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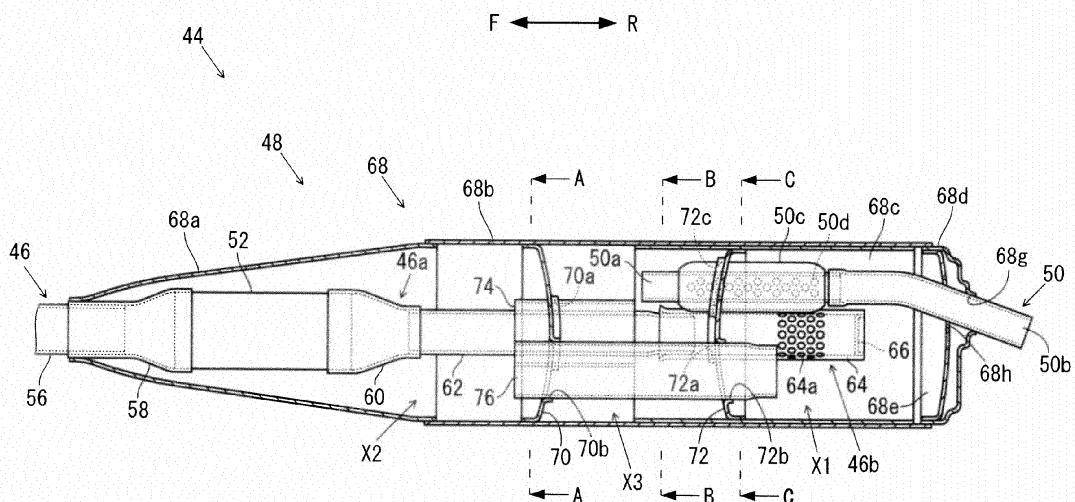
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(54) Muffler and saddle type vehicle

(57) There is provided a muffler which is capable of sufficiently reducing influence from heat generated in a catalyst. There is also provided a saddle type vehicle including the muffler. A saddle type vehicle 10 includes an engine 14 and a muffler 44. The muffler 44 includes an exhaust pipe 46, a silencer 48 and a catalyst 52. The silencer 48 includes a main body portion 68, a first separator 70 and a second separator 72. Inside the main body portion 68, a first expansion chamber X1 is on a rearward side of the second separator 72, a second expansion chamber X2 is on a forward side of the first separator 70, and a third expansion chamber X3 is between the first separator 70 and the second separator 72. The catalyst 52 is held by the exhaust pipe 46 inside the second expansion chamber X2. The exhaust pipe 46 passes through the through-hole 70a without making contact with the first separator 70, and is supported by the second separator 72. Exhaust gas from the engine 14 flows through the exhaust pipe 46, the first expansion chamber X1, the second expansion chamber X2 and the third expansion chamber X3 in this order, and then is released from the main body portion 68.

arator 70, and a third expansion chamber X3 is between the first separator 70 and the second separator 72. The catalyst 52 is held by the exhaust pipe 46 inside the second expansion chamber X2. The exhaust pipe 46 passes through the through-hole 70a without making contact with the first separator 70, and is supported by the second separator 72. Exhaust gas from the engine 14 flows through the exhaust pipe 46, the first expansion chamber X1, the second expansion chamber X2 and the third expansion chamber X3 in this order, and then is released from the main body portion 68.

FIG. 3**EP 2 735 715 A1**

Description

[0001] The present invention relates to mufflers and saddle type vehicles, and more specifically to a muffler including a catalyst, and to a saddle type vehicle including the same.

[0002] Conventionally, there is known a muffler including a catalyst for purification of engine exhaust gas.

[0003] For example, JP-A 2007-23866 discloses a structure for a muffler. The muffler includes a muffler main body having its interior space divided by a first separator and a second separator into a first expansion chamber, a second expansion chamber and a third expansion chamber. The second separator is supported by the muffler main body and is axially movable in an axial direction of the muffler main body. The first expansion chamber is sandwiched by the second expansion chamber and the third expansion chamber.

[0004] The engine and the first expansion chamber communicate with each other via an exhaust pipe. The first expansion chamber and the second expansion chamber communicate with each other via a communication tube supported by the first separator. The second expansion chamber and the third expansion chamber communicate with each other via a main catalyst supported by the first separator and the second separator. The third expansion chamber communicates with the outside environment via a tail pipe.

[0005] In the above-described arrangement, engine exhaust gas flows through the exhaust pipe and into the first expansion chamber, then through the communication pipe and then into the second expansion chamber. After flowing into the second expansion chamber, the exhaust gas passes through the main catalyst, flows into the third expansion chamber, passes through the tail pipe and then, is released to the outside.

[0006] It is stated in JP-A 2007-23866 that the second separator is movable, whereby it is possible to absorb thermal expansion of each component. However, in the muffler structure disclosed in JP-A 2007-23866, the main catalyst is supported directly by the first and the second separators, so it is therefore impossible to sufficiently reduce thermal influence on the first and the second separators caused by heat from the main catalyst.

[0007] Therefore, a primary object of the present invention is to provide a muffler capable of sufficiently reducing thermal influence caused by heat from the catalyst, and to provide a saddle type vehicle including the muffler.

[0008] According to an aspect of the present invention, there is provided a muffler for a saddle type vehicle, containing a catalyst for purification of engine exhaust gas. The muffler includes a tube-like main body portion extending in a fore-aft direction of the muffler; a first separator and a second separator inside the main body portion so as to divide an interior space of the main body portion into a first expansion chamber, a second expansion chamber and a third expansion chamber; and an exhaust pipe extending inside the main body portion from front toward rear, penetrating the first separator and the second separator. With this arrangement, the first separator is on a more forward position than the second separator; the first expansion chamber is on a rearward side of the second separator; the first separator divides a space on a forward side of the second separator inside the main body portion into the second expansion chamber and the third expansion chamber; the catalyst is in the exhaust pipe, inside the main body portion, at a position more forward than the first separator; the first separator has a through-hole passed by the exhaust pipe; the exhaust pipe passes through the through-hole without making contact with the first separator and is supported by the second separator; and the exhaust gas flows through the exhaust pipe, the first expansion chamber, the second expansion chamber and the third expansion chamber in this order and then is discharged to an outside of the main body portion.

[0009] According to the present invention, the catalyst is disposed at a more forward position than the first separator. Specifically, the arrangement allows the catalyst to be placed as close as possible to an engine. In this case, it is possible to supply high-temperature exhaust gas to the catalyst, which efficiently promotes activation of the catalyst. Also, exhaust gas which has passed through the catalyst is then introduced into the first expansion chamber through the exhaust pipe, and this pipe does not make contact with the first separator as it passes through the through-hole in the first separator. According to the arrangement, even if the high-temperature exhaust gas which has just come out of the catalyst has caused thermal expansion of the exhaust pipe, influence of the thermal expansion is prevented from reaching the first separator. The exhaust pipe is supported by the second separator. With this arrangement, the second separator is disposed at a more rearward position than the first separator. In other words, the second separator is disposed on a more downstream side than the first separator in the direction of flow of the exhaust gas inside the exhaust pipe. Therefore, part of the exhaust gas flowing through the exhaust pipe, and more specifically exhaust gas near the second separator, has a lower temperature than exhaust gas near the first separator. For this reason, part of the exhaust pipe which is supported by the second separator has less thermal expansion than part near the first separator. Therefore, the second separator is not influenced very much by the thermal expansion of the exhaust pipe although the exhaust pipe is supported by the second separator. As a result of these, it is possible to sufficiently reduce the thermal influence from the heat generated by the catalyst onto the muffler (more specifically, the first separator and the second separator). It should be noted here that in the muffler, exhaust gas flows from the second expansion chamber to the third expansion chamber via the through-hole in the first separator. More specifically, within the through-hole, there is a flow of exhaust gas in the outside space of the exhaust pipe. In this arrangement, the exhaust gas flowing outside of the exhaust pipe cools an outer circumferential surface of the exhaust pipe, so it is possible to lower the temperature of the exhaust gas inside the

exhaust pipe. With this arrangement, therefore, it is possible to efficiently lower the temperature of the exhaust gas which is flowing near the second separator inside the exhaust pipe.

[0010] Preferably, the exhaust pipe includes a holding portion holding the catalyst, and a fixed portion fixed to the second separator. With this, the holding portion is connected to the fixed portion slidably in a fore-aft direction with respect to the fixed portion. Such an arrangement allows the holding portion to slide in a fore-aft direction with respect to the fixed portion if the holding portion is expanded by the heat generated by the catalyst. This reduces movement of the fixed portion in the fore-aft direction which may be caused by the thermal expansion of the holding portion. As a result, it becomes possible to reduce influence from the thermal expansion of the holding portion on the second separator.

[0011] Further preferably, the holding portion and the fixed portion are connected to each other between the first separator and the second separator. According to the arrangement, the holding portion and the fixed portion are connected to each other on a rearward side of the first separator. In this case, it is possible to shorten the length of the fixed portion, and this makes it easy to assemble the muffler.

[0012] Alternatively, the holding portion and the fixed portion are preferably connected to each other at a position forward of the first separator. According to the arrangement, the holding portion and the fixed portion are connected to each other at a position sufficiently away from the second separator. In this case, the fixed portion is long, so the fixed portion also works in reducing influence from the thermal expansion of the holding portion. For example, when the holding portion is thermally expanded radially, the fixed portion may have its forward end portion (where it is connected to the holding portion) enlarged radially by the holding portion. However, since the fixed portion is long, there is smaller radial enlargement at the rear portion side (the side facing the second separator) of the fixed portion. This makes it possible to sufficiently reduce influence from the thermal expansion of the holding portion on the second separator.

[0013] Preferably, the muffler further includes a first communication tube for communication between the second expansion chamber and the third expansion chamber. With this arrangement, the first communication tube passes through the through-hole of the first separator and is supported by the first separator whereas the exhaust pipe passes inside the first communication tube without making contact with the first communication tube. In such an arrangement as the above, it is possible to let exhaust gas flow from the second expansion chamber to the third expansion chamber via the first communication tube. Since this reliably changes the pressure of the exhaust gas, the arrangement improves silencing effect of the muffler. Also, since the exhaust pipe does not make contact with the first communication tube, the arrangement is capable of preventing influence of the thermal expansion of the exhaust pipe from reaching the first separator via the first communication tube.

[0014] Further preferably, the muffler further includes a first communication tube for communication between the second expansion chamber and the third expansion chamber. With this arrangement, the first communication tube is supported by the first separator at a position away from the through-hole. In such an arrangement as the above, it is possible to let exhaust gas flow from the second expansion chamber to the third expansion chamber via the first communication tube in addition to the through-hole (which is passed by the exhaust pipe) in the first separator. Specifically, in the first separator, two passages are provided for the exhaust gas to flow from the second expansion chamber to the third expansion chamber. In this case, it is possible to cool the first separator by streams of exhaust gas which flow through the two passages. This sufficiently reduces thermal influence from the exhaust gas which flows through the exhaust pipe on the first separator.

[0015] Further, preferably, the muffler further includes a second communication tube for communication between the first expansion chamber and the second expansion chamber; and a third communication tube for communication between the third expansion chamber and an outside of the main body portion. Preferably, with this arrangement, the second expansion chamber is on a forward side of the first separator; the third expansion chamber is on a rearward side of the first separator; the second communication tube penetrates the first separator and the second separator and is supported by the first separator and the second separator; and the third communication tube penetrates the second separator and is supported by the second separator. According to the arrangement described above, the first expansion chamber which is on the rearward side of the second separator and the second expansion chamber which is on the forward side of the first separator are connected to each other by the second communication tube. In other words, the second communication tube passes through the third expansion chamber as it connects the first expansion chamber and the second expansion chamber to each other. Meanwhile, exhaust gas temperature in the third expansion chamber is lower than that of the exhaust gas which passes through the second communication tube. Thus, it is possible to cool the exhaust gas which is inside the second communication tube by the exhaust gas which is in the third expansion chamber. Also, since it is possible to let the exhaust gas flow from the first expansion chamber to the second expansion chamber via the second communication tube, the arrangement reliably changes the pressure of exhaust gas. This improves silencing effect of the muffler.

[0016] Alternatively, the second expansion chamber is on a rearward side of the first separator; the third expansion chamber is on a forward side of the first separator; the second communication tube penetrates the second separator and is supported by the second separator; and the third communication tube penetrates the first separator and the second separator and is supported by the first separator and the second separator. According to such an arrangement

as described, the third expansion chamber and the catalyst are on the forward side of the first separator, and the second expansion chamber is on the rearward side of the first separator. Specifically, the catalyst is disposed in the third expansion chamber which is on a more downstream side than the second expansion chamber in terms of the flow direction of the exhaust gas. In this case, even if the heat generated by the catalyst has increased the temperature of exhaust gas in the third expansion chamber, the arrangement prevents the heated exhaust gas from flowing into the second expansion chamber. This reduces temperature increase of the exhaust gas in the second expansion chamber. As a result, the arrangement provides efficient cooling of the exhaust gas which is flowing inside the exhaust pipe, by the exhaust gas in the second expansion chamber. Also, since it is possible to let the exhaust gas flow from the first expansion chamber to the second expansion chamber via the second communication tube, the arrangement reliably changes the pressure of exhaust gas. This improves silencing effect of the muffler.

[0017] Further preferably, the catalyst is at a more forward position than the first communication tube, the second communication tube and the third communication tube. In such an arrangement as described, when the muffler is viewed from a direction vertical to the fore-aft direction (for example, when the muffler is viewed from a side or from an up-down direction), the catalyst does not overlap the first communication tube, the second communication tube, nor the third communication tube. The arrangement makes it possible to reduce increase in the thickness of muffler, in cases, for example, where a thick catalyst (a catalyst having a large diameter) is used.

[0018] Mufflers used in saddle type vehicles are subject to heat generated by a catalyst, and the heat can cause strain etc. in various components of the mufflers. In this case, the muffler may see decrease in its silencing effect or generates abnormal noise as a result of strain etc. in various components thereof. For this reason, there is a requirement to the mufflers used in saddle type vehicles that influence from the heat generated in the catalyst should be reduced as much as possible. The muffler according to the present invention is capable of sufficiently reduce influence of the heat generated in catalyst, and therefore is suitably applicable to saddle type vehicles.

[0019] The above-described object and other objects, characteristics, aspects and advantages of the present invention will become clearer from the following detailed description of embodiments of the present invention with reference to the attached drawings.

Fig. 1 is a side view of a saddle type vehicle.

Fig. 2 is a side view showing an arrangement of a primary portion of the saddle type vehicle.

Fig. 3 is an illustrative sectional view (from a left side) showing an arrangement of a primary portion of a muffler.

Fig. 4 is an illustrative sectional view (from above) showing the arrangement of a primary portion of the muffler.

Fig. 5 includes end views of the muffler: Fig. 5(a) is an end view taken in lines A-A in Fig. 3 and Fig. 4; Fig. 5(b) is an end view taken in lines in B-B in Fig. 3 and Fig. 4; and Fig. 5(c) is an end view taken in lines C-C in Fig. 3 and Fig. 4.

Fig. 6 is an illustrative sectional view (from a left side) showing an arrangement of a primary portion of a muffler according to another embodiment of the present invention.

Fig. 7 is an illustrative sectional view (from above) showing the arrangement of the primary portion of the muffler according to said another embodiment of the present invention.

Fig. 8 is an illustrative sectional view (from a left side) showing an arrangement of a primary portion of a muffler according to still another embodiment of the present invention.

Fig. 9 is an illustrative sectional view (from a left side) showing an arrangement of a primary portion of a muffler according to still a different embodiment of the present invention.

[0020] Hereinafter, description will be made for a saddle type vehicle 10 which includes a muffler 44 according to an embodiment of the present invention with reference to the drawings.

[0021] Fig. 1 is a side view of the saddle type vehicle 10 whereas Fig. 2 is a side view showing an arrangement of a primary portion of the saddle type vehicle 10.

[0022] Referring to Fig. 1 and Fig. 2, the saddle type vehicle 10 is a motorcycle, and includes a frame 12, an engine 14, an air cleaner 16, an air intake unit 18 and an air exhaust unit 20. The frame 12 includes a head pipe 22, a main frame portion 24 and a seat frame portion 26.

[0023] Referring to Fig. 1, a steering shaft 28 is inserted rotatably into the head pipe 22. The steering shaft 28 has an upper end portion provided with a handlebar 30. The steering shaft 28 has a lower end portion, to which a front fork 32 is attached. The front fork 32 has a lower end portion, which supports a front wheel 34 rotatably.

[0024] Referring to Fig. 1 and Fig. 2, the main frame portion 24 includes an upper main frame portion 24a and a lower main frame portion 24b. The upper main frame portion 24a has a shape of a generally letter L in a side view, extends from the head pipe 22 obliquely in a rearward and downward direction and then bends downward. The lower main frame portion 24b extends from the head pipe 22 obliquely in a rearward and downward direction at a lower position than the upper main frame portion 24a. An engine 14 is supported between the upper main frame portion 24a and the lower main frame portion 24b by the upper main frame portion 24a and the lower main frame portion 24b.

[0025] Referring to Fig. 1, the upper main frame portion 24a has a lower end portion, which supports a swing arm 36

pivotably. The swing arm 36 has a rear end portion, which supports a rear wheel 38 rotatably. Power generated in the engine 14 is transmitted to the rear wheel 38 via an unillustrated transmission mechanism. Thus the rear wheel 38 is rotated to move the saddle type vehicle 10 forward.

[0026] Referring to Fig. 1 and Fig. 2, the seat frame portion 26 includes a pair of upper seat frame portions 26a (only the left-side upper seat frame portion 26a is shown) disposed side by side in a left-right direction, and a pair of lower seat frame portions 26b (only the left-side lower seat frame portion 26b is shown) disposed side by side in the left-right direction. Each of the upper seat frame portions 26a has its tip region connected to a substantially central region of the corresponding upper main frame portion 24a. The upper seat frame portions 26a extend rearward from the upper main frame portion 24a, being away from each other in the left-right direction. Referring to Fig. 1, the upper seat frame portions 26a support a seat 40.

[0027] Referring to Fig. 1 and Fig. 2, the pair of lower seat frame portions 26b extend below the upper seat frame portions 26a obliquely in a rearward and upward direction, from a lower region of the upper main frame portions 24a. The pair of lower seat frame portions 26b connect lower regions of the upper main frame portions 24a and rear regions of the pair of upper seat frame portions 26a to each other. The air cleaner 16 is supported by one of the upper seat frame portions 26a (the left one in the present embodiment) and one of the lower seat frame portions 26b (the left one in the present embodiment). The lower seat frame portions 26b and the swing arm 36 are connected to each other by a pair of rear suspensions 41 (Fig. 1 only shows the left side rear suspension 41).

[0028] The engine 14 and the air cleaner 16 are connected to each other by the air intake unit 18. The air intake unit 18 includes a throttle body 18a, and introduces air into the engine 14 after the air is purified at the air cleaner 16.

[0029] The engine 14 has a front surface, to which the air exhaust unit 20 is connected. The air exhaust unit 20 includes a connecting tube 42 and a muffler 44. The connecting tube 42 connects the engine 14 and the muffler 44 to each other. The muffler 44 is supported by the pair of lower seat frame portions 26b. Exhaust gas from the engine 14 passes through the connecting tube 42 and the muffler 44, and then is released to the outside. In the present embodiment, the engine 14 is provided by a single-cylinder engine, and the connecting tube 42 is provided by a piece of pipe. When the engine 14 is provided by a multi-cylinder engine, the connecting tube 42 is provided by an exhaust manifold for example.

[0030] Hereinafter, the muffler 44 will be described in detail.

[0031] Fig. 3 and Fig. 4 are illustrative sectional views showing an arrangement of a primary portion of the muffler 44. Fig. 3 is a view taken from a left side of the muffler 44 whereas Fig. 4 is a view taken from above the muffler 44. Fig. 5 includes end views of the muffler 44: Fig. 5(a) is an end view taken in lines A-A in Fig. 3 and Fig. 4; Fig. 5(b) is an end view taken in lines in B-B in Fig. 3 and Fig. 4; and Fig. 5(c) is an end view taken in lines C-C in Fig. 3 and Fig. 4.

[0032] In describing the muffler 44, the term forward side will be used to indicate a side closer to a side from which exhaust gas enters when viewed from a main body portion 68 which will be described later, whereas the term rearward side will be used to indicate a side closer to a side from which exhaust gas exits. In other words, the forward side is a side of the main body portion 68 connected to an exhaust pipe 46 (second pipe 58) which will be described later whereas the rearward side is a side of the main body portion 68 connected to a tail pipe 50 (second pipe 50b) which will be described later. Using still different words, the rearward direction is a direction in which the main body portion 68 extends from a place where the exhaust pipe 46 (the second pipe 58) and the main body portion 68 (front cap 68a) are connected to each other. In the present embodiment, a fore-aft direction is defined as a direction parallel to an axis of a fixed pipe 64 which will be described later; parallel to an axis of an outer tube 68b which will be described later; and parallel to an axis of a first communication tube 74 which will be described later. In the present embodiment, the fixed pipe 64, the outer tube 68b and the first communication tube 74 are parallel to each other. Fig. 3 and Fig. 4 use a symbol "F" to indicate the forward direction and a symbol "R" to indicate the rearward direction. In a plan view, the fore-aft direction of the muffler 44 is identical or generally identical with the fore-aft direction of the saddle type vehicle 10.

[0033] Referring to Fig. 2 through Fig. 4, the muffler 44 includes an exhaust pipe 46, a silencer 48, a tail pipe 50 (see Figs. 3 and 4) and a catalyst 52. The tail pipe 50 has a rear region covered by a cap 54 (see Fig. 2) which is provided at a rearward end portion of the silencer 48. In the present embodiment, the tail pipe 50 represents the third communication tube.

[0034] Referring to Fig. 3 and Fig. 4, the exhaust pipe 46 includes a holding portion 46a and a fixed portion 46b, and extends through the main body portion 68 which will be described later, from front toward rear. The holding portion 46a includes a plurality of pipes. In the present embodiment, the holding portion 46a includes a first pipe 56, a second pipe 58, a third pipe 60 and a fourth pipe 62. Each of the first pipe 56, the second pipe 58, the third pipe 60 and the fourth pipe 62 is cylindrical.

[0035] Referring to Fig. 2, the first pipe 56 has its forward end portion connected to the connecting tube 42. Referring to Fig. 2 and Fig. 4, the first pipe 56 extends rearward from the connecting tube 42, and then obliquely in a right and rearward direction.

[0036] Referring to Fig. 3 and Fig. 4, the first pipe 56 has its rearward end portion connected to a forward end portion of the second pipe 58. In the present embodiment, the first pipe 56 is fitted into the second pipe 58, and then the first pipe 56 and the second pipe 58 are fixed to each other by means of welding for example. The second pipe 58 has a

rearward end portion with a greater diameter than its forward end portion. Into the rearward end portion of the second pipe 58, a forward end portion of the catalyst 52 is fitted. The catalyst 52 can be provided by any one selected from those already known, so no details will be described here. In the present embodiment, the catalyst 52 has a cylindrical shape with a honeycomb-like structure for example.

[0037] The third pipe 60 has a forward end portion with a greater diameter than its rearward end portion. The catalyst 52 has its rearward end portion fitted into the forward end portion of the third pipe 60. Thus, the catalyst 52 is held by the second pipe 58 and the third pipe 60. Specifically, the catalyst 52 is held by the holding portion 46a. More specifically, the catalyst 52 is held inside the silencer 48 (inside the main body portion 68), at a front region thereof, by the holding portion 46a. In the present embodiment, the catalyst 52 is fixed to the second pipe 58 and the third pipe 60 by welding for example. Referring to Fig. 4, the second pipe 58, the catalyst 52 and the third pipe 60 extend obliquely in a rightward direction from front toward rear. The second pipe 58 and the third pipe 60 communicate with each other via the catalyst 52.

[0038] Referring to Fig. 3 and Fig. 4, the forward end portion of the fourth pipe 62 is connected to the rearward end portion of the third pipe 60. In the present embodiment, the fourth pipe 62 is fitted into the third pipe 60, and then the third pipe 60 and the fourth pipe 62 are fixed to each other by welding for example. Referring to Fig. 4, the fourth pipe 62 extends obliquely from the third pipe 60 in a right and rearward direction, and then bends toward the rear. The fourth pipe 62 has a rearward end portion with a smaller diameter than other portions thereof.

[0039] Referring to Fig. 3 and Fig. 4, the fixed portion 46b includes a fixed pipe 64 and a cap 66. The fixed pipe 64 is cylindrical, and is connected to a rearward end portion of the fourth pipe 62. More specifically, the fourth pipe 62 and the fixed pipe 64 are connected to each other so that the fourth pipe 62 is slidable with respect to the fixed pipe 64 in a fore-aft direction. In the present embodiment, the fourth pipe 62 has its rearward end portion slidably fitted into a forward end portion of the fixed pipe 64.

[0040] The fixed pipe 64 extends rearward from the fourth pipe 62, and is fixed to a second separator 72 which will be described later. Referring to Fig. 3 and Fig. 5(b), in the present embodiment, the forward end of the fixed pipe 64 has a larger inner diameter than an outer diameter of the rearward end portion of the fourth pipe 62 so that the fourth pipe 62 can be easily fitted into the fixed pipe 64.

[0041] Referring to Fig. 3 and Fig. 4, the fixed pipe 64 has a plurality of through-holes 64a along the fore-aft direction and in a circumferential direction. The through-holes 64a are located on a rearward side of the second separator 72 which will be described later. In other words, the through-holes 64a are inside a first expansion chamber X1 which will be described later.

[0042] The cap 66 is substantially disc shaped, and is fitted into a rearward end portion of the fixed pipe 64 so as to close a rearward end opening of the fixed pipe 64. The cap 66 is fixed to the rearward end portion of the fixed pipe 64 by welding for example.

[0043] The silencer 48 includes a main body portion 68, a first separator 70, a second separator 72, a first communication tube 74 and a second communication tube 76. The main body portion 68 has a tube-like shape and extends in a fore-aft direction. Specifically, the main body portion 68 has a front cap 68a, an outer tube 68b, an inner tube 68c, an end cap 68d and an inner cap 68e.

[0044] The front cap 68a is hollow, being shaped substantially in a frustum of a cone, being gradually wider toward the rear. The front cap 68a has its forward end portion connected to a forward end portion of the second pipe 58 in the exhaust pipe 46. In the present embodiment, the second pipe 58 has its forward end portion fitted into a forward end portion of the front cap 68a, and then the second pipe 58 and the front cap 68a are fixed to each other by welding for example. Referring to Fig. 4, the front cap 68a extends obliquely in a right and rearward direction from the forward end portion of the second pipe 58.

[0045] Referring to Fig. 3 through Fig. 5, the outer tube 68b is hollow and substantially cylindrical, extending in a fore-aft direction. Referring to Fig. 2, Fig. 4 and Fig. 5(b), the outer tube 68b has a recess 68f on the left side thereof at a substantially middle region in the fore-aft direction. The recess 68f is for avoiding the rear suspension 41, for example, which is on the right side of the rear wheel 38 (see Fig. 1). Referring to Fig. 3 and Fig. 4, the outer tube 68b has its forward end portion connected to a rearward end portion of the front cap 68a. In the present embodiment, the rearward end portion of the front cap 68a is fitted into the forward end portion of the outer tube 68b, and then the front cap 68a and the outer tube 68b are fixed to each other by welding for example.

[0046] Referring to Fig. 3, Fig. 4 and Figs. 5(b) and (c), the inner tube 68c is hollow and cylindrical, and is coaxial with the outer tube 68b. Referring to Fig. 4 and Fig. 5(b), in order to avoid the recess 68f, the inner tube 68c has its front portion shaped into a flipped letter of C when viewed from rear. In the present embodiment, the inner tube 68c is fitted into the outer tube 68b, and then the outer tube 68b and the inner tube 68c are fixed to each other by welding for example.

[0047] Referring to Fig. 3 and Fig. 4, the end cap 68d has a bowl-like shape and is fitted into a rearward end portion of the outer tube 68b to close an opening at the rearward end of the outer tube 68b. In the present embodiment, the end cap 68d is fixed to the outer tube 68b by welding for example. The end cap 68d has a through-hole 68g for the tail pipe 50 (more specifically, the second pipe 50b to be described later) to pass through. In the present embodiment, the tail pipe 50 (the second pipe 50b) is fixed to the end cap 68d by welding for example. Thus, the tail pipe 50 (the second

pipe 50b) is supported by the end cap 68d.

[0048] Referring to Fig. 3, the inner cap 68e has a bowl-like shape, and is inside the end cap 68d. In the present embodiment, the inner cap 68e is fitted into the end cap 68d, and then the end cap 68d and the inner cap 68e are fixed to each other by welding for example. The inner cap 68e has a through-hole 68h for the tail pipe 50 (the second pipe 50b) to pass through.

[0049] Referring to Fig. 3, Fig. 4 and Fig. 5(a), the first separator 70 has a bowl-like shape and is inside the outer tube 68b. In the present embodiment, the first separator 70 is fitted into the outer tube 68b, and then the outer tube 68b and the first separator 70 are fixed to each other by welding for example. Referring to Fig. 3 and Fig. 4, the second separator 72 is inside the main body portion 68 (more specifically inside the outer tube 68b), at a more rearward position than the first separator 70. Referring to Fig. 3, Fig. 4 and Fig. 5(c), the second separator 72 has a bowl-like shape and is inside the inner tube 68c. In the present embodiment, the second separator 72 is fitted into the inner tube 68c, and then the inner tube 68c and the second separator 72 are fixed to each other by welding for example. Therefore, the first separator 70 and the second separator 72 are immovable (i.e., fixed) with respect to the main body portion 68.

[0050] Referring to Fig. 3 and Fig. 4, interior space in the main body portion 68 is divided by the first separator 70 and the second separator 72 into a first expansion chamber X1, a second expansion chamber X2 and a third expansion chamber X3. Specifically, inside the main body portion 68, the first expansion chamber X1 is on a rearward side of the second separator 72. Also, inside the main body portion 68, space on a forward side of the second separator 72 is divided by the first separator 70 into the second expansion chamber X2 and the third expansion chamber X3. In the present embodiment, the second expansion chamber X2 is on a forward side of the first separator 70 whereas the third expansion chamber X3 is on a rearward side of the first separator 70, inside the main body portion 68.

[0051] Inside the main body portion 68, the catalyst 52 is placed in the exhaust pipe 46, at a more forward position than the first separator 70. In other words, the catalyst 52 is placed in the exhaust pipe 46 inside the second expansion chamber X2.

[0052] The first separator 70 has through-holes 70a, 70b whereas the second separator 72 has through-holes 72a, 72b and 72c. The first communication tube 74 is inserted through the through-hole 70a so as to penetrate the first separator 70 in the fore-aft direction. Referring to Fig. 3, Fig. 4 and Fig. 5(a), the first communication tube 74 is cylindrical, and is on the right side inside the main body portion 68. Referring to Fig. 3 and Fig. 4, the first communication tube 74 provides communication between the second expansion chamber X2 and the third expansion chamber X3. In the present embodiment, the first communication tube 74 is fixed to the first separator 70 by welding for example. Thus, the first communication tube 74 is supported by the first separator 70. The first communication tube 74 is disposed at a more rearward position than the catalyst 52. The through-hole 70a has a smaller diameter than an inner diameter of the main body portion 68 at a position where there is the first separator 70.

[0053] The exhaust pipe 46 is inserted through the through-hole 70a (more specifically the first communication tube 74) and the through-hole 72a so as to penetrate the first separator 70 and the second separator 72 in the fore-aft direction. More specifically, the fourth pipe 62 is inserted through the first communication tube 74 whereas the fixed pipe 64 is inserted through the through-hole 72a. The exhaust pipe 46 (the fourth pipe 62) does not make contact with the first separator 70 as it passes through the through-hole 70a. Referring to Fig. 5(a), in the present embodiment, the exhaust pipe 46 (the fourth pipe 62) is coaxial with the first communication tube 74, and does not make contact with the first communication tube 74 as it passes through inside the first communication tube 74. Referring to Fig. 3 and Fig. 4, the fixed pipe 64 is fixed to the second separator 72 by welding for example. Thus, the exhaust pipe 46 is supported by the second separator 72.

[0054] In the present embodiment, the holding portion 46a (the fourth pipe 62) and the fixed portion 46b (fixed pipe 64) are connected to each other between the first separator 70 and the second separator 72. In other words, the holding portion 46a and the fixed portion 46b are connected to each other in the third expansion chamber X3.

[0055] The second communication tube 76 is inserted through the through-hole 70b and the through-hole 72b so as to penetrate the first separator 70 and the second separator 72 in the fore-aft direction. Referring to Fig. 3, Fig. 4 and Fig. 5(a), the second communication tube 76 is cylindrical, and is on the left and lower side of the first communication tube 74. Referring to Fig. 3 and Fig. 4, the second communication tube 76 provides communication between the first expansion chamber X1 and the second expansion chamber X2. The second communication tube 76 has its forward region fixed to the first separator 70 by welding for example. The second communication tube 76 has its rearward region fitted through the through-hole 72b slidably in the fore-aft direction with respect to the second separator 72 for example. Thus, the second communication tube 76 is supported by the first separator 70 and the second separator 72. The second communication tube 76 is disposed at a more rearward position than the catalyst 52.

[0056] Referring to Fig. 3 and Fig. 4, the tail pipe 50 includes a first pipe 50a, a second pipe 50b and an assist pipe 50c, and provides communication between the third expansion chamber X3 and an outside environment of the main body portion 68. Each of the first pipe 50a, the second pipe 50b and the assist pipe 50c is cylindrical. The tail pipe 50 is disposed at a more rearward position than the catalyst 52.

[0057] Referring to Fig. 3, Fig. 4 and Figs. 5(c), the first pipe 50a and the assist pipe 50c are coaxial with each other.

The first pipe 50a and the assist pipe 50c are on the left and upper side of the fixed pipe 64, i.e., on the right and upper side of the second communication tube 76. Referring to Fig. 3 and Fig. 4, the first pipe 50a has a greater dimension in the fore-aft direction than that of the assist pipe 50c in the fore-aft direction. As inserted through the assist pipe 50c, the first pipe 50a has its forward and rearward end portions protruding from the assist pipe 50c. In the present embodiment, the assist pipe 50c has its forward end edge and rearward end edge fixed to an outer circumferential surface of the first pipe 50a by welding for example so that there is no gap between the forward end edge of the assist pipe 50c and the outer circumferential surface of the first pipe 50a, nor between the rearward end edge of the assist pipe 50c and the outer circumferential surface of the first pipe 50a.

[0058] Referring to Fig. 3, the first pipe 50a has a plurality of through-holes 50d. The through-holes 50d are located inside the assist pipe 50c. Like the through-holes 64a located in the fixed pipe 64, the through-holes 50d are made along the fore-aft direction and the circumferential direction of the first pipe 50a. Fig. 3 shows only some of the through-holes 50d to avoid complication in the drawing. Between the first pipe 50a and the assist pipe 50c, a sound absorbing member (not illustrated) may be disposed for example. However, the sound absorbing member is not mandatory.

[0059] Referring to Fig. 3 and Fig. 4, the first pipe 50a and the assist pipe 50c are inserted through the through-hole 72c so as to penetrate the second separator 72 in the fore-aft direction. The assist pipe 50c is fixed to the second separator 72 by welding for example. Thus, the tail pipe 50 (more specifically, the first pipe 50a and the assist pipe 50c) is supported by the second separator 72.

[0060] In the present embodiment, the first pipe 50a, the assist pipe 50c, the fixed pipe 64, the first communication tube 74 and the second communication tube 76 are parallel to each other.

[0061] The first pipe 50a has its rearward end portion connected to a forward end portion of the second pipe 50b. In the present embodiment, the first pipe 50a is fitted into the second pipe 50b, and then the first pipe 50a and the second pipe 50b are fixed to each other by welding for example. Referring to Fig. 3, the second pipe 50b extends rearward from the first pipe 50a and then bends obliquely in a rearward and downward direction. The second pipe 50b is inserted through the through-hole 68h and the through-hole 68g so as to penetrate the inner cap 68e and the end cap 68d obliquely in a downward direction from front to rear. In the present embodiment, the outer circumferential surface of the second pipe 50b is connected to the end cap 68d by welding for example, so as not to form a gap between the second pipe 50b and the end cap 68d at the through-hole 68g.

[0062] Referring to Fig. 1 and Fig. 2, in the saddle type vehicle 10, exhaust gas from the engine 14 passes through the connecting tube 42 and flows into the exhaust pipe 46 of the muffler 44. Referring to Fig. 3 and Fig. 4, the exhaust gas which flows into the exhaust pipe 46 is purified at the catalyst 52, and then flows through the through-holes 64a in the fixed pipe 64, into the first expansion chamber X1. The exhaust gas which flows into the first expansion chamber X1 then passes through the second communication tube 76 and flows into the second expansion chamber X2. The exhaust gas which flows into the second expansion chamber X2 then flows between the outer circumferential surface of the fourth pipe 62 and the inner circumferential surface of the first communication tube 74, into the third expansion chamber X3. The exhaust gas which flows into the third expansion chamber X3 then flows through the tail pipe 50 and is discharged to the outside of the main body portion 68.

[0063] Hereinafter, functions and advantages of the saddle type vehicle 10 will be described.

[0064] In the muffler 44 of the saddle type vehicle 10, the catalyst 52 is at a more forward position than the first separator 70. Specifically, the arrangement allows the catalyst 52 to be placed as close as possible to the engine 14. In this case, it is possible to supply high-temperature exhaust gas to the catalyst 52, which efficiently promotes activation of the catalyst 52. Also, exhaust gas which has passed through the catalyst 52 is then introduced into the first expansion chamber X1 through the exhaust pipe 46, and this pipe does not make contact with the first separator 70 as it passes through the through-hole 70a. According to the arrangement, even if high-temperature exhaust gas which has just come out of the catalyst 52 has thermally expanded the exhaust pipe 46, influence of the thermal expansion is prevented from reaching the first separator 70. The exhaust pipe 46 is supported by the second separator 72. With this arrangement, the second separator 72 is disposed at a more rearward position than the first separator 70. In other words, the second separator 72 is on a more downstream side than the first separator 70 in the direction of flow of the exhaust gas inside the exhaust pipe 46. Therefore, part of the exhaust gas flowing through the exhaust pipe 46, and more specifically exhaust gas near the second separator 72, has a lower temperature than exhaust gas near the first separator 70. As a result, part of the exhaust pipe 46 (the fixed pipe 64 in the present embodiment) which is supported by the second separator 72 has less thermal expansion than part (the fourth pipe 62 in the present embodiment) near the first separator. Therefore, the second separator 72 is not influenced very much by the thermal expansion of the exhaust pipe 46 although the exhaust pipe 46 is supported by the second separator 72. As a result of these, it is possible to sufficiently reduce the thermal influence from the heat generated by the catalyst 52 onto the muffler 44 (more specifically, the first separator 70 and the second separator 72). It should be noted here that in the muffler 44, exhaust gas flows from the second expansion chamber X2 to the third expansion chamber X3 via the through-hole 70a of the first separator 70. More specifically, within the through-hole 70a, there is a flow of exhaust gas in the outside space of the exhaust pipe 46. The gas flowing through the through-hole 70a in the space outside the exhaust pipe 46 flows in parallel (substantially parallel)

to the exhaust gas flowing inside the exhaust pipe 46. In this arrangement, the exhaust gas flowing outside of the exhaust pipe 46 cools the outer circumferential surface of the exhaust pipe 46, so it is possible to lower the temperature of the exhaust gas inside the exhaust pipe 46. Specifically, the exhaust gas flowing outside of the exhaust pipe 46 has a lower temperature than the exhaust gas flowing inside the exhaust pipe 46, and it is therefore possible to cool the outer circumferential surface of the exhaust pipe 46 by the exhaust gas which is flowing outside of the exhaust pipe 46. With this arrangement, it is possible to efficiently lower the temperature of the exhaust gas which is flowing near the second separator 72 inside the exhaust pipe 46.

[0065] According to the muffler 44, the exhaust pipe 46 includes a holding portion 46a which holds the catalyst 52, and a fixed portion 46b which is fixed to the second separator 72, and the holding portion 46a is slidable in a fore-aft direction with respect to the fixed portion 46b as connected to the fixed portion 46b. The holding portion 46a and the fixed portion 46b are arranged in the fore-aft direction. The arrangement allows the holding portion 46a to slide in the fore-aft direction with respect to the fixed portion 46b when the holding portion 46a is expanded by the heat generated in the catalyst 52. This reduces movement of the fixed portion 46b in the fore-aft direction which may be caused by the thermal expansion of the holding portion 46a. As a result, it becomes possible to reduce influence from the thermal expansion of the holding portion 46a on the second separator 72.

[0066] According to the muffler 44, the holding portion 46a and the fixed portion 46b are connected to each other between the first separator 70 and the second separator 72. In this case, it is possible to shorten the length of the fixed portion 46b, making it easy to assemble the muffler 44.

[0067] According to the muffler 44, the first communication tube 74 passes through the through-hole 70a of the first separator 70 and is supported by the first separator 70 whereas the exhaust pipe 46 passes through the first communication tube 74 without making contact with the first communication tube 74. In this case, it is possible to let exhaust gas flow from the second expansion chamber X2 to the third expansion chamber X3 via the first communication tube 74. Since this reliably changes the pressure of the exhaust gas, the arrangement improves silencing effect of the muffler 44. Also, since the exhaust pipe 46 does not make contact with the first communication tube 74, the arrangement is capable of preventing influence of the thermal expansion of the exhaust pipe 46 from reaching the first separator 70 via the first communication tube 74.

[0068] According to the muffler 44, the first expansion chamber X1 which is on the rearward side of the second separator 72, and the second expansion chamber X2 which is on the forward side of the first separator 70 communicate with each other by the second communication tube 76. In other words, the second communication tube 76 passes through the third expansion chamber X3 as it provides communication between the first expansion chamber X1 and the second expansion chamber X2. Meanwhile, exhaust gas temperature in the third expansion chamber X3 is lower than that of the exhaust gas which passes through the second communication tube 76. Thus, it is possible to cool the exhaust gas which is inside the second communication tube 76 by the exhaust gas which is in the third expansion chamber X3. Also, since it is possible to let the exhaust gas flow from the first expansion chamber X1 to the second expansion chamber X2 via the second communication tube 76, the arrangement reliably changes the pressure of exhaust gas. This improves silencing effect of the muffler 44.

[0069] According to the muffler 44, the catalyst 52 is disposed at a more forward position than the first communication tube 74, the second communication tube 76 and the tail pipe 50. In other words, when the muffler 44 is viewed from a direction vertical to the fore-aft direction (for example, when the muffler 44 is viewed from a side or from an up-down direction), the catalyst 52 does not overlap the first communication tube 74, the second communication tube 76, nor the tail pipe 50. The arrangement makes it possible to reduce increase in the thickness of muffler 44 in cases, for example, where a thick catalyst 52 (a catalyst 52 having a large diameter) is used.

[0070] In the embodiment described above, description was made for a case where the second expansion chamber X2 is on the forward side of the first separator 70 and the third expansion chamber X3 is on the rearward side of the first separator 70. However, positions of the second expansion chamber and the third expansion chamber are not limited to the embodiment described above.

[0071] Fig. 6 and Fig. 7 are illustrative sectional views showing an arrangement of a primary portion of a muffler 44a according to another embodiment of the present invention. Fig. 6 is a view taken from a left side of the muffler 44a whereas Fig. 7 is a view taken from above the muffler 44a. Fig. 6 and Fig. 7 use a symbol "F" to indicate the forward direction and a symbol "R" to indicate the rearward direction. Hereinafter, description will cover the muffler 44a only in terms of differences from the muffler 44, without repetitions on commonalities to the muffler 44.

[0072] Referring to Fig. 6 and Fig. 7, the muffler 44a differs from the muffler 44 in that the silencer 48 is replaced by a silencer 48a, and the tail pipe 50 is replaced by a tail pipe 78. In the present embodiment, the tail pipe 78 represents the third communication tube.

[0073] The silencer 48a differs from the silencer 48 in that the first separator 70 is replaced by a first separator 80, and the second communication tube 76 is replaced by a second communication tube 82. In the silencer 48a, a second expansion chamber Y2 is on the rearward side of the first separator 80, and a third expansion chamber Y3 is on the forward side of the first separator 80.

[0074] The tail pipe 78 differs from the tail pipe 50 in that it further has a fourth pipe 78a which is connected to a forward end portion of the first pipe 50a. The fourth pipe 78a extends forward from the first pipe 50a and penetrates the first separator 80. In the present embodiment, the first pipe 50a has its forward end portion fitted into a rearward end portion of the fourth pipe 78a, and then the first pipe 50a and the fourth pipe 78a are fixed to each other by welding for example.

The tail pipe 78 is supported by the first separator 80, the second separator 72 and the end cap 68d.

[0075] The first separator 80 differs from the first separator 70 in that it does not have the through-hole 70b, but has a through-hole 80a for the fourth pipe 78a to pass through. The through-hole 80a is on the left and upper side of the through-hole 70a. In the present embodiment, the fourth pipe 78a is inserted into the through-hole 80a slidably in the fore-aft direction with respect to the first separator 80 for example.

[0076] The second communication tube 82 differs from the second communication tube 76 in that the second communication tube 82 has a smaller dimension in the fore-aft direction than that of the second communication tube 76, and that the second communication tube 82 does not penetrate the first separator 80. The second communication tube 82 is inserted through the through-hole 72b (see Fig. 6) so as to penetrate the second separator 72 in the fore-aft direction, and provides communication between the first expansion chamber X1 and the second expansion chamber Y2. In the present embodiment, the second communication tube 82 is fixed to the second separator 72 by welding for example.

[0077] In the muffler 44a, exhaust gas which flows from the exhaust pipe 46 into the first expansion chamber X1 passes through the second communication tube 82 and flows into the second expansion chamber Y2. The exhaust gas which flows into the second expansion chamber Y2 then flows between the outer circumferential surface of the fourth pipe 62 and the inner circumferential surface of the first communication tube 74, into the third expansion chamber Y3. The exhaust gas which flows into the third expansion chamber Y3 then flows through the tail pipe 78 and is discharged to the outside of the main body portion 68.

[0078] According to the arrangement described above, the muffler 44a is also capable, like the muffler 44, of sufficiently reducing thermal influence from the catalyst 52 onto the muffler 44a, and efficiently lowering the temperature of exhaust gas near the second separator 72 inside the exhaust pipe 46. Also like the muffler 44, the arrangement makes it easy to assemble the muffler 44a, improves silencing effect of the muffler 44a, and reduces increase in the thickness of the muffler 44a.

[0079] According to the muffler 44a, the third expansion chamber Y3 and the catalyst 52 are on the forward side of the first separator 80, and the second expansion chamber Y2 is on the rearward side of the first separator 80. Specifically, the catalyst 52 is disposed in the third expansion chamber Y3 which is on a more downstream side than the second expansion chamber Y2 in terms of the flow direction of the exhaust gas. In this case, even if the heat generated by the catalyst 52 has increased the temperature of exhaust gas in the third expansion chamber Y3, the arrangement prevents the heated exhaust gas from flowing into the second expansion chamber Y2. This reduces temperature increase of the exhaust gas in the second expansion chamber Y2. As a result, the arrangement provides efficient cooling of the exhaust gas which is flowing inside the exhaust pipe 46, by the exhaust gas in the second expansion chamber Y2.

[0080] In the embodiments described above, description was made for a case where the first communication tube 74 is inserted through the through-hole 70a of the first separator 70 or of the first separator 80. However, the position of the first communication tube is not limited to the embodiments described above.

[0081] Fig. 8 is an illustrative sectional view showing an arrangement of a primary portion of a muffler 44b according to still another embodiment of the present invention. Fig. 8 is a view taken from the left side of the muffler 44b. Fig. 8 uses a symbol "F" to indicate the forward direction and a symbol "R" to indicate the rearward direction. Hereinafter, description will cover the muffler 44b only in terms of differences from the muffler 44a, without repetitions on commonalities with the muffler 44a.

[0082] Referring to Fig. 8, the muffler 44b differs from the muffler 44a in that the silencer 48a is replaced by a silencer 48b. The silencer 48b differs from the silencer 48a in that the first separator 80 is replaced by a first separator 84, and the first communication tube 74 is replaced by a first communication tube 74a. It should be noted here that as will be described later, the silencer 48b has the first communication tube 74a at a different position from the position where the first communication tube 74 is disposed in the silencer 48a. In the silencer 48b, a second expansion chamber Z2 is on the rearward side of the first separator 84, and a third expansion chamber Z3 is on the forward side of the first separator 84.

[0083] The first separator 84 differs from the first separator 80 in that it further has a through-hole 70b. The through-hole 70b is made at the same position as the through-hole 70b (see Fig. 3) of the first separator 70 (see Fig. 3).

[0084] The first communication tube 74a differs from the first communication tube 74 in that the first communication tube 74a has a smaller diameter than the first communication tube 74, and that the first communication tube 74a is inserted through a through-hole 70b, instead of the through-hole 70a (not illustrated in Fig. 8; see Fig. 6). Specifically, in the muffler 44b, the first communication tube 74a is disposed at a position spaced from the through-hole 70a. In the present embodiment, the first communication tube 74a is fixed to the first separator 84 by welding for example. Thus, the first communication tube 74a is supported by the first separator 84. It should be noted here without going into detail, that like in the muffler 44a, the fourth pipe 62 passes through the through-hole 70a (see Fig. 6) without making contact

with the first separator 84.

[0085] In the muffler 44b, exhaust gas which flows from the exhaust pipe 46 into the first expansion chamber X1 passes through the second communication tube 82 and flows into the second expansion chamber Z2. The exhaust gas which flows into the second expansion chamber Z2 then passes through the through-hole 70a (see Fig. 6) and the first communication tube 74a, and then flows into the third expansion chamber Z3. The exhaust gas which flows into the third expansion chamber Z3 then flows through the tail pipe 78 and is discharged to the outside of the main body portion 68.

[0086] According to the arrangement described above, the muffler 44b is also capable, like the muffler 44a, of sufficiently reducing thermal influence from the catalyst 52 onto the muffler 44b, and efficiently lowering the temperature of exhaust gas near the second separator 72 inside the exhaust pipe 46. Also, like the muffler 44a, the arrangement makes it easy to assemble the muffler 44b, improves silencing effect of the muffler 44b, and reduces increase in the thickness of the muffler 44b.

[0087] According to the muffler 44b, the second expansion chamber Z2 and the third expansion chamber Z3 communicate with each other via the through-hole 70a (see Fig. 6), and the second expansion chamber Z2 and the third expansion chamber Z3 communicate with each other via the first communication tube 74a. Therefore, the muffler 44b is capable of letting the exhaust gas flow from the second expansion chamber Z2 to the third expansion chamber Z3, not only via the through-hole 70a which is made as a route for the exhaust pipe 46 but also via the first communication tube 74a. Specifically, in the first separator 84, two passages are provided for the exhaust gas to flow from the second expansion chamber Z2 to the third expansion chamber Z3. In this case, the first separator 84 is cooled by streams of exhaust gas which flow through the two passages (the through-hole 70a and the first communication tube 74a). This sufficiently reduces thermal influence from the exhaust gas which flows through the exhaust pipe 46 on the first separator 84.

[0088] In the embodiments described above, description was made for a case where the holding portion 46a and the fixed portion 46b are connected to each other between the first separator and the second separator. However, position where the holding portion and the fixed portion are connected to each other is not limited to the embodiments described above.

[0089] Fig. 9 is an illustrative sectional view showing an arrangement of a primary portion of a muffler 44c according to still a different embodiment of the present invention. Fig. 9 is a view taken from the left side of the muffler 44c. Fig. 9 uses a symbol "F" to indicate the forward direction and a symbol "R" to indicate the rearward direction. Hereinafter, description will cover the muffler 44c only in terms of differences from the muffler 44, without repetitions on commonalities with the muffler 44.

[0090] Referring to Fig. 9, the muffler 44c differs from the muffler 44 in that the exhaust pipe 46 is replaced by an exhaust pipe 86. The exhaust pipe 86 differs from the exhaust pipe 46 in that it has a holding portion 86a instead of the holding portion 46a, and a fixed portion 86b instead of the fixed portion 46b.

[0091] The holding portion 86a differs from the holding portion 46a in that the fourth pipe 62 is replaced by a fourth pipe 88. The fourth pipe 88 differs from the fourth pipe 62 in that the fourth pipe 88 has a shorter dimension in the fore-aft direction than that of the fourth pipe 62.

[0092] The fixed portion 86b differs from the fixed portion 46b in that the fixed pipe 64 is replaced by a fixed pipe 90. The fixed pipe 90 differs from the fixed pipe 64 in that the fixed pipe 90 has a longer dimension in the fore-aft direction than that of the fixed pipe 64.

[0093] In the muffler 44c, the holding portion 86a (the fourth pipe 88) and the fixed portion 86b (fixed pipe 90) are connected to each other on the forward side of the first separator 70. In the present embodiment, the fourth pipe 88 has its rearward end portion fitted into a forward end portion of the fixed pipe 90 so that the fourth pipe 88 is slidable in the fore-aft direction with respect to the fixed pipe 90.

[0094] Following the arrangement described above, the holding portion 86a and the fixed portion 86b are connected to each other at a place with a sufficient distance away from the second separator 72, according to the muffler 44c. In this case, the fixed portion 86b is long, so the fixed portion 86b also works in reducing influence from thermal expansion of the holding portion 86a. For example, when the holding portion 86a (the fourth pipe 88) is thermally expanded radially, a forward end portion of the fixed portion 86b (fixed pipe 90) may be enlarged radially by the holding portion 86a. However, since the fixed portion 86b is long, there is smaller radial enlargement at the rear portion side (the side facing the second separator 72) of the fixed portion 86b. This makes it possible to sufficiently reduce influence from the thermal expansion of the holding portion 86a on the second separator 72.

[0095] It should be noted here that, like the muffler 44, the muffler 44c includes the silencer 48. Therefore, the muffler 44c offers functions and advantages (functions and advantages provided by those other than the exhaust pipe 46) provided by the muffler 44.

[0096] In the above, description was made for the muffler 44c which includes an exhaust pipe 86, a silencer 48 and the tail pipe 50. However, the exhaust pipe 86 is usable in mufflers of different arrangements. For example, the muffler 44a (see Fig. 6) may use the exhaust pipe 86 instead of the exhaust pipe 46, and the muffler 44b (see Fig. 8) may use the exhaust pipe 86 instead of the exhaust pipe 46.

[0097] In the embodiments described above, description was made for cases where the first communication tube is disposed in the first separator 70, 80 or 84. However, the first communication tube need not be disposed in the first separator 70, 80 or 84.

[0098] In the embodiment shown in Fig. 6 and Fig. 8, description was made for a case where the second communication tube 82 is disposed in the second separator 72. However, the second communication tube 82 need not be disposed in the second separator 72.

[0099] In the embodiments described above, description was made for cases where the first separator and the second separator have a bowl-like shape. However, the shape of the first separator and the second separator is not limited to the embodiment described above. For example, the first separator may have a disc-like shape, and/or the second separator may have a disc-like shape.

[0100] The connecting tube and the exhaust pipe are not limited to those described thus far, and may be designed in many different ways. For example, in the embodiment described above, description was made for a case where the connecting tube 42 and the first pipe 56 of the exhaust pipe 46 are separate individual parts. However, there may be cases where the connecting tube is integrally formed with the first pipe. In other words, there may be cases where the connecting tube and the first pipe are provided as a single part. In this case, the connecting tube is also included in the exhaust pipe. Also, in the embodiments described above, description was made for cases where the first pipe 56 and the second pipe 58 are separate individual parts. However, the first pipe and the second pipe may be integral with each other. In other words, there may be cases where the first pipe and the second pipe are provided as a single part. Likewise, the third pipe and the fourth pipe may be integral with each other.

[0101] Positional relationships between the exhaust pipe, the first communication tube, the second communication tube, and the tail pipe are not limited to the embodiments described above. For example, in any of the mufflers described as the embodiments thus far, the positional relationship between the exhaust pipe, the first communication tube, the second communication tube and the tail pipe may be flipped horizontally to make left-side right, or may be inverted vertically to make upside down.

[0102] The saddle type vehicle to which the present invention is applicable is not limited to motorcycles. Specifically, the present invention is applicable to other kinds of saddle type vehicles such as all-terrain vehicles (ATV), and automotive tricycles. Also, those motorcycles to which the present invention may be applied are not limited to the type in which the engine is fixed to the frame. Specifically, the present invention is also applicable to a type of motorcycle (such as scooter) in which the engine is pivotable with respect to the frame.

[0103] The present invention being thus far described in terms of preferred embodiments, it is obvious that these may be varied in many ways within the scope and the spirit of the present invention. The scope of the present invention is only limited by the accompanied claims.

LEGEND

[0104]

10	Saddle type vehicle
12	Frame
14	Engine
20	Exhaust unit
44, 44a, 44b, 44c	Mufflers
46, 86	Exhaust pipes
46a, 86a	Holding portions
46b, 86b	Fixed portions
48, 48a, 48b	Silencers
50, 78	Tail pipes
52	Catalyst
68	Main body portion
70, 80, 84	First separators
70a, 70b, 72a, 72b, 72c, 80a	Through-holes
72	Second separator
74, 74a	First communication tubes
76, 82	Second communication tubes
X1	First expansion chamber
X2, Y2, Z2	Second expansion chambers
X3, Y3, Z3	Third expansion chambers

Claims

1. A muffler (44; 44a; 44b; 44c) for a saddle type vehicle (10), containing a catalyst (52) for purification of engine exhaust gas, the muffler (44; 44a; 44b; 44c) comprising:

a tube-like main body portion (68) extending in a fore-aft direction of the muffler (44; 44a; 44b; 44c);
 a first separator (70; 80; 84) and a second separator (72) inside the main body portion (68) so as to divide an interior space of the main body portion (68) into a first expansion chamber (X1), a second expansion chamber (X2; Y2; Z2) and a third expansion chamber (X3; Y3; Z3); and
 an exhaust pipe (46; 86) extending inside the main body portion (68) from the front toward the rear of the muffler (44; 44a; 44b; 44c), penetrating the first separator (70; 80; 84) and the second separator (72); wherein the first separator (70; 80; 84) is located at a position further forward than the second separator (72), the first expansion chamber (X1) is on a rearward side of the second separator (72), the first separator (70; 80; 84) divides a space on a forward side of the second separator (72) inside the main body portion (68), into the second expansion chamber (X2; Y2; Z2) and the third expansion chamber (X3; Y3; Z3), the catalyst (52) is in the exhaust pipe (46; 86), inside the main body portion (68), located at a position further forward than the first separator (70; 80; 84), the first separator (70; 80; 84) has a through-hole (70a) passed by the exhaust pipe (46; 86), the exhaust pipe (46; 86) passes through the through-hole (70a) without making contact with the first separator (70; 80; 84) and is supported by the second separator (72), and the exhaust gas flows through the exhaust pipe (46; 86), the first expansion chamber (X1), the second expansion chamber (X2; Y2; Z2) and the third expansion chamber (X3; Y3; Z3) in this order and then is discharged to an outside of the main body portion (68).

2. The muffler (44; 44a; 44b; 44c) according to claim 1, wherein the exhaust pipe (46; 86) includes a holding portion (46a; 86a) holding the catalyst (52), and a fixed portion (46b; 86b) fixed to the second separator (72), and the holding portion (46a; 86a) is connected to the fixed portion (46b; 86b) slidably in a fore-aft direction with respect to the fixed portion (46b; 86b).

3. The muffler (44; 44a; 44b) according to claim 2, wherein the holding portion (46a) and the fixed portion (46b) are connected to each other between the first separator (70; 80; 84) and the second separator (72).

4. The muffler (44c) according to claim 2, wherein the holding portion (86a) and the fixed portion (86b) are connected to each other at a position forward of the first separator (70).

5. The muffler (44; 44a; 44c) according to one of claims 1 through 4, further comprising a first communication tube (74) for communication between the second expansion chamber (X2; Y2) and the third expansion chamber (X3; Y3), wherein the first communication tube (74) passes through the through-hole (70a) of the first separator (70; 80) and is supported by the first separator (70; 80), and the exhaust pipe (46; 86) passes inside the first communication tube (74) without making contact with the first communication tube (74).

6. The muffler (44b) according to one of claims 1 through 4, further comprising a first communication tube (74a) for communication between the second expansion chamber (Z2) and the third expansion chamber (Z3), wherein the first communication tube (74a) is supported by the first separator (84) at a position away from the through-hole (70a).

7. The muffler (44; 44a; 44b; 44c) according to claim 5 or 6, further comprising a second communication tube (76; 82) for communication between the first expansion chamber (X1) and the second expansion chamber (X2; Y2; Z2); and a third communication tube (50; 78) for communication between the third expansion chamber (X3; Y3; Z3) and an outside of the main body portion (68).

8. The muffler (44; 44c) according to claim 7, wherein the second expansion chamber (X2) is on a forward side of the first separator (70), the third expansion chamber (X3) is on a rearward side of the first separator (70), the second communication tube (76) penetrates the first separator (70) and the second separator (72) and is supported by the first separator (70) and the second separator (72), and

the third communication tube (50) penetrates the second separator (72) and is supported by the second separator (72).

5 9. The muffler (44a; 44b) according to claim 7, wherein
the second expansion chamber (Y2; Z2) is on a rearward side of the first separator (80; 84),
the third expansion chamber (Y3; Z3) is on a forward side of the first separator (80; 84), the second communication
tube (82) penetrates the second separator (72) and is supported by the second separator (72), and
the third communication tube (78) penetrates the first separator (80; 84) and the second separator (72) and is
10 supported by the first separator (80; 84) and the second separator (72).

10 10. The muffler (44; 44a; 44b; 44c) according to claim 8 or 9, wherein the catalyst (52) is at a more forward position
than the first communication tube (74; 74a), the second communication tube (76; 82) and the third communication
tube (50; 78).

15 11. A saddle type vehicle (10) comprising the muffler (44; 44a; 44b; 44c) according to one of claims 1 through 10.

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FIG. 1

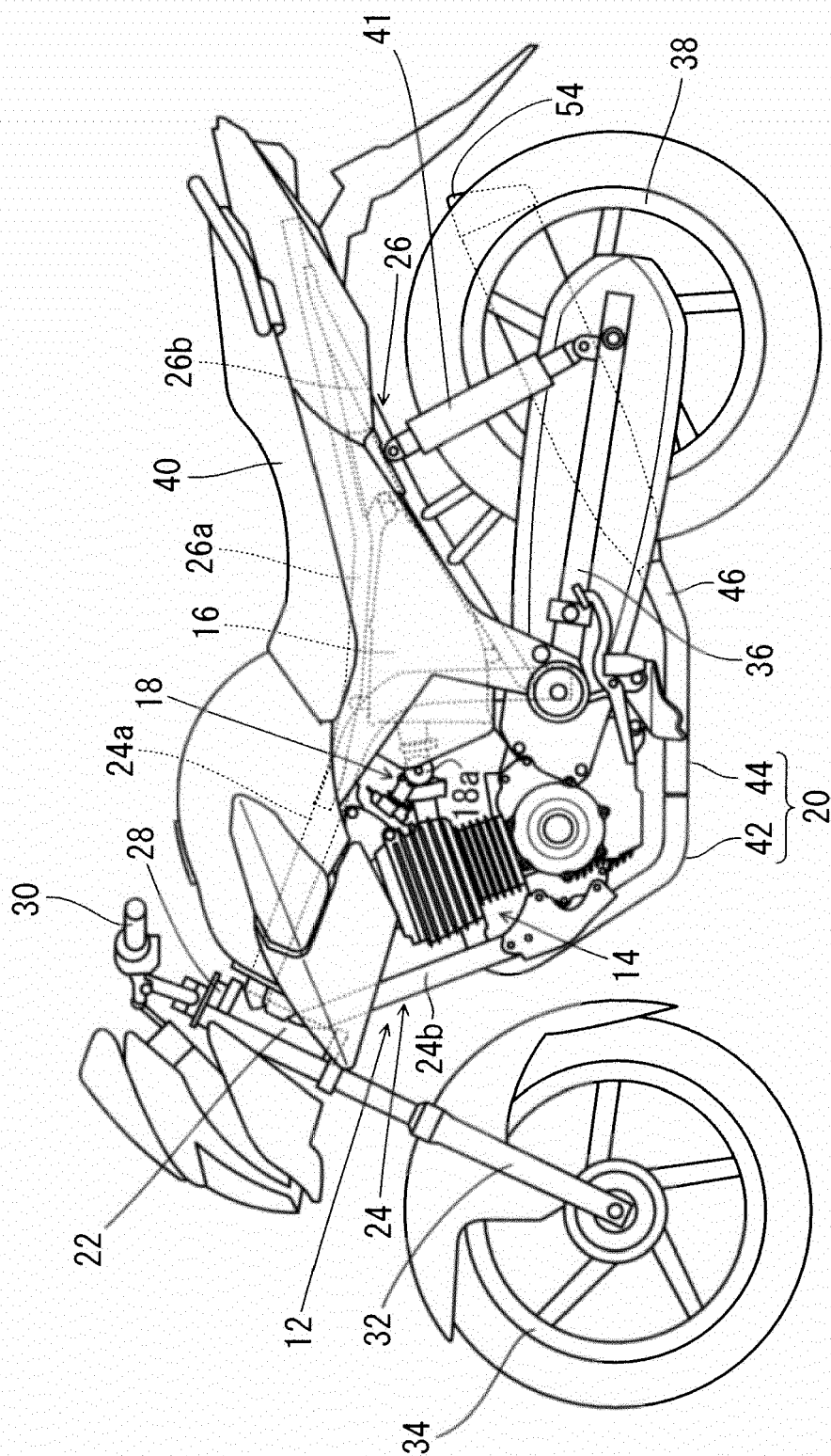


FIG. 2

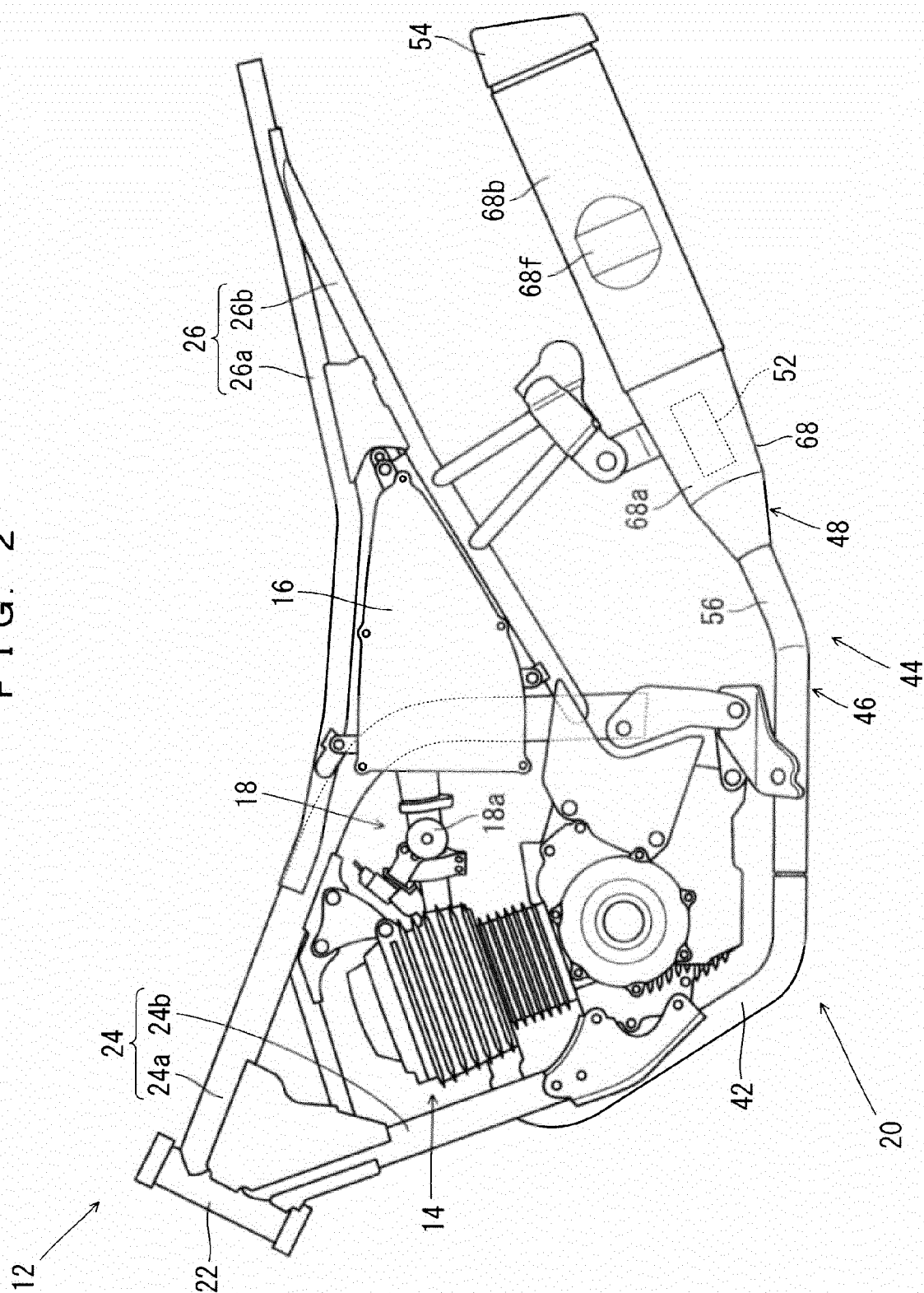


FIG. 4

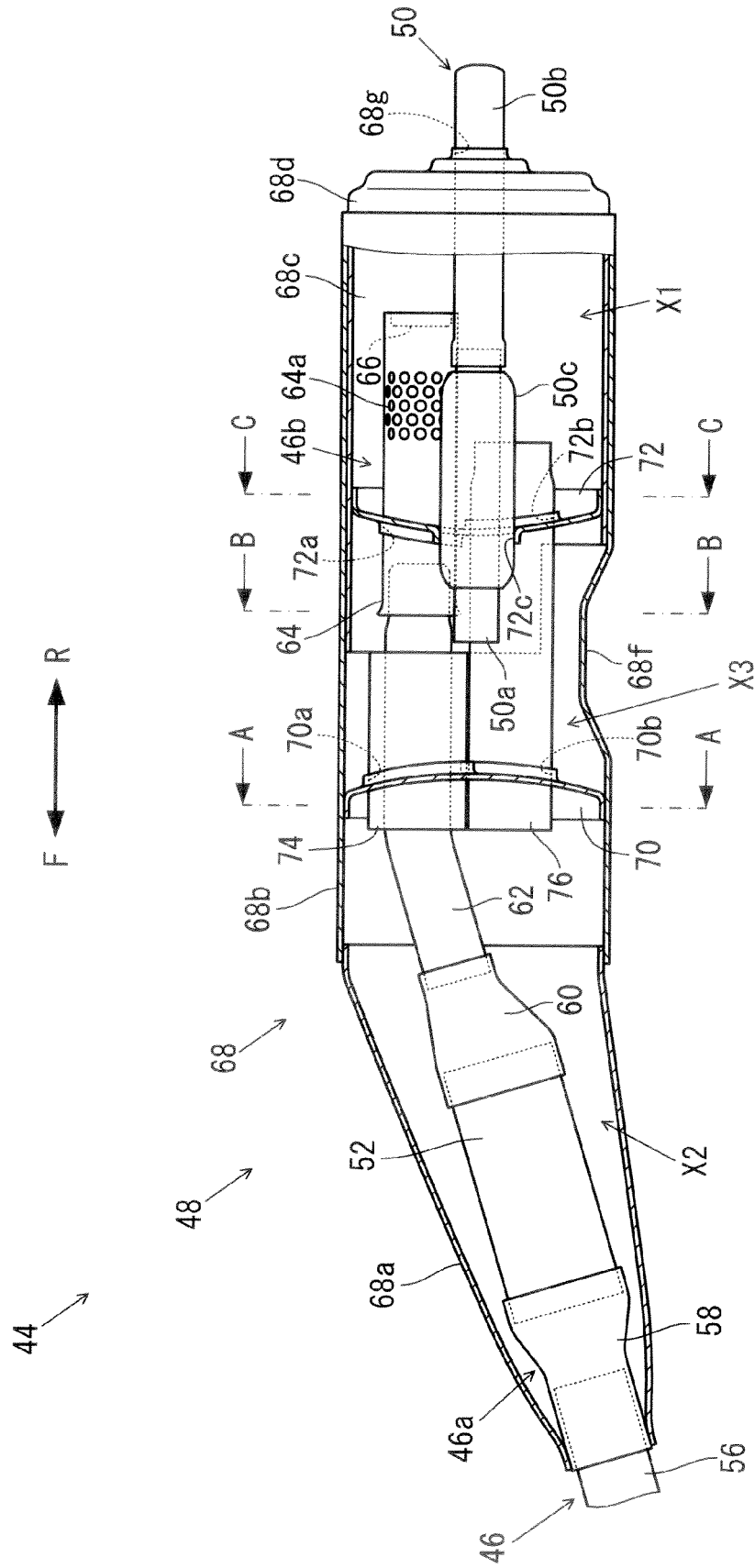


FIG. 5

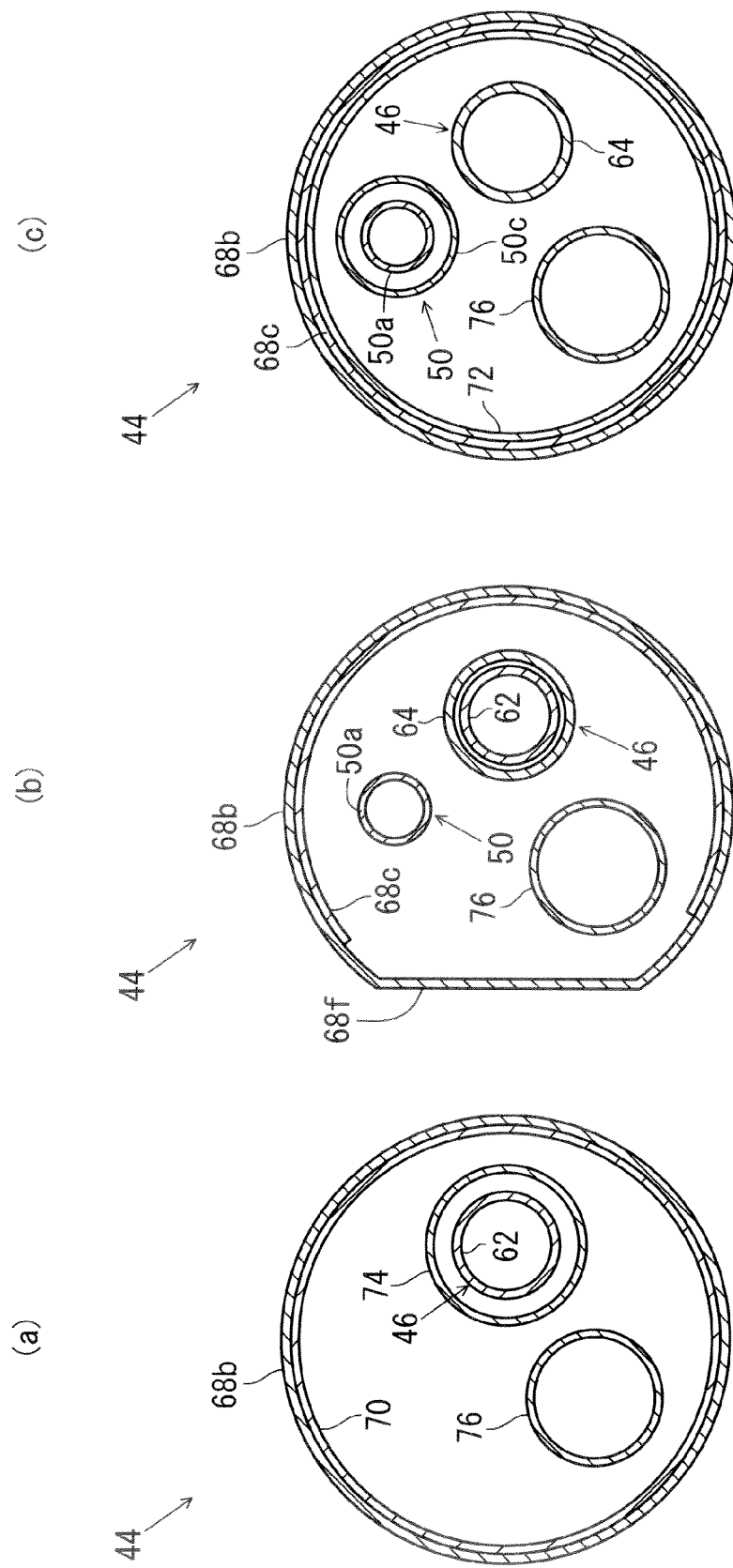
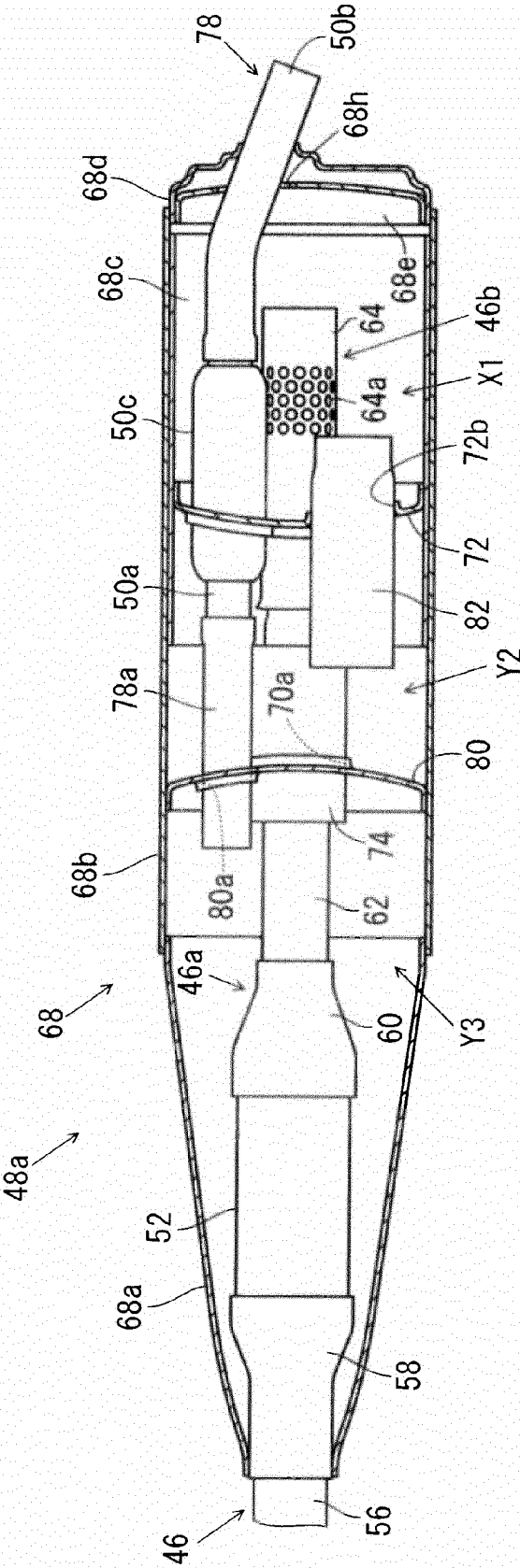


FIG. 6

F ← R



LEIGH

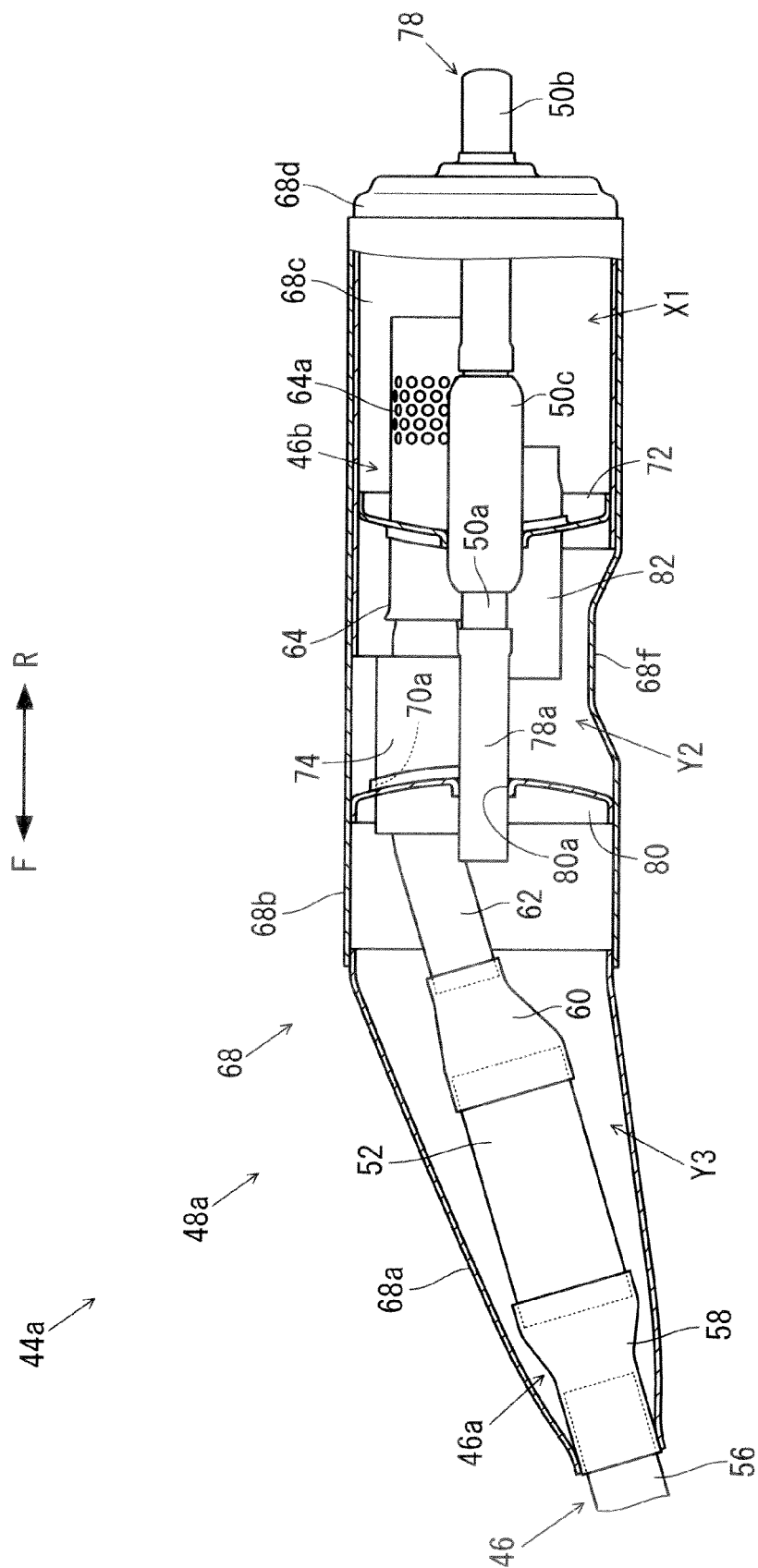


FIG. 8

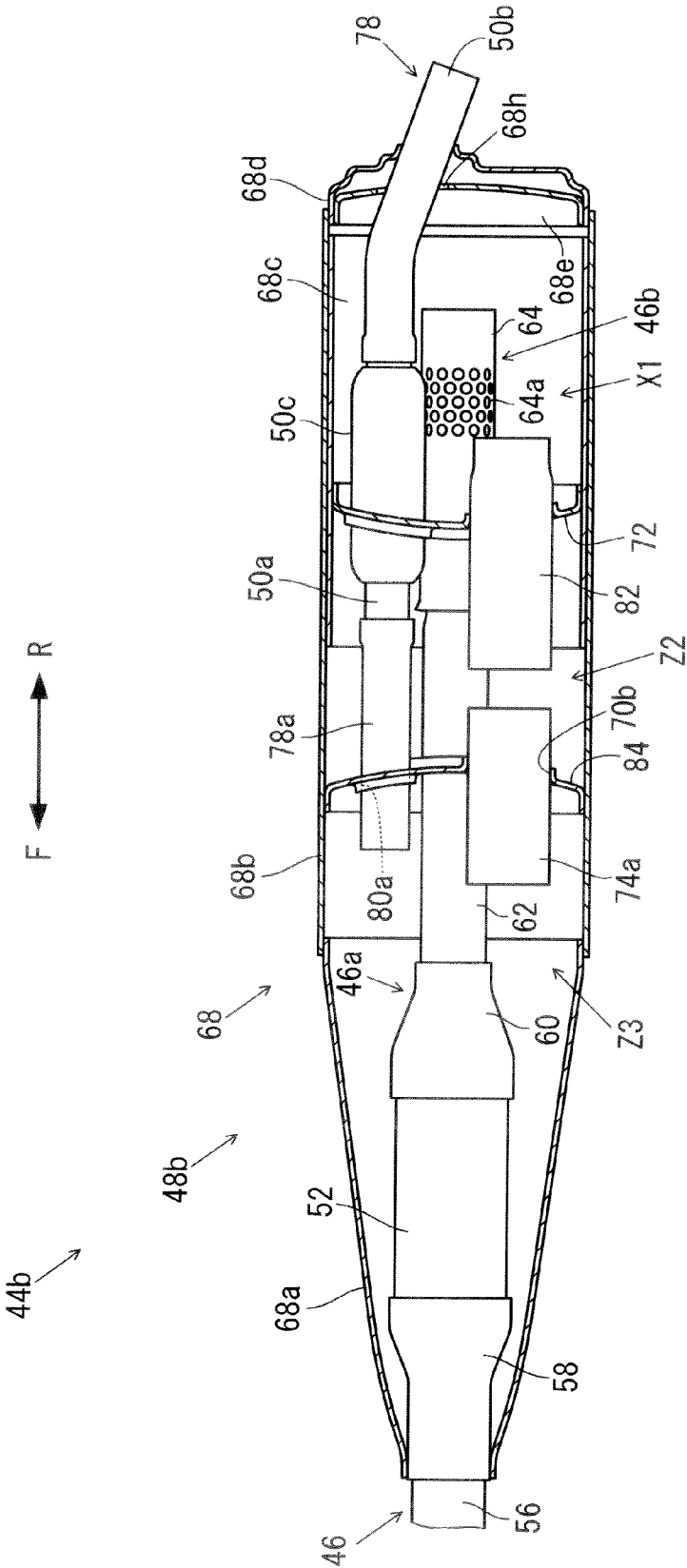
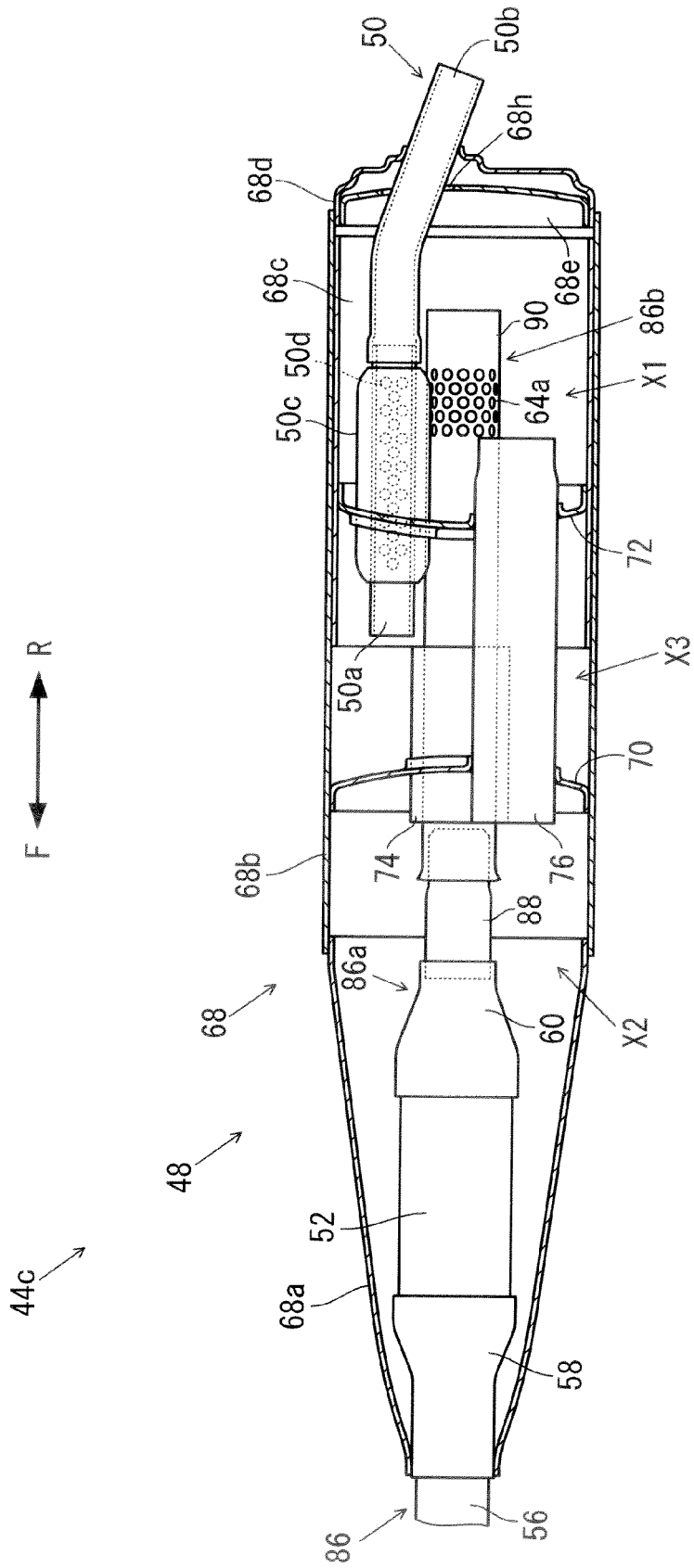


FIG. 9





EUROPEAN SEARCH REPORT

Application Number
EP 13 19 4540

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			F01N
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Place of search Munich		Date of completion of the search 21 March 2014	Examiner Seifert, Marco
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