of the license plate caused by an exhaust gas discharged from the inner pipe 53 can be prevented. Further, because an exhaust gas is not blowing at the license plate, generation of an abnormal noise caused by vibra-

tion of the license plate can be prevented. Further, an exhaust gas can be prevented from being discharged sideward from the inner pipe 53.

**[0049]** In the vehicle side view, the inner pipe 52 is arranged at a position further downward than the downstream pipe 42, and the inner pipe 53 is arranged at a position further upward than the downstream pipe 42 (see Fig. 8). An inner diameter of the downstream pipe 42 is larger than an inner diameter of each of the inner pipes 52, 53. Thus, an increase in size of the outer pipe 51 in the top-and-bottom direction can be prevented. Further, the inner pipes 52, 53 can be easily arranged in the outer pipe 51 having an elliptical cross section. Further, the inner diameter of the inner pipe 53 is smaller than the inner diameter of the inner pipe 52. Thus, even in the case where the inner pipe 53 is arranged to pass through the upstream expansion chamber E1, a reduction in volume of the upstream expansion chamber E1 can be prevented.

**[0050]** Further, the inner pipe 53 is arranged at a position further upward than a center of the outer pipe 51 in the top-and-bottom direction. In this case, an entrance of foreign objects stirred up from the ground surface due to the travel of the motorcycle 100 into the outer pipe 51 from the inner pipe 53 can be prevented.

**[0051]** An outer peripheral surface of the outer pipe 51 is covered by the cover member 55. A sound absorbing member 57 such as glass wool is provided between an outer peripheral surface of the outer pipe 51 and the cover member 55. In a region of the outer pipe 51 in which the downstream expansion chamber E2 is provided, a plurality of holes 51 h that penetrate an inner peripheral surface and the outer peripheral surface are formed in an entire periphery. In Fig. 6, only part of the holes 51h is drawn. The plurality of holes 51 h are punched holes, for example. In the present embodiment, a shape of each hole 51 h is a circle.

**[0052]** Three attachment portions 55a, 55b, 55c are provided at the cover member 55. The attachment portion 55a is arranged at a front upper portion in an outer peripheral surface of the cover member 55. The attachment portion 55b is arranged at a front lower portion in the outer peripheral surface of the cover member 55. The attachment portion 55c is arranged in a rear lower portion in the outer peripheral surface of the cover member 55.

**[0053]** The outer pipe 51 is arranged to overlap with the swingarm 1 (Fig. 2) in the vehicle side view. Thus, in the vehicle plan view, the swingarm 1 is located between the outer pipe 51 and the rear wheel 60 (Fig. 3). The outer pipe 51 inclines such that a rear end is higher than a front end, and inclines to pass through a position further upward than the axle 61 of the rear wheel 60. In this state, the attachment portions 55a to 55c of the cover member 55 are attached to the swingarm 1 by fixing members such as bolts. Thus, the silencer 50 is fixed.

**[0054]** Fig. 9 is a diagram for explaining a detailed positional relationship between the exhaust pipe 40 and the silencer 50. As shown in Fig. 9, a position P1 at an upper

end of a rear end of the silencer 50 is preferably arranged at a position further upward than a position P2 at an upper end of the head cover 31c of the cylinder head 31b. In this case, the rear end of the silencer 50 inclines sufficiently upwardly, so that a bank angle of the motorcycle 100 can be more sufficiently increased. Further, an exhaust path for an exhaust gas can be more sufficiently lengthened.

**[0055]** In the vehicle side view, a position P3 at a lower end of the silencer 50 is preferably arranged at a position further upward than a position P4 at a lower end of the crankcase 32a and further rearward than a position P5 at a rear end of the crankcase 32a. In this case, the silencer 50 is located sufficiently upwardly, so that the bank angle of the motorcycle 100 can be more sufficiently increased.

**[0056]** In the vehicle side view, a position P6 at a lower end of the exhaust pipe 40 is preferably arranged at a position further upward than the position P4 at the lower end of the crankcase 32a. In this case, the exhaust pipe 40 is located sufficiently upwardly, the back angle of the motorcycle 100 can be more sufficiently increased. In the present example, the upstream pipe 41 of the exhaust pipe 40 extends downward from the exhaust port 31 p and then extends to incline upward and rearward. Thus, the position P6 at the lower end of the exhaust pipe 40 is equivalent to the position P6 at a lower end of the upstream pipe 41.

### (3) Effects

**[0057]** In the motorcycle 100 according to the present embodiment, an exhaust gas discharged from the cylinder head 31b is led to a downstream position from an upstream position and through the exhaust pipe 40, and is cleaned by passing through the catalytic converter 56 provided in the downstream pipe 42. In the unit swing type engine 30, the exhaust path is relatively short. Therefore, when being arranged at upstream of the exhaust path, the catalytic converter 56 is likely to melt by coming into contact with an excessively high temperature exhaust gas. In the present example, the catalytic converter 56 is provided in the downstream pipe 42 in the outer pipe 51 located at downstream of the exhaust path, thereby not coming into contact with an excessively high temperature exhaust gas. Thus, the catalytic converter 56 can be prevented from melting.

**[0058]** The exhaust gas that has passed through the catalytic converter 56 is led to the upstream expansion chamber E1 through the plurality of holes 42h of the downstream pipe 42 and expands in the upstream expansion chamber E1. The exhaust gas that has expanded in the upstream expansion chamber E1 is led to the downstream expansion chamber E2 through the inner pipe 52 and expands in the downstream expansion chamber E2. Part of the exhaust gas that has expanded in the downstream expansion chamber E2 is led to the sound absorbing member 57 through the plurality of

holes 51 h of the outer pipe 51, and the sound of the exhaust gas is absorbed by the sound absorbing member 57. Another part of the exhaust gas that has expanded in the downstream expansion chamber E2 passes through the inner pipe 53 and is discharged to the outside from the rear end of the outer pipe 51.

**[0059]** In the vehicle side view, the inner pipe 52 is arranged at a position further downward than the downstream pipe 42, and the inner pipe 53 is arranged at a position further upward than the downstream pipe 42. This arrangement enables a dimension of the outer pipe 51 in the width direction to be sufficiently smaller than a dimension of the outer pipe 51 in the top-and-bottom direction. Therefore, even in the configuration in which the outer pipe 51 overlaps with the swingarm 1 due to the inclination of the outer pipe 51 with the rear end of the outer pipe 51 located at a position higher than the front end, an increase in dimension of the motorcycle 100 including the silencer 50 in the width direction H is inhibited. As a result, the bank angle of the motorcycle 100 can be increased, and an increase in dimension of the motorcycle 100 in the width direction H can be inhibited.

**[0060]** Further, the rider sometimes prefers the design of the configuration in which the silencer 50 (the outer pipe 51) is arranged to incline. Therefore, the silencer 50 is provided at the swingarm 1 while inclining, so that the commercial value of the motorcycle 100 can be improved.

**[0061]** Further, the downstream pipe 42 projects from the closing member 51 a at the front portion of the outer pipe 51 by a predetermined distance. Because the inner diameter of the downstream pipe 42 is larger than the inner diameter of the upstream pipe 41, the strength of the downstream pipe 42 is larger than the strength of the upstream pipe 41. Therefore, even in the case where the outer pipe 51 is arranged to incline, it is possible to more firmly support the outer pipe 51 by arranging the downstream pipe 42 as described above.

### (4) Other Embodiments

**[0062]** While the outer pipe 51 has an elliptical cross section in the above-mentioned embodiment, the present invention is not limited to this. The outer pipe 51 may have an oblong cross section. Alternatively, as long as the dimension of the outer pipe 51 in the width direction is smaller than the dimension of the outer pipe 51 in the top-and-bottom direction in a cross sectional orthogonal to the direction in which the outer pipe 51 extends, the outer pipe 51 may have a cross section in another shape.

### (5) Correspondences between Constituent Elements in Claims and Parts in Preferred Embodiments

**[0063]** In the following paragraphs, non-limiting examples of correspondences between various elements recited in the claims below and those described above with respect to various preferred embodiments are explained.

**[0064]** In the above-mentioned embodiment, the body frame 10 is an example of a body frame, the engine 30 is an example of an engine, the swingarm 1 is an example of a swingarm, and the rear wheel 60 is an example of a drive wheel. The cylinder head 31 b is an example of a cylinder head, the exhaust pipe 40 is an example of an exhaust pipe, the expansion chamber E is an example of an expansion chamber, the upstream expansion chamber E1 is an example of an upstream expansion chamber, and the downstream expansion chamber E2 is an example of a downstream expansion chamber.

**[0065]** The silencer 50 is an example of a silencer, the crankcase 32a is an example of a crankcase, the belt case 32b is an example of a belt case, and the oil storage 33 is an example of an oil storage. The window portion 33b is an example of a window portion, the outer pipe 51 is an example of an outer pipe, the separator 54 is an example of a separator, the inner pipe 52 is an example of an inner pipe and a first inner pipe, and the inner pipe 53 is an example of an inner pipe and a second inner pipe.

**[0066]** The axle 61 is an example of an axle, the motorcycle 100 is an example of a straddled vehicle, the storage box 2 is an example of a storage box, and the oil filling port 33a is an example of an oil filling port. The catalytic converter 56 is an example of a catalytic converter, the upstream pipe 41 is an example of a first portion, the downstream pipe 42 is an example of a second portion, the exhaust port 31 p is an example of an exhaust port, and the head cover 31c is an example of a head cover.

**[0067]** As each of constituent elements recited in the claims, various other elements having configurations or functions described in the claims can be also used.

**[0068]** The present invention can be effectively utilized for various types of straddled vehicles including silencers.

## Claims

### 1. A straddled vehicle (100) comprising:

a body frame (10);  
 a unit swing type engine (30) swingably attached to the body frame (10);  
 a swingarm (1) swingably provided at the engine (30);  
 a drive wheel (60) rotated by motive power of the engine (30);  
 an exhaust pipe (40) connected to a cylinder head (31 b) of the engine (30); and  
 a silencer (50) that is connected to the exhaust pipe (40) and has an expansion chamber (E) inside, wherein  
 the engine (30) includes a crankcase (32a) that is configured to store a crankshaft and a belt case (32b) that is configured to store a transmission mechanism,

an oil storage (33) that is configured to store oil is formed in a lower portion in the crankcase (32a),

a light-transmitting window portion (33b) through which a height of a liquid surface of the oil stored in the oil storage (33) is viewable is provided at an outer surface of the crankcase (32a),

the exhaust pipe (40) is configured to overlap with the crankcase (32a) in a vehicle side view, the window portion (33b) is arranged at a position further downward than the exhaust pipe (40),

the silencer (50) includes

an outer pipe (51);

a separator (54) that is arranged in the outer pipe (51) and is configured to section the expansion chamber (E) into an upstream expansion chamber (E1) and a downstream expansion chamber (E2), and

a plurality of inner pipes that are configured to penetrate the separator (54) and connect the upstream expansion chamber (E1) to the downstream expansion chamber (E2),

the upstream expansion chamber (E1) is arranged at a position further rearward than the downstream expansion chamber (E2) in the vehicle side view,

the exhaust pipe (40), in the outer pipe (51), is configured to pass through the downstream expansion chamber (E2), is configured to penetrate the separator (54) and is configured to extend to the upstream expansion chamber (E1), the plurality of inner pipes include

a first inner pipe (52) that, in the outer pipe (51), is configured to penetrate the separator (54) and is configured to lead an exhaust gas from the upstream expansion chamber (E1) to the downstream expansion chamber (E2), and

a second inner pipe (53) that, in the outer pipe (51), is configured to penetrate the separator (54), allows an exhaust gas to pass through the upstream expansion chamber (E1) from the downstream expansion chamber (E2) and be led to outside of the outer pipe (51), and is configured to project from a rear end of the outer pipe (51),

the first inner pipe (52) is arranged at a position further upward or further downward than the exhaust pipe (40) in the vehicle side view,

the second inner pipe (53), in the vehicle side view, is arranged to be opposite to the first inner pipe (52) with the exhaust pipe (40) sandwiched therebetween,

the drive wheel (60) is supported between the belt case (32b) and the swingarm (1),

the swingarm (1) is located between the outer pipe (51) and the drive wheel (60) in a vehicle



- plan view,  
the outer pipe (51) is configured to extend in a vehicle front-and-rear direction (L) in the vehicle plan view, is configured to overlap with the swingarm (1) in the vehicle side view, is configured to incline such that a rear end of the outer pipe (51) is higher than a front end, and is configured to incline to pass through a position further upward than an axle (61) of the drive wheel (60), and  
a dimension of the outer pipe (51) in a width direction (H) is smaller than a dimension of the outer pipe (51) in a top-and-bottom direction (V) in a cross section orthogonal to a direction in which the outer pipe (51) extends.
2. The straddled vehicle (100) according to claim 1, further comprising a storage box (2) provided at a position further upward than the engine (30), wherein an oil filling port (33a) through which the oil storage (33) is filled with oil is formed at the crankcase (32a), and  
the oil filling port (33a) is arranged to overlap with the storage box (2) in the vehicle plan view.
  3. The straddled vehicle (100) according to claim 1 or 2, wherein  
a rear portion of the second inner pipe (53) is curved in the vehicle plan view such that a rear end opening of the second inner pipe (53) is directed obliquely outward.
  4. The straddled vehicle (100) according to claim 3, wherein  
inclination of a center axis of the rear portion of the second inner pipe (53) with respect to the vehicle front-and-rear direction (L) is 30 degrees or less in the vehicle plan view.
  5. The straddled vehicle (100) according to any one of claims 1 to 4, wherein  
a catalytic converter (56) is provided inside of the outer pipe (51).
  6. The straddled vehicle (100) according to any one of claims 1 to 5, wherein  
the outer pipe (51) is oblong or elliptical in a cross section orthogonal to a direction in which the outer pipe (51) extends.
  7. The straddled vehicle (100) according to any one of claims 1 to 6, wherein  
the second inner pipe (53) is arranged at a position further upward than a center of the outer pipe (51) in the top-and-bottom direction (V).
  8. The straddled vehicle (100) according to claim 7, wherein  
the second inner pipe (53) is arranged at a position further upward than the first inner pipe (52).
  9. The straddled vehicle (100) according to any one of claims 1 to 8, wherein  
an inner diameter of the exhaust pipe (40), in the outer pipe (51), is larger than an inner diameter of the first inner pipe (52) and an inner diameter of the second inner pipe (53).
  10. The straddled vehicle (100) according to any one of claims 1 to 9, wherein  
an inner diameter of the second inner pipe (53) is smaller than an inner diameter of the first inner pipe (52).
  11. The straddled vehicle (100) according to any one of claims 1 to 10, wherein  
the exhaust pipe (40) has a first portion (41) having a first inner diameter and a second portion (42) having a second diameter,  
the first portion (41) of the exhaust pipe (40) is connected to an exhaust port (31 p) of the cylinder head (31 b),  
the second portion (42) of the exhaust pipe (40) is configured to penetrate the separator (54) from the upstream expansion chamber (E1), is configured to pass through the downstream expansion chamber (E2) and is configured to project from a front portion of the outer pipe (51) by a predetermined distance, and  
the second inner diameter is larger than the first inner diameter.
  12. The straddled vehicle (100) according to any one of claims 1 to 11, wherein  
an upper end at a rear end of the silencer (50) is located at a position further upward than an upper end of a head cover of the cylinder head (31 b).
  13. The straddled vehicle (100) according to any one of claims 1 to 12, wherein  
a lower end of the silencer (50) is located at a position further upward than a lower end of the crankcase (32a) and further rearward than a rear end of the crankcase (32a) in the vehicle side view.
  14. The straddled vehicle (100) according to any one of claims 1 to 13, wherein  
a lower end of the exhaust pipe (40) is located at a position further upward than a lower end of the crankcase (32a) in the vehicle side view.

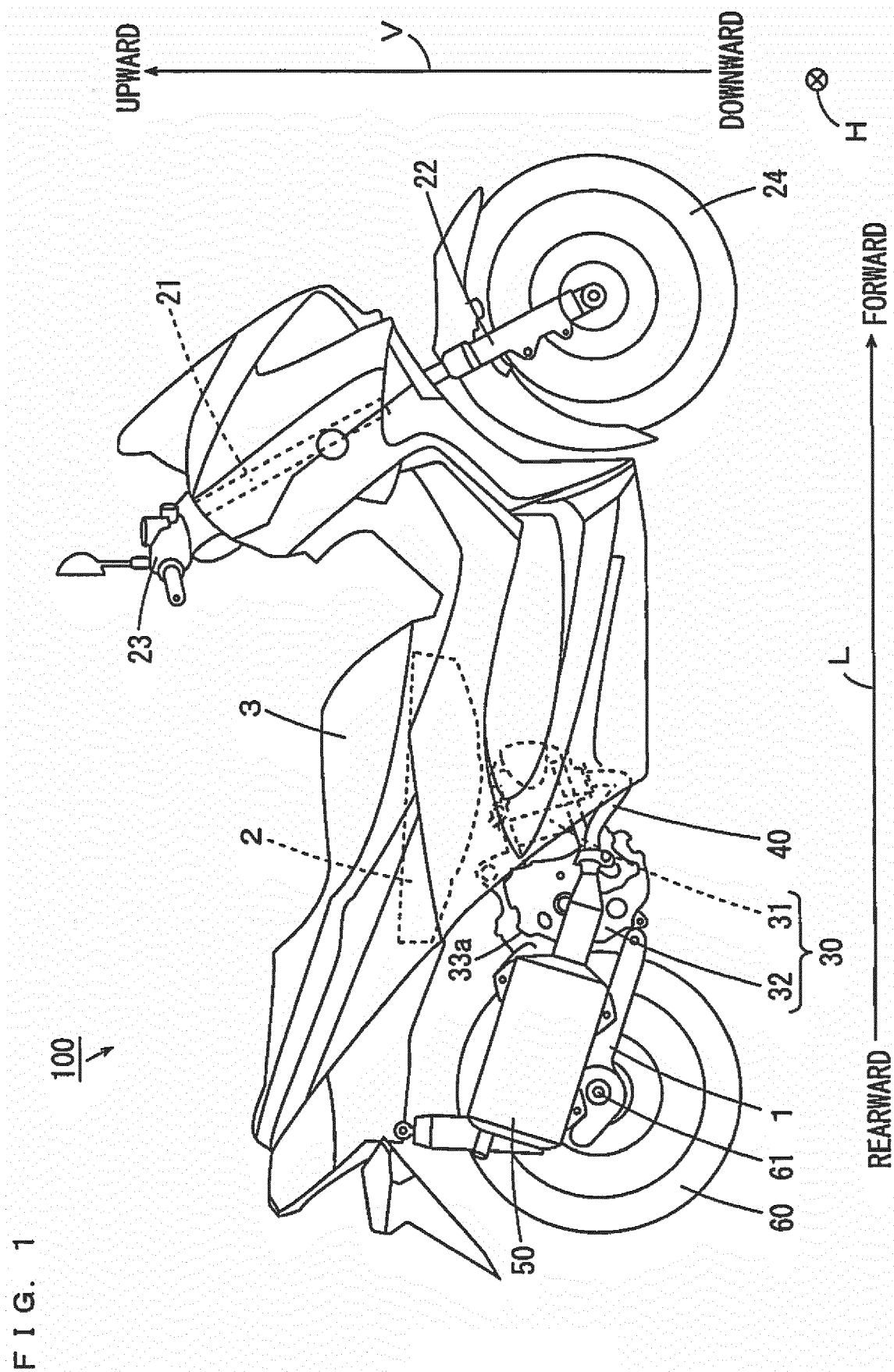
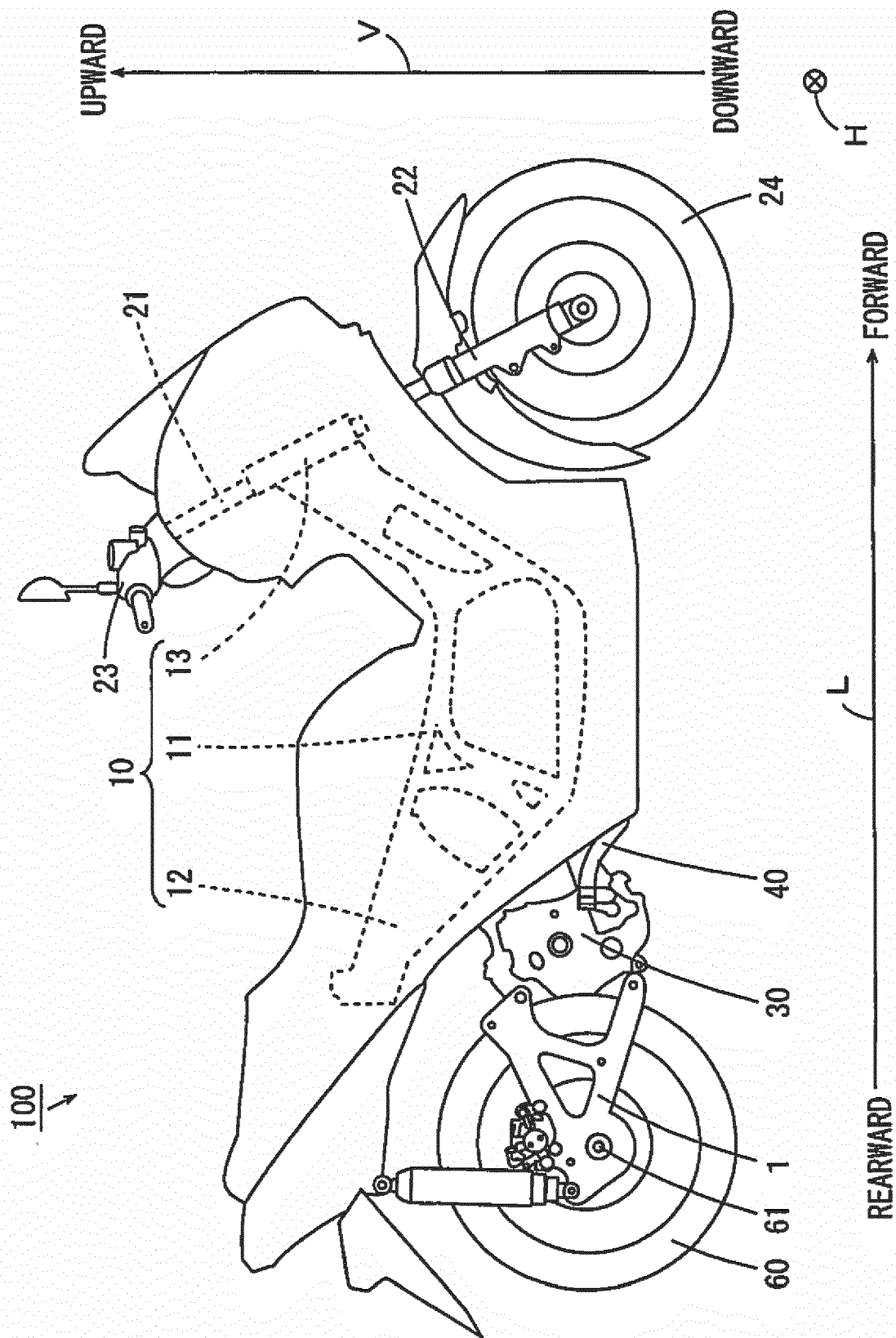


FIG. 2



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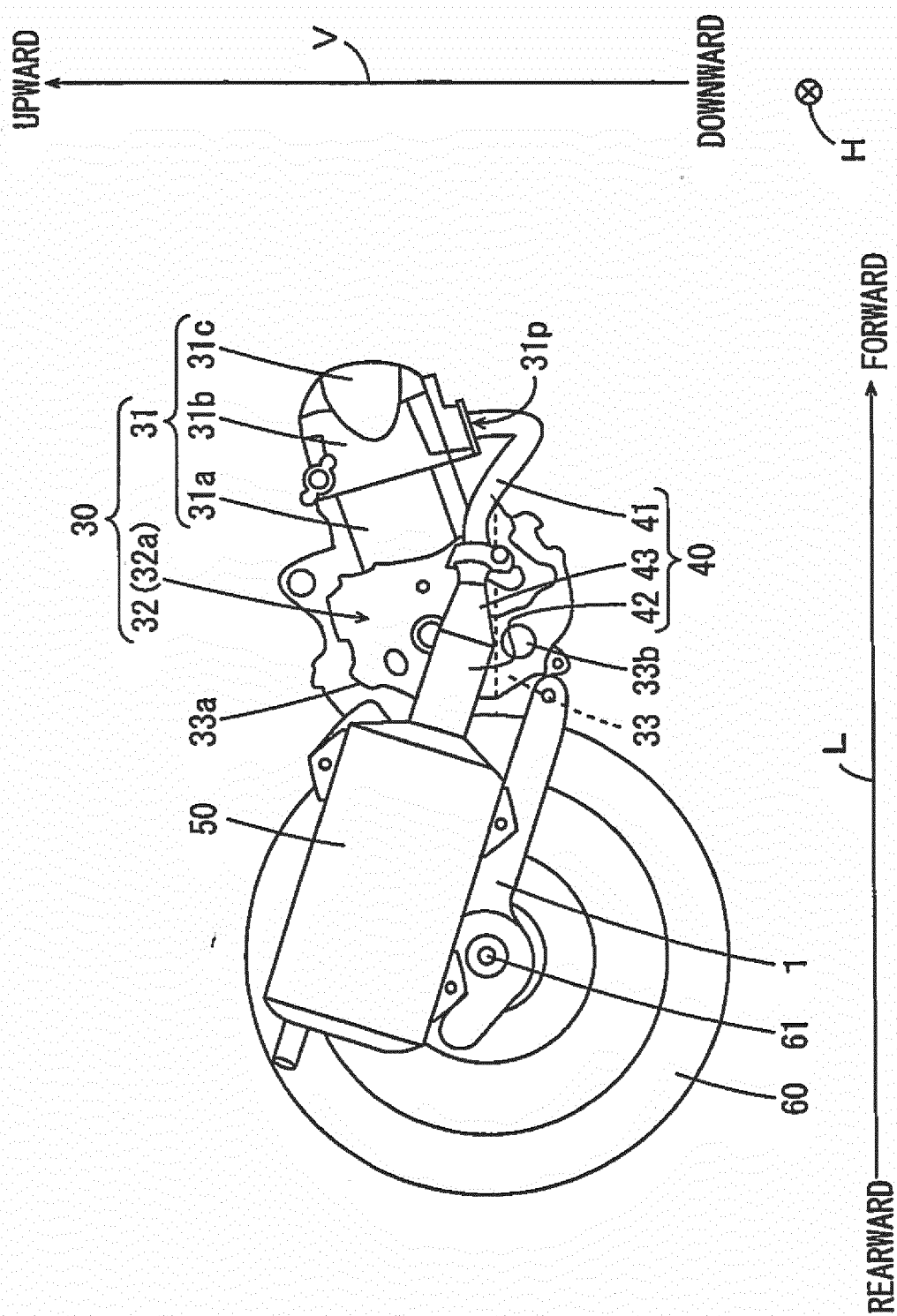


FIG. 4

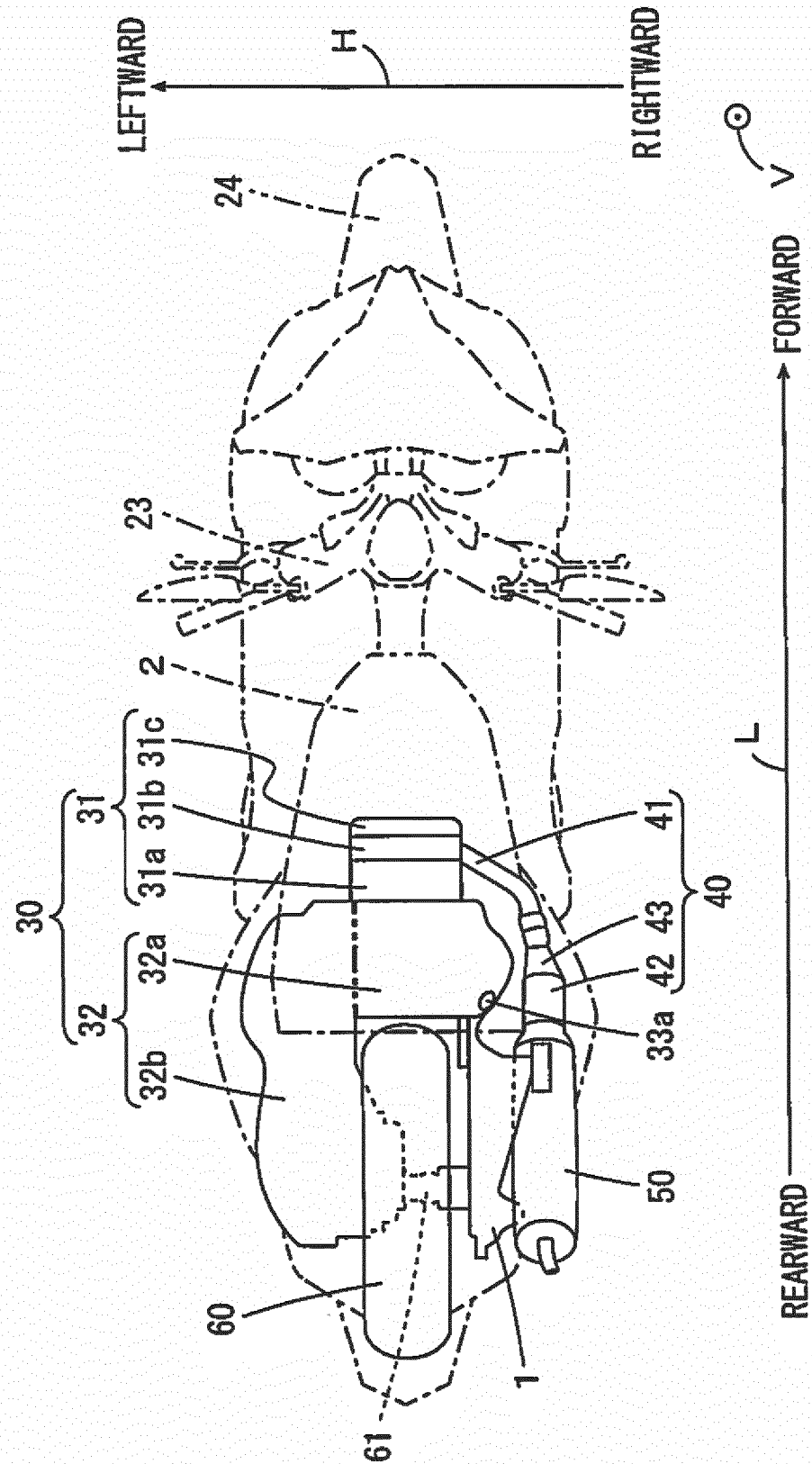


FIG. 5

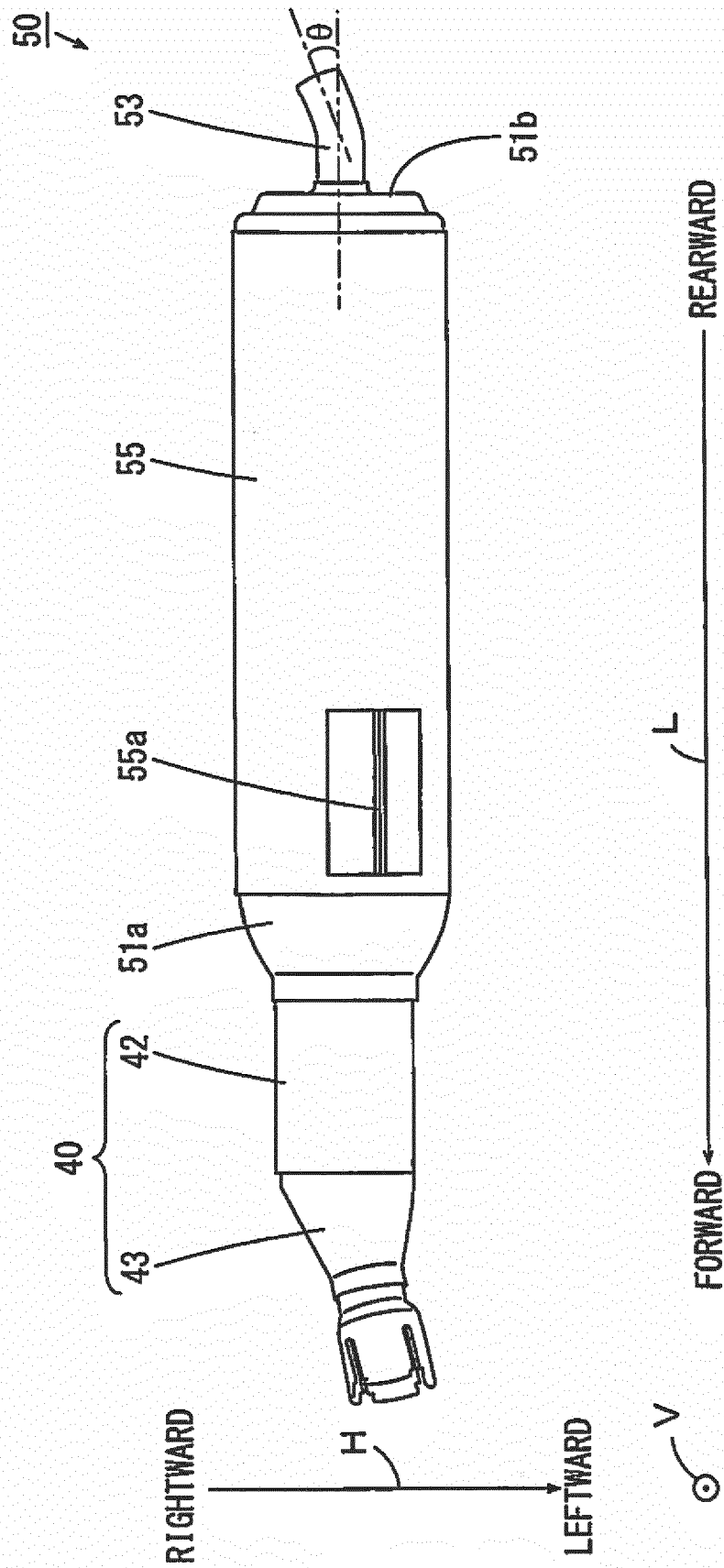


FIG. 6

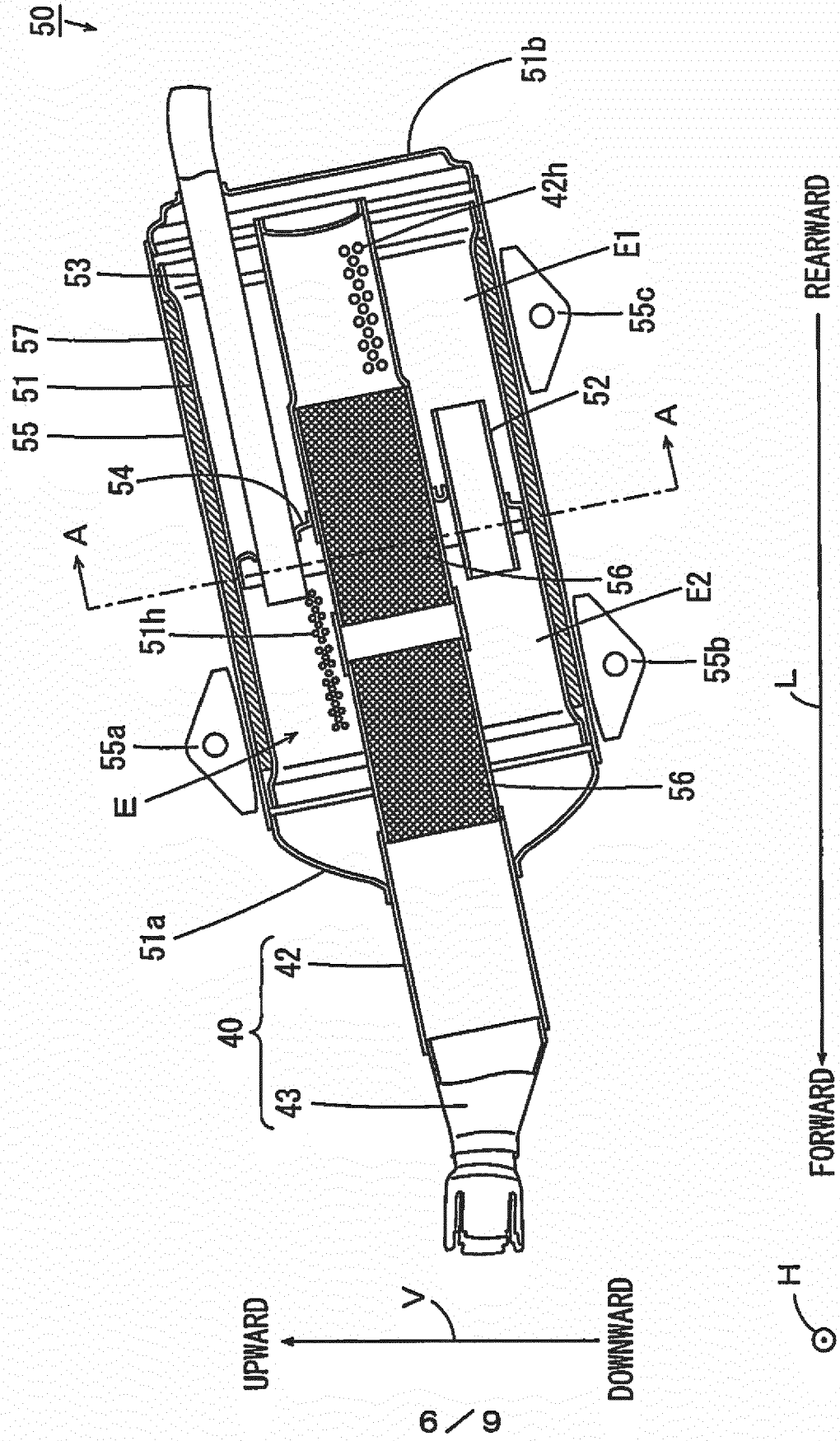


FIG. 7

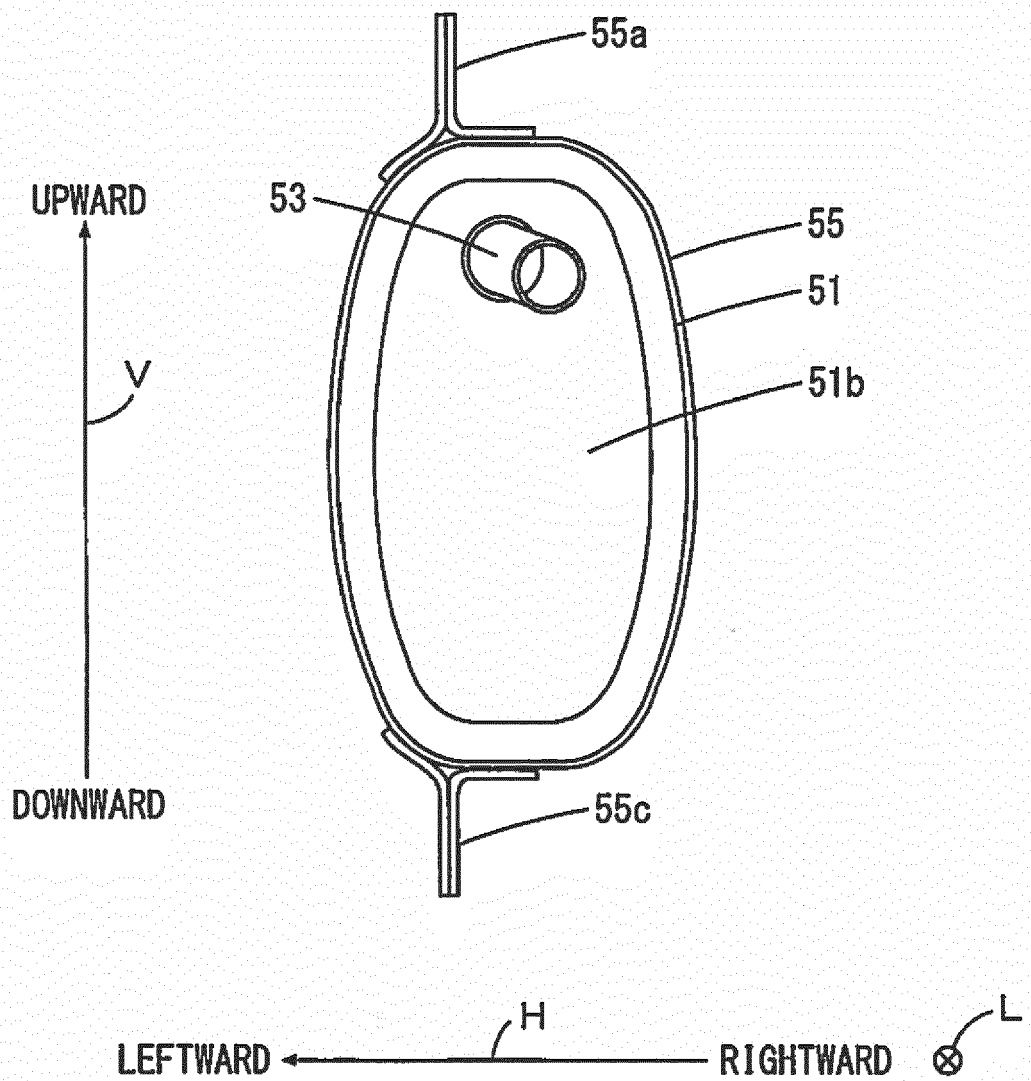




FIG. 8

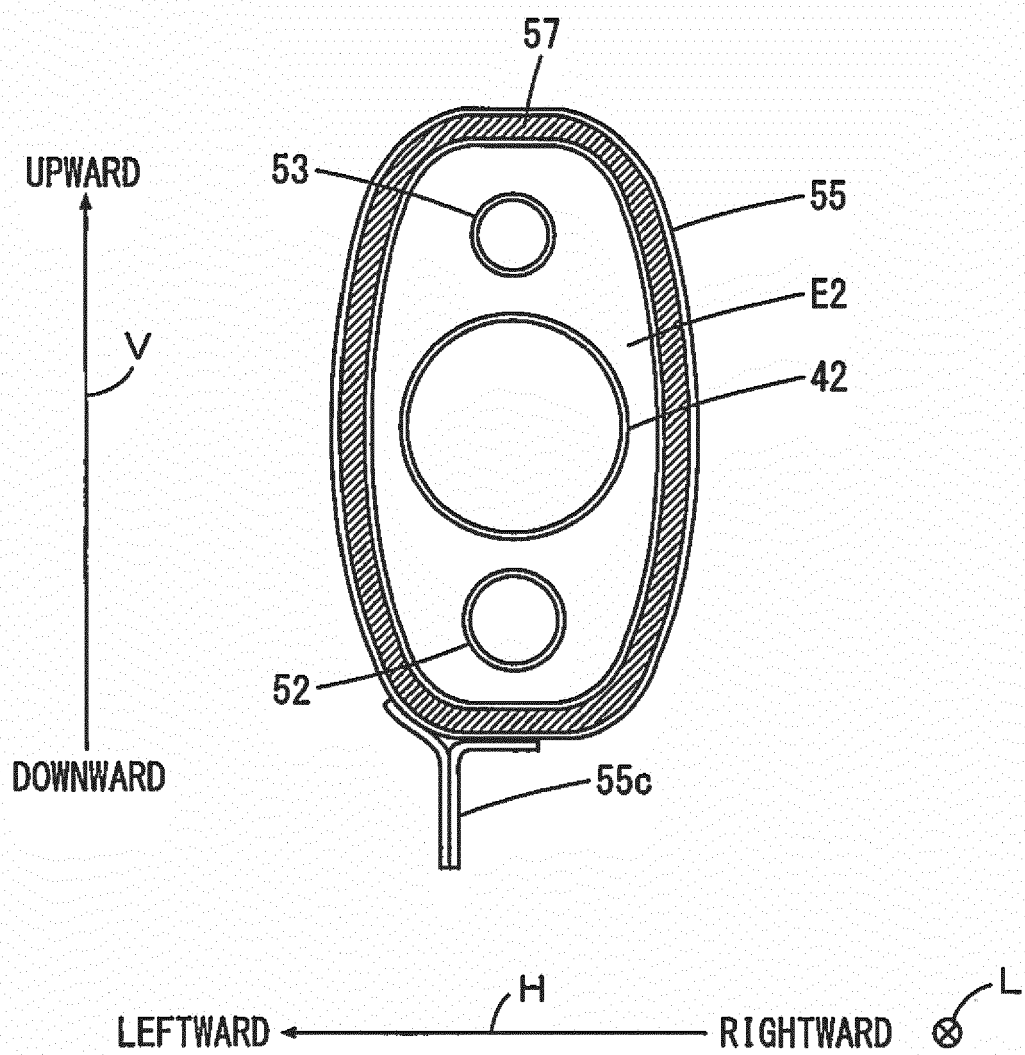
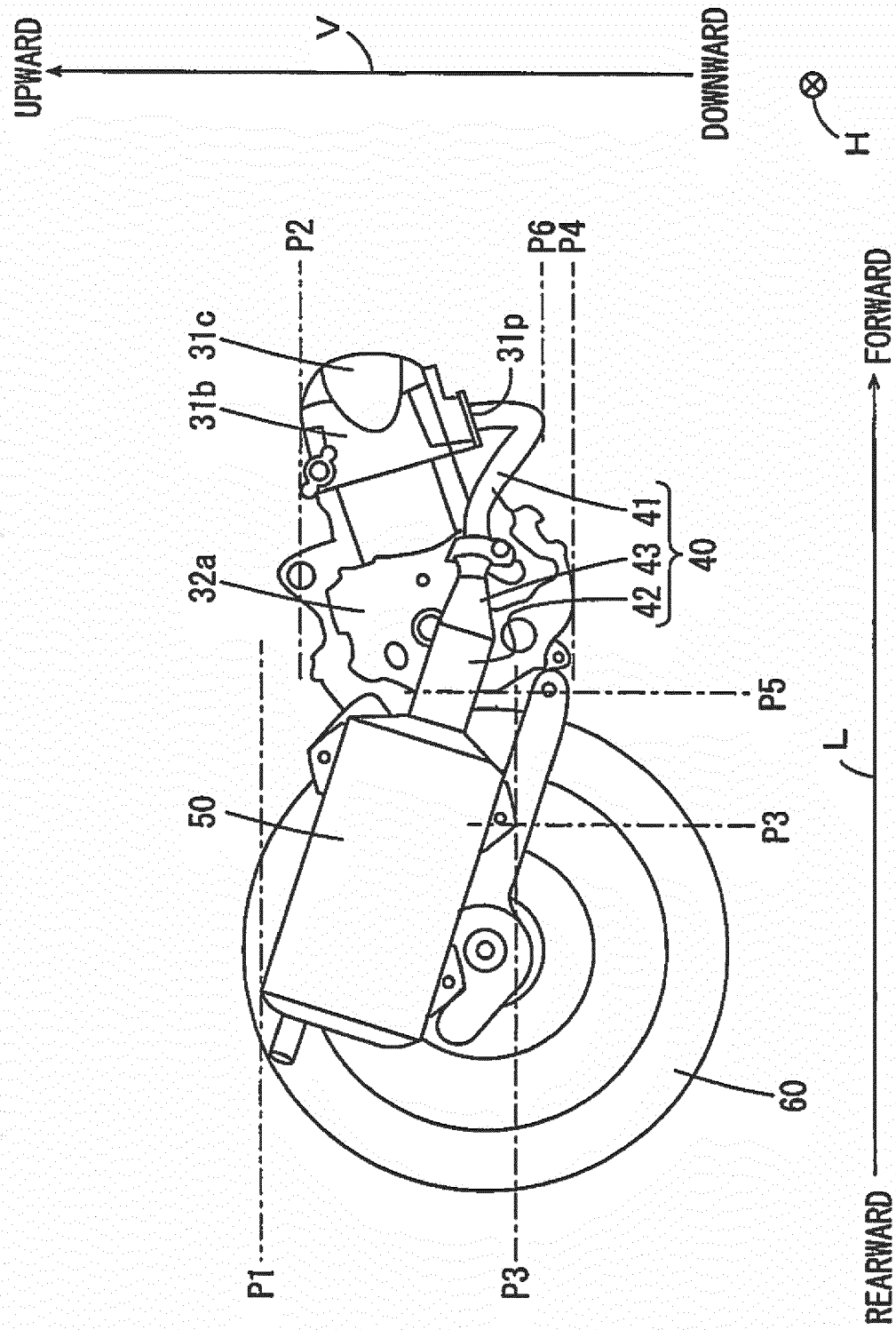


FIG. 9





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