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(54) EXHAUST PURIFICATION DEVICE

(57) An exhaust purification device having high exhaust purification performance can be implemented with a simple structure.

In an exhaust purification device in which catalyst is carried in a plurality of honeycomb bodies that are arranged in series so as to be spaced from one another through gaps, a single outer tube 55 constituting a part of an exhaust passage of an exhaust device 40 of an internal combustion engine is provided, a first honeycomb body 81, a second honeycomb body 82 and a third honeycomb body 83 are accommodated in this order from an upstream side of exhaust in the outer tube 55, the catalyst is carried in passages of the first honeycomb body 81, the second honeycomb body 82 and the third honeycomb body 83, the second honeycomb body 82 is shared as the same part as the third honeycomb body 83, the first honeycomb body 81 has the same outer diameter as the second honeycomb body 82 and the third honeycomb body 83, and the number of cells per unit area of cells comparted in a gird form in the first honeycomb body 81 is smaller than the number of cells in the third honeycomb body 83.

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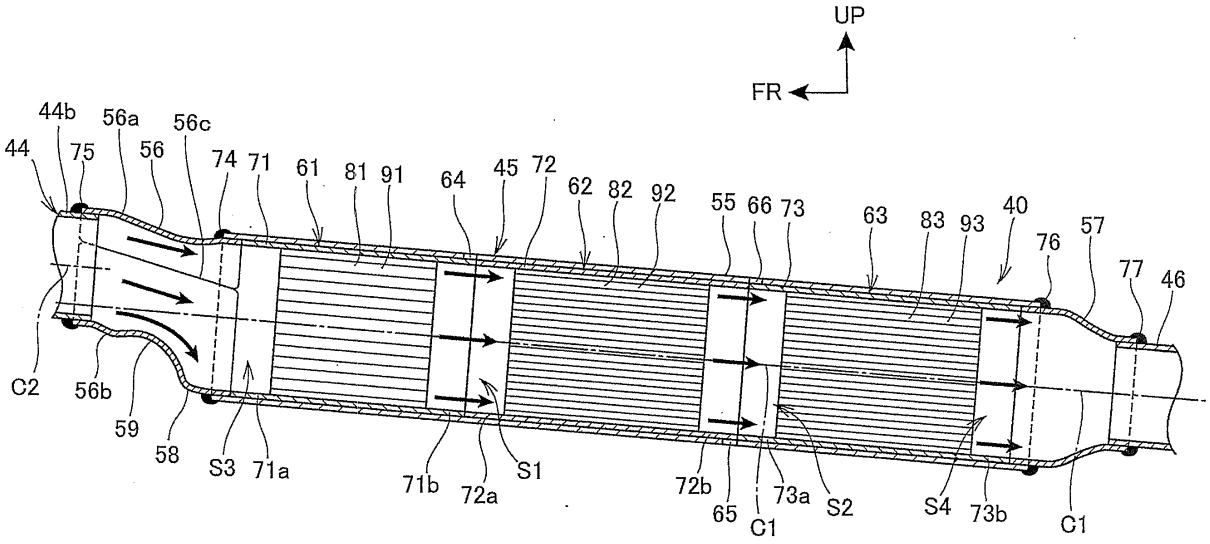
FIG.4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75
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81
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57
77
46
C2
56b
59
58
S3
71a
71b
72a
S1
72b
65
C1
73a
S2
S4
73b
C1

Description

Technical Field

[0001] The present invention relates to an exhaust purification device.

Background Art

[0002] An exhaust purification device having three honeycomb-shaped catalysts arranged in series in an exhaust device to enhance purification performance has been hitherto known as an exhaust purification device for exhaust gas of an internal combustion engine (see Patent Document 1, for example).

Prior Art Document

Patent Document

[0003] Patent Document 1: JP-A-2010-37965

Summary of the Invention

Problem to be solved by the Invention

[0004] In the conventional exhaust purification device described above, the purification performance is enhanced by changing the outer diameters or the like of the catalysts in conformity with the arrangement places of the catalysts. In the above exhaust purification device, a first catalyst carrier at the upstream side and a second catalyst carrier at the downstream side are different in outer diameter, and the second catalyst carrier and a third catalyst carrier are different in length whereas they are the same in outer diameter. Therefore, it is necessary to prepare three kinds of catalyst carriers, and thus the structure is complicated.

[0005] The present invention has been implemented in view of the foregoing circumstances, and has an object to provide an exhaust purification device having high exhaust purification performance with a simple structure.

Means of solving the Problem

[0006] The whole content of Japanese Patent Application No. 2013-030999 filed on February 20, 2013 is contained in this specification.

[0007] In order to attain the above object, according to the present invention, an exhaust purification device in which catalyst is carried in a plurality of honeycomb bodies (81, 82, 83) that are arranged in series so as to be spaced from one another through gaps, is characterized in that a single outer tube (55) constituting a part of an exhaust passage of an exhaust device (40, 140) of an internal combustion engine (20, 120) is provided, a first honeycomb body (81), a second honeycomb body (82) and a third honeycomb body (83) are accommodated in this order from an upstream side of exhaust in the outer tube (55), the catalyst is carried in passages of the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83), the second honeycomb body (82) is shared as the same part as the third honeycomb body (83), the first honeycomb body (81) has the same outer diameter as the second honeycomb body (82) and the third honeycomb body (83), and the number of cells per unit area of cells comparted in a gird form in the first honeycomb body (81) is smaller than the number of cells in the third honeycomb body (83).

[0008] According to the present invention, the second honeycomb body and the third honeycomb body are shared, and further the three honeycomb bodies are configured to have the same outer diameter, so that the structure can be simplified. In addition, by a rectifying effect obtained by the first honeycomb body whose cell number is smaller than that of the honeycomb bodies at the downstream side, exhaust can be made to uniformly flow to the second honeycomb body and the third honeycomb body. Therefore, the exhaust purification device having high exhaust purification performance can be implemented with a simple structure.

[0009] According to the present invention, holding tubes (71, 72, 73) in which the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83) are held are provided, the holding tubes (71, 72, 73) have protrusion portions (71b, 72a, 72b, 73a) that further protrude from end faces of the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83) respectively, and the protrusion portions (71b, 72a, 72b, 73a) are made to butt against one another to form gaps (S1, S2) between the respective honeycomb bodies (81, 82, 83).

[0010] According to the present invention, the respective protrusion portions of the holding tubes are made to butt

against one another, thereby forming the gap between the respective honeycomb bodies. Therefore, the gap can be highly precisely formed between the honeycomb bodies with a simple structure.

[0011] The present invention is characterized in that welding positions at which the holding tubes (71, 72, 73) of at least two adjacent honeycomb bodies (81, 82, 83) are welded to the outer tube (55) are set to be different from each other in an outer peripheral direction between an upstream position and a downstream position.

[0012] According to the present invention, the welding positions of the holding tubes of the honeycomb bodies and the outer tube are set to be different from each other in the outer peripheral direction between the upstream position and the downstream position. Therefore, an effect of heat of the welding on the outer tube can be dispersed, and the exhaust purification device can be formed with a high precision.

[0013] Furthermore, the present invention is characterized in that funnel-shaped connection pipes (56, 57) connected to exhaust pipes (44, 46) that are arranged at front and rear sides of the outer tube (55) and smaller in diameter than the outer tube (55) are arranged so as to pinch the holding tubes (71, 72, 73) of the three honeycomb bodies (81, 82, 83) in the outer tube (55) at the front and rear sides of the outer tube (55).

[0014] According to the present invention, the funnel-shaped connection pipes are arranged so as to pinch the holding tubes of the three honeycomb bodies in the outer tube at the front and rear sides of the outer tube. Therefore, it is unnecessary to provide any special construction for supporting the holding tubes, and thus the holding tubes can be supported with a simple structure.

[0015] Furthermore, the present invention is characterized in that the connection pipe (56) provided at the upstream side connects the outer tube (55) and the exhaust pipe (44) at the upstream side whose axial center (C2) is set to be offset from an axial center (C1) of the outer tube (55), and the connection pipe (56) has a recess (59) curving and upheaving to the inside of the connection pipe (56) on a slope surface (58) at an opposite side to a side at which the exhaust pipe (44) is offset.

[0016] According to the present invention, the connection pipe has the recess which curves and upheaves to the inside of the connection pipe and is provided on the slope surface of the connection pipe at the opposite side to the side at which the exhaust pipe is offset. Therefore, the exhaust can be made to diffuse along the curving and upheaving recess, and flow into the broad area of the first honeycomb body. Therefore, the purification performance of the exhaust purification device can be enhanced.

[0017] Furthermore, the present invention is characterized in that no catalyst is carried in the first honeycomb body (81) at the most upstream side out of the three honeycomb bodies (81, 82, 83).

[0018] According to the present invention, no catalyst is carried in the first honeycomb body at the most upstream side. Therefore, the use amount of catalyst to be carried can be reduced in accordance with required purification performance, and the exhaust can be uniformly rectified by the first honeycomb body, whereby the purification performance in the honeycomb body at the downstream side can be enhanced.

[0019] Still furthermore, the present invention is characterized in that the outer tube (55) is disposed at some position of the exhaust pipe (41) passing over a lower side of the internal combustion engine (20).

[0020] According to the present invention, by merely disposing the single outer tube below the internal combustion engine, the exhaust purification device having high purification performance can be provided without greatly changing the exhaust device.

[0021] Still furthermore, the present invention is characterized in that the outer tube (55) is disposed in a muffler (142) of the exhaust device (140) to be near to the front of the muffler (142).

[0022] According to the present invention, the space at the downstream side in the muffler can be secured, and the exhaust purification device having high purification performance can be provided without greatly changing the shape of the muffler.

[0023] According to the present invention, an exhaust purification device in which catalyst is carried in a plurality of honeycomb bodies (81, 82, 83) that are arranged in series so as to be spaced from one another through gaps, is characterized in that a first honeycomb body (81), a second honeycomb body (82) and a third honeycomb body (83) are accommodated in this order from an upstream side of exhaust in a part of an exhaust passage of an exhaust device (40, 140) of an internal combustion engine (20, 120), catalyst is carried in passages of the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83), the second honeycomb body (82) is shared as the same part as the third honeycomb body (83), the first honeycomb body (81) has the same outer diameter as the second honeycomb body (82) and the third honeycomb body (83), and the number of cells per unit area of cells comparted in a gird form in the first honeycomb body (81) is smaller than the number of cells in the third honeycomb body (83).

[0024] According to the present invention, the second honeycomb body and the third honeycomb body can be configured to be shared, and the three honeycomb bodies are configured to have the same outer diameter, whereby the structure can be simplified. In addition, the exhaust can be made to uniformly flow to the second honeycomb body and the third honeycomb body with the rectifying effect obtained by the first honeycomb body whose cell number is smaller than the cell number of the honeycomb bodies at the downstream side. Therefore, the exhaust purification device having high exhaust purification performance can be implemented with a simple structure.

[0025] Furthermore, the present invention is characterized in that the length in the axial direction of the first honeycomb body (81) is set to be smaller than the length in the axial direction of the third honeycomb body (83).

[0026] According to the present invention, the resistance to the exhaust in the first honeycomb body can be suppressed while the rectifying effect is obtained in the first honeycomb body.

Effect of the Invention

[0027] In the exhaust purification device according to the present invention, the second honeycomb body and the third honeycomb body are shared, and further the three honeycomb bodies are configured to have the same outer diameter, so that the structure can be simplified. In addition, by a rectifying effect obtained by the first honeycomb body whose cell number is smaller than that of the honeycomb bodies at the downstream side, exhaust can be made to uniformly flow to the second honeycomb body and the third honeycomb body. Therefore, the exhaust purification device having high exhaust purification performance can be implemented with a simple structure.

[0028] Furthermore, the gap can be highly precisely formed between the respective honeycomb bodies with a simple structure.

[0029] The effect of the welding heat on the outer tube can be dispersed, and the exhaust purification device can be formed with high precision.

[0030] Furthermore, no special construction for supporting the holding tube is necessary, and the holding tube can be supported with a simple structure.

[0031] Still furthermore, the exhaust diffuses along the recess which curves and upheaves in the connection pipe, and the exhaust can be made to flow over the broad area of the first honeycomb body, so that the purification performance of the exhaust purification device can be enhanced.

[0032] The use amount of the catalyst to be carried can be reduced in accordance with the required purification performance, and the exhaust can be uniformly rectified by the first honeycomb body, whereby the purification performance in the honeycomb body at the downstream side can be enhanced.

[0033] Furthermore, the exhaust purification device having high purification performance can be provided without greatly changing the exhaust device by merely disposing the single outer tube below the internal combustion engine.

[0034] Still furthermore, the space at the downstream side in the muffler can be secured, and the exhaust purification device having high purification performance can be provided without greatly changing the shape of the muffler.

[0035] Still furthermore, the resistance to the exhaust in the first honeycomb body can be suppressed while obtaining the rectifying effect in the first honeycomb body.

Brief Description of the Drawings

[0036]

[Fig. 1] is a right side view showing a motorcycle according to a first embodiment of the present invention.
[Fig. 2] is a side view of an exhaust device when the exhaust device is viewed from the inside in a vehicle width direction.
[Fig. 3] is a side view of an exhaust pipe.
[Fig. 4] is a cross-sectional view of a catalyst accommodating pipe.
[Fig. 5] is a right side view of a motorcycle according to a second embodiment.
[Fig. 6] is a plan view of a muffler when the muffler is viewed from the upper side.
[Fig. 7] is a cross-sectional view of VII-VII of Fig. 6.

Modes for carrying out the Invention

[0037] Embodiments according to the present invention will be described hereunder with reference to the drawings. In the description, directions such as front-and-rear direction and right-and-left direction are the same as the directions based on the vehicle body if not otherwise specified. Character FR in the respective figures represents the front side of the vehicle body, character UP represents the upper side of the vehicle body, and character LE represents the left side of the vehicle body.

[First Embodiment]

[0038] Fig. 1 is a right side view of a motorcycle according to a first embodiment.

[0039] The motorcycle 1 is a saddle-type vehicle in which an engine 20 is disposed at the center in the front-and-rear direction of a vehicle body frame F, a front fork 10 for supporting a front wheel 2 is steerably supported at the front end

of the vehicle body F, a swing arm 11 for supporting a rear wheel 3 is provided at the rear portion side of the vehicle body frame F, and a seat 12 on which a vehicle occupant sits is provided at the upper side of the vehicle body frame F. Most of the vehicle body frame F is covered by a vehicle body cover C formed of resin.

[0040] The vehicle body frame F has a head pipe (not shown) provided at the front end, a pair of right and left main frames 13 extending rearwards from the head pipe so as to be inclined downwardly, a pair of right and left center frames 14 extending downwards from the rear ends of the main frames 13, a pair of right and left seat frames (not shown) extending rearwards and upwards from the upper portions of the center frames 14 to the rear portion of the vehicle, and a down frame (not shown) extending downwards from the front portions of the main frames 13.

[0041] The seat frames are provided with step stays 18 for supporting tandem steps 17 for a vehicle occupant on a rear seat 12a.

[0042] The front fork 10 is freely turnably pivoted through a steering shaft (not shown) by the head pipe, and the front wheel 2 is pivotally supported by the lower portion of the front fork 10. A steering handle 15 is fixed to the upper end of the front fork 10.

[0043] The swing arm 11 is freely turnably and pivotally supported by a pivot shaft 16 which is inserted in the center frame 14 in the vehicle width direction, and the rear wheel 3 is pivotally supported by the rear end of the swing arm 11.

[0044] An engine 20 is a water cooling type single-cylinder four-cycle engine. The engine 20 has a crankcase 21, a cylinder 22 provided to the upper surface of the front portion of the crankcase 21, and a cylinder head 23, and the cylinder axis L is provided to be tilted forwards.

[0045] The engine 20 is fixed to the center frames 14 and the down frame, and located at the lower side of the main frame 13.

[0046] A fuel tank 24 is disposed at the upper side of the main frames 13.

[0047] The vehicle cover C has a front cover 25 for covering the vehicle body frame F from the front side, front side covers 26 for covering the front portion of the vehicle body frame F and the upper portion of the engine 20, center covers 27 for covering the upper portions of the main frames 13 from the sides thereof, rear covers 28 for covering the seat frames from the sides thereof, and an under-cover 29 for covering the crankcase 21 from the lower side thereof.

[0048] An exhaust device 40 is connected to the engine 20. The exhaust device 40 has an exhaust pipe 41 connected to an exhaust port 23a of the front face of the cylinder head 23, and a muffler 42 connected to the rear end of the exhaust pipe 41. The muffler 42 has a muffler cover 43.

[0049] Fig. 2 is a side view of the exhaust device 40 when the exhaust device 40 is viewed from the inside in the vehicle width direction.

[0050] As shown in Figs. 1 and 2, the exhaust pipe 41 has an upstream-side exhaust pipe 44 (small-diameter exhaust pipe) which is drawn forwards and downwards from the exhaust port 23a and then extends downwards along the front face of the engine 20, a catalyst accommodating pipe 45 (exhaust purification device) which is connected to the downstream end of the upstream-side exhaust pipe 44 and extends rearwards along the bottom face of the crankcase 21, and a muffler connection pipe 46 (small-diameter exhaust pipe) which is bent outwards in the vehicle width direction from the downstream end of the catalyst accommodating pipe 45 and then extends rearwards. Specifically, the upstream-side exhaust pipe 44 is located substantially at the center in the vehicle width direction, the catalyst accommodating pipe 45 is obliquely disposed so as to be shifted more outwards in the vehicle width direction as it extends more rearwards, and the muffler connection pipe 46 is located below the pair of right and left center frames 14.

[0051] The muffler 42 is connected to the muffler connection pipe 46 at the lower side of the center frame 14. The muffler 42 has a box-shaped upstream-side muffler portion 47 connected to the muffler connection pipe 46, a rear connection pipe 48 extending rearwards from the upstream-side muffler portion 47, and a box-shaped downstream-side muffler portion 49 connected to the rear end of the rear connection pipe 48. The upstream-side muffler portion 47 constitutes an upstream-side expansion chamber in which exhaust gas passing through the exhaust pipe 41 expands, and the downstream-side muffler portion 49 constitutes a downstream-side expansion chamber in which exhaust gas flowing from the upstream-side muffler portion 47 to the rear connection pipe 48 expands. The inside of the downstream-side muffler portion 49 is partitioned into plural expansion chambers, and exhaust gas expanding here is exhausted from the tail pipe 50 at the rear end of the downstream-side muffler portion 49 to the rear side.

[0052] A stay 51 to be fixed to the lower portion of the center frame 14 is provided to the upper portion of the upstream-side muffler portion 47. A stay 52 to be fixed to the step stay 18 is provided to the upper portion of the downstream-side muffler portion 49.

[0053] The upper portion of the upstream-side exhaust pipe 44 is covered by the front side cover 26, and the side of the lower portion of the upstream-side exhaust pipe 44 and the side of the catalyst accommodating pipe 45 are covered by the under-cover 29. The muffler 42 is covered over the whole length thereof from the outside by the muffler cover 43. That is, the exhaust device 40 is wholly covered and hidden by the covers in side view.

[0054] Fig. 3 is a side view showing the exhaust pipe 41. As shown in Fig. 3, the upstream-side exhaust pipe 44 has a flange portion 44a to be connected to the exhaust port 23a at the upstream end of the exhaust pipe 44. A bent pipe portion 44b which is bent to the rear side and then extends substantially horizontally is formed at the downstream end

of the upstream-side exhaust pipe 44.

[0055] The catalyst accommodating pipe 45 has an outer tube 55 as a catalyst case for accommodating catalyst, a funnel-shaped upstream-side taper pipe 56 (connection pipe) provided to the front end of the outer tube 55, and a funnel-shaped downstream-side taper pipe 57 (connection pipe) provided to the rear end of the outer tube 55.

[0056] The outer tube 55 is a pipe which extends to have substantially the same outer and inner diameters over the whole length and is configured to have a substantially circular cross-section, and disposed obliquely so that the axial line C1 (axial center) thereof is slightly inclined rearwards and downwards. The outer tube 55 is a single tube constituting a part of the exhaust passage of the exhaust device 40.

[0057] The upstream-side taper pipe 56 is a pipe through which the bent pipe portion 44b having a smaller diameter than the outer tube 55 and the outer tube 55 are connected to each other, and it is configured in such a taper shape as to be tapered to the upstream side thereof. The bent pipe portion 44b is disposed to be offset upwards with respect to the outer tube 55, and the axial line C2 is offset upwards with respect to the axial line C1 although the axial line C2 (axial center) of the bent pipe portion 44b and the axial line C1 of the outer tube 55 are substantially parallel to each other. The offset amount is set to such a value that an extension line obtained by extending the upper surface of the downstream end of the bent pipe portion 44b in the axial direction is substantially coincident with the upper surface of the upstream end of the outer tube 55. Since the outer tube 55 is upwards offset as described above, the opposite surface to the offset surface of the upstream-side taper pipe 56, that is, the lower surface of the upstream-side taper pipe 56 is set as a slope surface 58 (slope face) which is inclined rearwards and downwards.

[0058] The downstream-side taper pipe 57 is a pipe through which the outer tube 55 and the muffler connection pipe 46 having a smaller diameter than the outer tube 55 are connected to each other, and is configured in such a taper shape as to be tapered to the downstream side.

[0059] Fig. 4 is a cross-sectional view of the catalyst accommodating pipe 45.

[0060] As shown in Fig. 4, a first catalyst unit 61, a second catalyst unit 62 and a third catalyst unit 63 are arranged in series in the axial direction from the upstream side of the exhaust in this order in the outer tube 55.

[0061] The first catalyst unit 61 has a first holding tube 71 mounted in the outer tube 55, and a first honeycomb body 81 held in the first holding tube 71.

[0062] The second catalyst unit 62 has a second holding tube 72 mounted in the outer tube 55, and a second honeycomb body 82 held in the second holding tube 72.

[0063] The third catalyst unit 63 has a third holding tube 73 mounted in the outer tube 55, and a third honeycomb body 83 held in the third holding tube 73. The second catalyst unit 62 and the third catalyst unit 63 are formed of the same parts.

[0064] Each of the honeycomb bodies 81, 82, 83 is configured as a honeycomb-shaped porous structure having many cells (fine pores) which are arranged in a grid-like shape in the cylindrical outer shell of the honeycomb body so as to extend along the axial line direction, thereby increasing the surface area of the inside. Platinum, rhodium and palladium which decompose exhaust gas components are carried as catalyst in each of the honeycomb-shaped bodies 81, 82, 83 serving as catalyst carriers, whereby a first catalyst body 91, a second catalyst body 92 and a third catalyst body 93 are formed from the upstream side in this order. In this case, each of the honeycomb-shaped bodies 81, 82, 83 is configured as a metal honeycomb structure using metal as a base material. However, it is not limited to this metal honeycomb structure, and may be configured as a ceramic honeycomb structure having ceramic material as a base material.

[0065] The first honeycomb body 81 has the same outer diameter as the second honeycomb body 82 and the third honeycomb body 83, but the number of cells per unit area of the cells of the first honeycomb body 81 which are comparted in the grid form are set to be smaller than the number of cells per unit area of the second honeycomb body 82 and the third honeycomb body 83. The length in the axial direction of the first honeycomb body 81 is set to be shorter than the length of each of the second honeycomb body 82 and the third honeycomb body 83. The second honeycomb body 82 and the third honeycomb body 83 are identical to each other in the number of cells per unit area and the length in the axial direction because the second honeycomb body 82 and the third honeycomb body 83 are formed of the same parts. The length in the axial direction of the second honeycomb body 82 and the third honeycomb body 83 is set to be longer than the outer diameter of the second and third honeycomb bodies 82 and 83. The length in the axial direction of the first honeycomb body 81 is set to be substantially equal to the outer diameter thereof.

[0066] Here, as an example, the number of cells per square inch of each of the honeycomb bodies 81, 82, 83 is set to 400 for the second honeycomb body 82 and the third honeycomb body 83, and to 300 for the first honeycomb body 81. The number of cells per unit area of the first honeycomb body 81 is set in the range from 25% to 75% of the number of cells per unit area of each of the honeycomb bodies 82, 83 at the downstream side from the viewpoint of purification performance and a rectifying effect.

[0067] The first holding tube 71 is a hollow cylinder which is longer in the axial direction than the first honeycomb body 81, and the first honeycomb body 81 is fixed to an intermediate portion in the axial direction of the first holding tube 71. That is, the first holding tube 71 has protrusion portions 71a, 71b which further protrude in the axial direction from both the end faces of the first honeycomb body 81.

[0068] The second holding tube 72 is a hollow cylinder which is longer in the axial direction than the second honeycomb body 82, and the second honeycomb body 82 is fixed to an intermediate portion in the axial direction of the second holding tube 72. That is, the second holding tube 72 has protrusion portions 72a, 72b which further protrude in the axial direction from both the end faces of the second honeycomb body 72.

[0069] The third holding tube 73 is a hollow cylinder which is longer in the axial direction than the third honeycomb body 83, and the third honeycomb body 83 is fixed to an intermediate portion in the axial direction of the third holding tube 73. That is, the third holding tube 73 has protrusion portions 73a, 73b which further protrude in the axial direction from both the end faces of the third honeycomb body 83.

[0070] The respective holding tubes 71, 72 and 73 are configured to have the same outer diameter and inner diameter. The holding tubes 71, 72 and 73 are arranged in the outer tube 55 so as to butt against one another in the axial direction. Under the state that the holding tubes 71, 72, 73 butt against one another as described above, the total length of the respective holding tubes 71, 72, 73 is set to be shorter than the whole length of the outer tube 55. Therefore, gaps are formed at the inner peripheral portions of both the ends of the outer tube 55. The upstream-side taper pipe 56 and the downstream-side taper pipe 57 are fitted in these gaps. Specifically, the downstream end of the upstream-side taper pipe 56 is made to butt against the protrusion portion 71a, and the upstream end of the downstream-side taper pipe 57 is made to butt against the protrusion portion 73b, whereby the respective holding tubes 71, 72, 73 are clamped in the axial direction in the outer tube 55.

[0071] The respective holding tubes 71, 72, 73 are made to mutually butt against one another, whereby a gap S1 corresponding to only the protrusion portions 71b, 72a is formed in the axial direction between the first honeycomb body 81 and the second honeycomb body 82, and a gap S2 corresponding to only the protrusion portions 72b, 73a is formed in the axial direction between the second honeycomb body 82 and the third honeycomb body 83. The lengths in the axial direction of the gaps S1 and S2 are substantially equal to each other.

[0072] The upstream-side taper pipe 56 is made to butt against the first holding tube 71, whereby a gap S3 corresponding to only the protrusion portion 71a is formed in the axial direction between the downstream end of the upstream-side taper pipe 56 and the first honeycomb body 81. The downstream-side taper pipe 57 is made to butt against the third holding tube 73, whereby a gap S4 corresponding to only the protrusion portion 73b is formed in the axial direction between the upstream end of the downstream-side taper pipe 57 and the third honeycomb body 83.

[0073] A first welding hole 64 for plug welding is formed at the position corresponding to the end of the protrusion portion 71b of the first holding tube 71 on the upper surface of the outer peripheral surface of the outer tube 55. The first catalyst unit 61 is joined to the outer tube 55 with a welding bead 64a (Fig. 3) formed at the first welding hole 64.

[0074] A second welding hole 65 for plug welding is formed at the position corresponding to the end of the protrusion portion 72b of the second holding tube 72 on the lower surface of the outer peripheral surface of the outer tube 55. The second catalyst unit 62 is joined to the outer tube 55 with a welding bead 65a (Fig. 3) formed at the second welding hole 65. The second welding hole 65 is formed at a position which is different from the first welding hole 65 by substantially 180° in the peripheral direction.

[0075] A third welding hole 66 for plug welding is formed at the position corresponding to the end of the protrusion portion 73a of the third holding tube 73 on the upper surface of the outer peripheral surface of the outer tube 55. The third catalyst unit 63 is joined to the outer tube 55 with a welding bead 66a (Fig. 3) formed at the third welding hole 66. The third welding hole 66 is formed at a position which is different from the second welding hole 65 by substantially 180° in the peripheral direction.

[0076] The upstream-side taper pipe 56 is formed in a pipe-shape by combining gutter-shaped upper half body 56a and lower half body 56b and welding the upper and lower half bodies 56a and 56b at the mating faces 56c thereof. The upstream-side taper pipe 56 is joined to the outer tube 55 by the welding bead 74 which makes a circuit around the upstream end of the outer tube 55 under the state that the lower stream end of the upstream-side taper pipe 56 is fitted to the inner peripheral portion of the upstream end of the outer tube 55.

[0077] The downstream end of the bent pipe portion 44b is fitted to the inner peripheral portion of the upstream end of the upstream-side taper pipe 56, and welded to the upstream-side taper pipe 56 by the welding bead 75 which makes a circuit around the upstream end of the upstream-side taper pipe 56.

[0078] A recess 59 which curves and upheaves to the inside of the upstream-side taper pipe 56 is formed on the slope surface 58 of the upstream-side taper pipe 56. The upper end of the recess portion 59 is located at substantially the same height as the lower end of the downstream end of the bent pipe portion 44b.

[0079] The downstream-side taper pipe 57 is joined to the outer tube 55 by the welding bead 76 which makes a circuit around the downstream end of the outer tube 55 under the state that the upstream end of the downstream-side taper pipe 57 is fitted to the inner peripheral portion of the downstream end of the outer tube 55. The muffler connection pipe 46 is joined by the welding bead 77 under the state that the upstream end of the muffler connection pipe 46 is fitted to the inner peripheral portion of the downstream end of the downstream-side taper pipe 57.

[0080] Here, an example of a method of fabricating the catalyst accommodating pipe 45 will be described.

[0081] First, the first catalyst unit 61, the second catalyst unit 62 and the third catalyst unit 63 which have been formed

in advance are fitted to the inner peripheral portion of the outer tube 55, and made to butt against one another. Since the second catalyst unit 62 and the third catalyst unit 63 are the same parts, and thus it is unnecessary to discriminate them from each other. When they are made to butt against one another, the butting positions of the catalyst units 61, 62 and 63 are settled by a jig provided in the outer tube 55 or the like, or the upstream-side taper pipe 56 is welded, whereby the catalyst units 61, 62, 63 can be made to butt against one another and accurately positioned. Subsequently, the catalyst units 61, 62 and 63 are pinched by the upstream-side taper pipe 56 and the downstream-side taper pipe 57, and the upstream-side taper pipe 56 and the downstream-side taper pipe 57 are welded and fixed under the above state. Thereafter, the respective catalyst units 61, 62 and 63 are fixed to the outer tube 55 by plug welding of the welding holes 64, 65 and 66.

[0082] In the first embodiment, the second honeycomb body 82 and the third honeycomb body 83 are the same parts, and the second holding tube 72 and the third holding tube 73 which hold these bodies are the same parts. Therefore, the outer diameter of the first honeycomb body 81 is equal to that of the third honeycomb body 83, and also the outer diameter of the first holding tube 71 is equal to that of the third holding tube 73, so that the manufacturing facilities for the catalyst units 61, 62, 63 can be shared, and the manufacturing process can be facilitated. Furthermore, the catalyst units 61, 62, 63 having the same outer diameter are fitted to the inner peripheral portion of the outer tube 55 which has the same diameter over the whole length thereof, so that the catalyst units 61, 62, 63 can be easily set to the outer tube 55 and thus the productivity is high.

[0083] The gaps S1 to S4 can be simply formed with high precision by merely making the catalyst units 61, 62, 63 butt against one another in the outer tube 55.

[0084] Furthermore, the catalyst units 61, 62, 63 are pinched by the upstream-side taper pipe 56 and the downstream-side taper pipe 57 and made to butt against one another, whereby the catalyst units 61, 62, 63 can be positioned in the axial direction with a simple construction, and the catalyst units 61, 62, 63 can be easily fixed in the peripheral direction by plug welding of the welding holes 64, 65, 66. Furthermore, the adjacent welding holes 64, 65, 66 are arranged at different positions in the peripheral direction, and thus the effect of the welding heat on the outer tube 55 can be dispersed. Since the catalyst units 61, 62, 63 are made to butt against one another and positioned with high precision, the plug welding can be performed at accurate positions, and the effect of this welding can be prevented from reaching the honeycomb bodies 81, 82 and 83.

[0085] Next, the flow of exhaust of the exhaust pipe 41 will be described. In Fig. 4, the flow of the exhaust is represented by arrows.

[0086] The exhaust of the engine 20 flows from the upstream-side exhaust pipe 44 through the upstream-side taper pipe 56 into the first catalyst body 91 to be purified, flows through the gap S1 into the second catalyst body 92, flows through the gap S2 into the third catalyst body 93 to be purified, and then flows through the muffler connection pipe 46 into the muffler 42.

[0087] Since the axial line C2 is upwards offset from the axial line C1 between the bent pipe portion 44b of the upstream-side exhaust pipe 44 and the outer tube 55, the amount of the exhaust flowing at the lower surface side of the upstream-side taper pipe 56 trends to be small. However, in the first embodiment, the slope surface 58 of the lower surface is provided with the recess 59 which curves and upheaves inwards, so that a part of the exhaust flow downwardly along the inner surface of the recess 59. Accordingly, the exhaust can be made to effectively flow to the slope surface 58 side of the first catalyst body 91, and the catalyst can purify over the whole body of the first catalyst body 91, whereby the purification performance can be enhanced.

[0088] The number of cells per unit area of the first honeycomb body 81 is smaller than those of the second honeycomb body 82 and the third honeycomb body 83, and the resistance of the first honeycomb body 81 to the flow of the exhaust is smaller than that of the second honeycomb body 82. Therefore, even when the exhaust passage from the bent pipe portion 44b to the outer tube 55 is enlarged in diameter, the exhaust at the upstream side of the first honeycomb body 81 can be radially diffused due to moderately large resistance of the first honeycomb body 81, and the exhaust can be made to uniformly flow to the whole face of the upstream end of the first honeycomb body 81, so that the purification performance can be enhanced. That is, the first honeycomb body 81 serves both as a catalyst body and as a rectifying member for rectifying and making the distribution in the radial direction of the exhaust flow uniform.

[0089] With respect to the exhaust flowing from the first honeycomb body 81 to the gap S1, the flow of the exhaust rectified at the first honeycomb body 81 is received and further diffused in the gap S1, and then flows into the second honeycomb 82. In the second honeycomb body 82, the number of cells per unit area is larger than that of the first honeycomb body 81, and also the exhaust rectified at the first honeycomb body 81 flows into the whole body of the second honeycomb body 82, so that high purification performance can be obtained.

[0090] The exhaust flowing from the second honeycomb body 82 to the gap S2 is further diffused in the gap S2, and flows into the third honeycomb body 83. The third honeycomb body 83 is formed of the same part as the second honeycomb body 82, and has a larger number of cells, and the exhaust which is made uniform at the upstream side flows in the third honeycomb body 83, so that the exhaust can be effectively purified over the whole body of the third honeycomb body 83.

[0091] As described above, according to the first embodiment to which the present invention is applied, the catalysts are carried in the passages of the first honeycomb body 81, the second honeycomb body 82 and the third honeycomb body 83 which are accommodated in the single outer tube 55, the second honeycomb body 82 is shared as the same part as the third honeycomb body 83, the first honeycomb body 81 has the same outer diameter as the second honeycomb body 82 and the third honeycomb body 83, and the number of cells per unit area of the cells comparted in the grid form in the first honeycomb body 81 is smaller than the number of cells of the third honeycomb body 83. Therefore, the second honeycomb body 82 and the third honeycomb body 83 are shared, and further the three honeycomb bodies 81, 82 and 83 are configured to have the same outer diameter, thereby simplifying the structure. In addition, the exhaust can be made to uniformly flow to the second honeycomb body 82 and the third honeycomb body 83 by the rectifying effect which is obtained by the first honeycomb body 81 having a smaller number of cells than the second honeycomb body 82 and the third honeycomb body 83 at the downstream side. Therefore, the catalyst accommodating pipe 45 having high exhaust purification performance can be implemented with a simple structure.

[0092] Furthermore, the first holding tube 71, the second holding tube 72 and the third holding tube 73 which hold the first honeycomb body 81, the second honeycomb body 82 and the third honeycomb body 83 therein are provided, and the holding tubes 71, 72 and 73 respectively have the protrusion portion 71b, the protrusion portions 72a and 72b and the protrusion portion 73a which further protrude from the respective end faces of the honeycomb bodies 81, 82 and 83 respectively, and the protrusion portions 71b, 72a, 72b, 73a are made to butt against one another, whereby the gaps S1, S2 are respectively formed between the respective honeycomb bodies 81, 82, 83. Therefore, by setting the gaps S1, S2 with high precision, the exhaust can be efficiently diffused through the gaps S1, S2 according to the setting, whereby the purification performance can be enhanced.

[0093] The welding positions of the respective holding tubes 71, 72 of the adjacent first and second honeycomb bodies 81 and 82 and the outer tube 55 are set to the welding hole 64 at the upstream side and the welding hole 65 at the downstream side which are positionally different from each other in the outer peripheral direction of the outer tube 55, so that the effect of the welding heat on the outer tube 55 can be dispersed, and the catalyst accommodating pipe 45 can be formed with high precision. Furthermore, the welding positions of the respective holding tubes 72, 73 of the adjacent second and third honeycomb bodies 82 and 83 and the outer tube 55 are set to the welding hole 65 at the upstream side and the welding hole 66 at the downstream side which are positionally different from each other in the outer peripheral direction of the outer tube 55, so that the effect of the welding heat on the outer tube 55 can be dispersed, and the catalyst accommodating pipe 45 can be formed with high precision.

[0094] Furthermore, the funnel-shaped upstream-side taper pipe 56 and the funnel-shaped downstream-side taper pipe 57 which are arranged at the front and rear sides of the outer tube 55 and connected to the exhaust pipe having a smaller diameter than the outer tube 55 are arranged at the front and rear sides of the outer tube 55 so that the respective holding tubes 71, 72, 73 of the three honeycomb bodies 81, 82, 83 are pinched in the outer tube 55. Therefore, it is unnecessary to provide a special construction for supporting the respective holding tubes 71, 72, 73, and the respective holding tubes 71, 72, 73 can be supported with a simple structure.

[0095] Furthermore, the upstream-side taper pipe 56 connects the outer tube 55 and the upstream-side exhaust pipe 44 which is disposed so that the axial line C2 thereof is offset from the axial line C1 of the outer tube 55, and also the upstream-side taper pipe 56 has the recess 59 curving and upheaving to the inside of the upstream-side taper pipe 56 on the slope surface 58 of the upstream-side taper pipe 56 at the opposite side to the side to which the upstream-side exhaust pipe 44 is offset. Therefore, the exhaust can be diffused along the curved surface of the recess 59, and the exhaust can be made to flow over the broad area of the first honeycomb body 81. Therefore, the purification performance of the catalyst accommodating pipe 45 can be enhanced.

[0096] Furthermore, the outer tube 55 is disposed at some position of the exhaust pipe 41 passing over a lower side of the engine 20. Therefore, the catalyst accommodating pipe 45 having high purification performance can be provided without greatly changing the exhaust device 40 by merely disposing the single outer tube 55 below the engine 20.

[0097] Furthermore, the length in the axial direction of the first honeycomb body 81 is smaller than the length in the axial direction of the third honeycomb body 83. Therefore, the exhaust resistance in the first honeycomb body 81 can be suppressed with obtaining the rectifying effect in the first honeycomb body 81.

[0098] The first embodiment described above is a mode to which the present invention is applied, and the present invention is not limited to the above first embodiment.

[0099] In the first embodiment, the catalyst is carried in the first honeycomb body 81 to form the first catalyst body 91. However, the present invention is not limited to this style. For example, the device may be configured so that no catalyst is carried in the first honeycomb body 81 at the most upstream side, and the first honeycomb body 81 is used as only the rectifying member. In this case, the using amount of the catalyst to be carried may be reduced according to the purification performance required to the catalyst accommodating pipe 45, and also the exhaust can be uniformly rectified by the first honeycomb body 81, whereby purification performance in each of the honeycomb bodies 82, 83 at the downstream side can be enhanced.

[0100] In the first embodiment, it is described that each of the honeycomb bodies 81, 82, 83 is held by each of the

holding tubes 71, 72, 73. However, the present invention is not limited to this style, and the device may be configured so that the respective holding tubes 71, 72, 73 are not provided, and the respective honeycomb bodies 81, 82, 83 are arranged in series in the outer tube 55 so as to be mutually spaced from one another. In this case, since the second honeycomb body 82 and the third honeycomb body 83 are also formed of the same parts, and the outer diameter of the first honeycomb body 81 is also equal to the outer diameter of the second and third honeycomb bodies 82 and 83, the manufacturing facilities for the honeycomb bodies 81, 82, 83, etc. can be simply constructed, and the respective honeycomb bodies 81, 82, 83 can be easily assembled in the outer tube 55.

[0101] Furthermore, in the first embodiment, it is described that the lengths in the axial direction of the gap S1 and the gap S2 are substantially equal to each other. However, the present invention is not limited to this style, and the length of the gap S1 may be set to be longer than the length of the gap S2, for example. In this case, the exhaust which is rectified at the first honeycomb body 81 side and then reaches the gap S1 is easily further diffused in the gap S1, so that the purification performance can be enhanced.

[0102] In the first embodiment, it is described that the first honeycomb body 81, the second honeycomb body 82 and the third honeycomb body 83 are accommodated in the single outer tube 55. However, the present invention is not limited to this style. For example, plural pipes may be connected to one another in the axial direction to constitute an outer tube, and then the first honeycomb body 81, the second honeycomb body 82 and the third honeycomb body 83 may be accommodated in the outer tube.

[Second Embodiment]

[0103] A second embodiment to which the present invention is applied will be described hereunder with reference to Figs. 5 to 7. In the second embodiment, the same constituent parts as the first embodiment are represented by the same reference numerals, and the description thereof is omitted.

[0104] In the first embodiment, it is described that the catalyst accommodating pipe 45 is disposed below the engine 20. The second embodiment is different from the first embodiment in that the catalyst accommodating pipe 145 is disposed in the muffler 142.

[0105] Fig. 5 is a right side view showing a motorcycle 101 according to a second embodiment.

[0106] The motorcycle 101 is a saddle-type vehicle in which an engine 120 is disposed at the center in the front-and-rear direction of a vehicle body frame 108, a front fork 110 for supporting a front wheel 102 is steerably supported at the front end of the vehicle body frame 108, a swing arm 111 for supporting a rear wheel 103 is provided at the rear portion side of the vehicle body frame 108, and a seat 112 on which a vehicle occupant sits is provided at the upper side of the vehicle body frame 108. Most of the vehicle body frame 108 is covered by a vehicle body cover 105 formed of resin.

[0107] The vehicle body frame 108 has a head pipe (not shown) provided at the front end of the vehicle body frame 108, a pair of right and left main frames 113 which obliquely extends rearwards and downwards from the head pipe, a pair of right and left center frames 114 which extend downwards from the rear ends of the main frames 113, a pair of right and left seat frames 119 which extend rearwards and upwards from the upper portions of the center frames 114 to the rear portion of the vehicle, and a down frame (not shown) extending downwards from the front portions of the main frames 113.

[0108] The seat frames 119 are provided with step stays 118 for supporting the tandem steps 117 for the vehicle occupant of the rear seat 112a.

[0109] The front fork 110 is pivotally supported through a steering shaft (not shown) by the head pipe so as to be freely turnable, and the front wheel 102 is supported through a shaft at the lower portion of the front fork 110. A steering handle 115 is fixed to the upper end of the front fork 110.

[0110] The swing arm 111 is pivotally supported through a pivot shaft 116 penetrating through the center frames 114 in the vehicle width direction so as to be freely turnable, and the rear wheel 103 is supported through a shaft by the rear end of the swing arm 111.

[0111] An engine 120 is a water cooling type single-cylinder four-cycle engine. The engine 120 has a crankcase 121, a cylinder 122 provided to the upper surface of the front portion of the crankcase 121, and a cylinder head 123, and the cylinder axis 106 is provided to be tilted forwards.

[0112] The engine 120 is fixed to the center frames 114 and the down frame, and located at the lower sides of the main frames 113.

[0113] A fuel tank 124 is disposed at the upper side of the main frames 113.

[0114] The vehicle cover 105 has a front cover 125 for covering the vehicle body frame 108 from the front side, front side covers 126 for covering the front portion of the vehicle body frame 108 and the upper portion of the engine 20, center covers 127 for covering the upper portions of the main frames 113 from the sides thereof, rear covers 28 for covering the seat frames 119 from the sides thereof, and an under-cover 129 for covering the crankcase 21 from the lower side thereof.

[0115] An exhaust device 140 is connected to the engine 120. The exhaust device 140 has an exhaust pipe 141

connected to an exhaust port 123a of the front face of the cylinder head 123, and a muffler 142 connected to the rear end of the exhaust pipe 141. The front portion of the muffler 142 is covered by a muffler cover 143.

[0116] The exhaust pipe 141 extends downwards from the exhaust port 123a along the front face of the engine 120, bends rearwards, passes below the engine 120 and extends to the lower side of one center frame 114.

[0117] The muffler 142 is connected to the rear end of the exhaust pipe 141 below the center frame 114. The muffler 142 passes over the outside of the swing arm 111, extends rearwards and upwards, and then is fixed to the step stay 118 through the stay 151 on the upper surface of the rear portion of the muffler 142.

[0118] Fig. 6 is a plan view taken when the muffler 142 is viewed from the upper side.

[0119] The muffler 142 is configured as a multi-stage expansion type in which a cylindrical catalyst accommodating pipe 145 and plural expansion chambers are provided in a box-shaped muffler case 131 extending in the front-and-rear direction. The muffler case 131 has a front case 132 for covering the catalyst accommodating pipe 145 and a rear case 133 which forms the outer walls of the expansion chambers.

[0120] The front case 132 is formed in a pipe-shape so as to have a larger diameter than the catalyst accommodating pipe 145, and has a taper pipe portion tapered to the tip side at the upstream end of the front case 132. The catalyst accommodating pipe 145 is configured so that the upstream end thereof is fitted to the inner diameter portion of the taper pipe portion 132a, and extends to the rear portion of the front case 132 in the front case 132.

[0121] Partition walls 134, 135 through which an expansion chamber is partitioned in the front-and-rear direction are arranged at the front and rear portions in the rear case 133. By providing the partition walls 134, 135, a third expansion chamber Z, a second expansion chamber Y and a first expansion chamber X are formed in this order from the front end side in the muffler 142. The third expansion chamber Z is a space formed around the catalyst accommodating pipe 145 in the front case 132.

[0122] A first intercommunication pipe 137a (small-diameter exhaust pipe) connected to the downstream end of the catalyst accommodating pipe 145 penetrates through the partition walls 134, 135 and extends to the first expansion chamber X. The first expansion chamber X intercommunicates with the second expansion chamber Y through a second intercommunication pipe 137b penetrating through the partition wall 135. The second expansion chamber Y intercommunicates with the third expansion chamber Z through a third intercommunication pipe (not shown) penetrating through the partition wall 134. The third expansion chamber Z intercommunicates with the outside through a tail pipe 138 which penetrates through the partition walls 134, 135 and is opened to the rear face of the muffler case 131. The exhaust of the engine 120 passes through the exhaust pipe 141, flows from the catalyst accommodating pipe 145 into the muffler 142, flows into the first expansion chamber X, the second expansion chamber Y and the third expansion chamber Z in this order, and then is discharged from the tail pipe 138 to the outside.

[0123] Fig. 7 is a cross-sectional view of VII-VII of Fig. 6.

[0124] As shown in Fig. 7, the catalyst accommodating pipe 145 has a similar structure to that of the catalyst accommodating pipe 45 described in the first embodiment. Therefore, the same parts as the first embodiment are represented by the same reference numerals as the first embodiment, the description thereof is omitted, and different portions will be described hereunder.

[0125] The structure of the catalyst accommodating pipe 145 is the same as the catalyst accommodating pipe 45 except that the upstream-side taper pipe 56 and the downstream-side taper pipe 57 of the catalyst accommodating pipe 45 of the first embodiment are changed to other pipes and also the respective lengths in the axial direction of the honeycomb bodies 81, 82, 83 are smaller than the respective outer diameters thereof.

[0126] The catalyst units 61, 62 and 63 are accommodated in the outer tube 55, and the funnel-shaped upstream-side taper pipe 156 (connection pipe) and downstream-side taper pipe 157 (connection pipe) are connected to the inner peripheral portions of the upstream end and downstream end of the outer tube 55. The catalyst units 61, 62, 63 are pinched in the axial direction by the upstream-side taper pipe 156 and the downstream-side pipe 157.

[0127] The upstream-side taper pipe 156 is formed in a taper-shape tapered to the upstream side, and a joint pipe 178 (small-diameter exhaust pipe) having a smaller diameter than the outer tube 55 is joined to the inner diameter portion of the upstream end of the upstream-side taper pipe 156. The front end of the joint pipe 178 is fitted to the taper pipe portion 132a of the front case 132, whereby the catalyst accommodating pipe 145 is connected to the front case 132. The rear end of the exhaust pipe 141 is connected to the joint pipe 178, whereby the muffler 142 is connected to the exhaust pipe 141.

[0128] The rear end of the exhaust pipe 141 is connected to the joint pipe 178. The axial line C3 of the joint pipe 178 and the axial line C4 of the upstream-side taper pipe 156 are substantially coincident with the axial line C1 of the outer tube 55.

[0129] The downstream-side taper pipe 157 is formed in a taper-shape tapered to the downstream side, and the first intercommunication pipe 137a having a smaller diameter than the outer tube 55 is joined to the downstream end of the downstream-side taper pipe 157.

[0130] The exhaust flowing from the exhaust pipe 141 into the upstream-side taper pipe 156 can be diffused in the radial direction at the upstream side of the first honeycomb body 81 by moderately large resistance in the first honeycomb

body 81. Therefore, the exhaust can be made to uniformly flow to the whole surface of the upstream end of the first honeycomb body 81, and high purification performance can be obtained. Thereafter, the exhaust which is made uniform in the first honeycomb body 81 is efficiently purified in the second honeycomb body 82 and the third honeycomb body 83 which have a larger number of cells.

[0131] According to the second embodiment, the single outer tube 55 is disposed in the muffler 142 of the exhaust device 140 to be near to the front of the muffler 142. Accordingly, the space at the downstream side in the muffler 142 can be secured, whereby the expansion chamber can be enlarged, and also the catalyst accommodating pipe 145 having high purification performance can be provided without greatly changing the shape of the muffler 142. Furthermore, the lengths in the axial direction of the honeycomb bodies 81, 82, 83 are set to be smaller than the respective outer diameters thereof, whereby the outer diameters of the honeycomb bodies are increased while the honeycomb bodies are made compact in the axial direction, thereby securing the volume of the honeycomb bodies 81, 82, 83. Accordingly, the outer tube 55 can be easily disposed in the muffler 142 of the exhaust device 140 to be near to the front of the muffler 142, and a large space can be secured at the rear side.

[0132] The second embodiment is a mode to which the present invention is applied, and the present invention is not limited to the second embodiment.

[0133] In the second embodiment, it is described that the axial line 3 of the joint pipe 178 is substantially coincident with the axial line C1 of the outer tube 55. However, the present invention is not limited to this style. For example, in the structure that the axial line C3 is offset from the axial line C1 of the outer tube 55, a recess which curves and upheaves to the inside of the upstream-side taper pipe 156 may be provided to the slope surface of the upstream-side taper pipe 156 at the opposite side to the offset side.

Description of Reference Numerals

[0134]

20, 120	engine (internal combustion engine)
40, 140	exhaust device
41	exhaust pipe (exhaust pipe passing below the internal combustion engine)
44	upstream-side exhaust pipe (small-diameter exhaust pipe)
45, 145	catalyst accommodating pipe (exhaust purification device)
46	muffler connection pipe (small-diameter exhaust pipe)
55	outer tube
56, 156	upstream-side taper pipe (connection pipe)
57, 157	downstream-side taper pipe (connection pipe)
58	slope surface (inclined face)
59	recess
71	first holding tube (holding tube)
71b, 72a, 72b, 73a	protrusion portion
72	second holding tube (holding tube)
73	third holding tube (holding tube)
81	first honeycomb body
82	second honeycomb body
83	third honeycomb body
137a	first intercommunication pipe (small-diameter exhaust pipe)
142	muffler
178	joint pipe (small-diameter exhaust pipe)
C1	axial line (axial center of the outer tube)
C2	axial line (axial center)
S1	gap
S2	gap

Claims

1. An exhaust purification device in which catalyst is carried in a plurality of honeycomb bodies (81, 82, 83) that are arranged in series so as to be spaced from one another through gaps, **characterized in that** a single outer tube (55) constituting a part of an exhaust passage of an exhaust device (40, 140) of an internal combustion engine (20, 120) is provided, a first honeycomb body (81), a second honeycomb body (82) and a third honeycomb body (83)

are accommodated in this order from an upstream side of exhaust in the outer tube (55), the catalyst is carried in passages of the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83), the second honeycomb body (82) is shared as the same part as the third honeycomb body (83), the first honeycomb body (81) has the same outer diameter as the second honeycomb body (82) and the third honeycomb body (83), and the number of cells per unit area of cells comparted in a gird form in the first honeycomb body (81) is smaller than the number of cells in the third honeycomb body (83).

2. The exhaust purification device according to claim 1, wherein holding tubes (71, 72, 73) in which the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83) are held are provided, the holding tubes (71, 72, 73) have protrusion portions (71b, 72a, 72b, 73a) that further protrude from end faces of the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83) respectively, and the protrusion portions (71b, 72a, 72b, 73a) are made to butt against one another to form gaps (S1, S2) between the respective honeycomb bodies (81, 82, 83).

3. The exhaust purification device according to claim 1 or 2, wherein welding positions at which the holding tubes (71, 72, 73) of at least two adjacent honeycomb bodies (81, 82, 83) are welded to the outer tube (55) are set to be different from each other in an outer peripheral direction between an upstream position and a downstream position.

4. The exhaust purification device according to claim 2 or 3, wherein funnel-shaped connection pipes (56, 57) connected to exhaust pipes (44, 46) that are arranged at front and rear sides of the outer tube (55) and smaller in diameter than the outer tube (55) are arranged so as to pinch the holding tubes (71, 72, 73) of the three honeycomb bodies (81, 82, 83) in the outer tube (55) at the front and rear sides of the outer tube (55).

5. The exhaust purification device according to claim 4, wherein the connection pipe (56) provided at the upstream side connects the outer tube (55) and the exhaust pipe (44) at the upstream side whose axial center (C2) is set to be offset from an axial center (C1) of the outer tube (55), and the connection pipe (56) has a recess (59) curving and upheaving to the inside of the connection pipe (56) on a slope surface (58) at an opposite side to a side at which the exhaust pipe (44) is offset.

6. The exhaust purification device according to any one of claims 1 to 5, wherein no catalyst is carried in the first honeycomb body (81) at the most upstream side out of the three honeycomb bodies (81, 82, 83).

7. The exhaust purification device according to any one of claims 1 to 6, wherein the outer tube (55) is disposed at some position of the exhaust pipe (41) passing over a lower side of the internal combustion engine (20).

8. The exhaust purification device according to any one of claims 1 to 6, wherein the outer tube (55) is disposed in a muffler (142) of the exhaust device (140) to be near to the front of the muffler (142).

9. An exhaust purification device in which catalyst is carried in a plurality of honeycomb bodies (81, 82, 83) that are arranged in series so as to be spaced from one another through gaps, **characterized in that** a first honeycomb body (81), a second honeycomb body (82) and a third honeycomb body (83) are accommodated in this order from an upstream side of exhaust in a part of an exhaust passage of an exhaust device (40, 140) of an internal combustion engine (20, 120), catalyst is carried in passages of the first honeycomb body (81), the second honeycomb body (82) and the third honeycomb body (83), the second honeycomb body (82) is shared as the same part as the third honeycomb body (83), the first honeycomb body (81) has the same outer diameter as the second honeycomb body (82) and the third honeycomb body (83), and the number of cells per unit area of cells comparted in a gird form in the first honeycomb body (81) is smaller than the number of cells in the third honeycomb body (83).

10. The exhaust purification device according to any one of claims 1 to 9, wherein the length in the axial direction of the first honeycomb body (81) is set to be smaller than the length in the axial direction of the third honeycomb body (83).

FIG.1

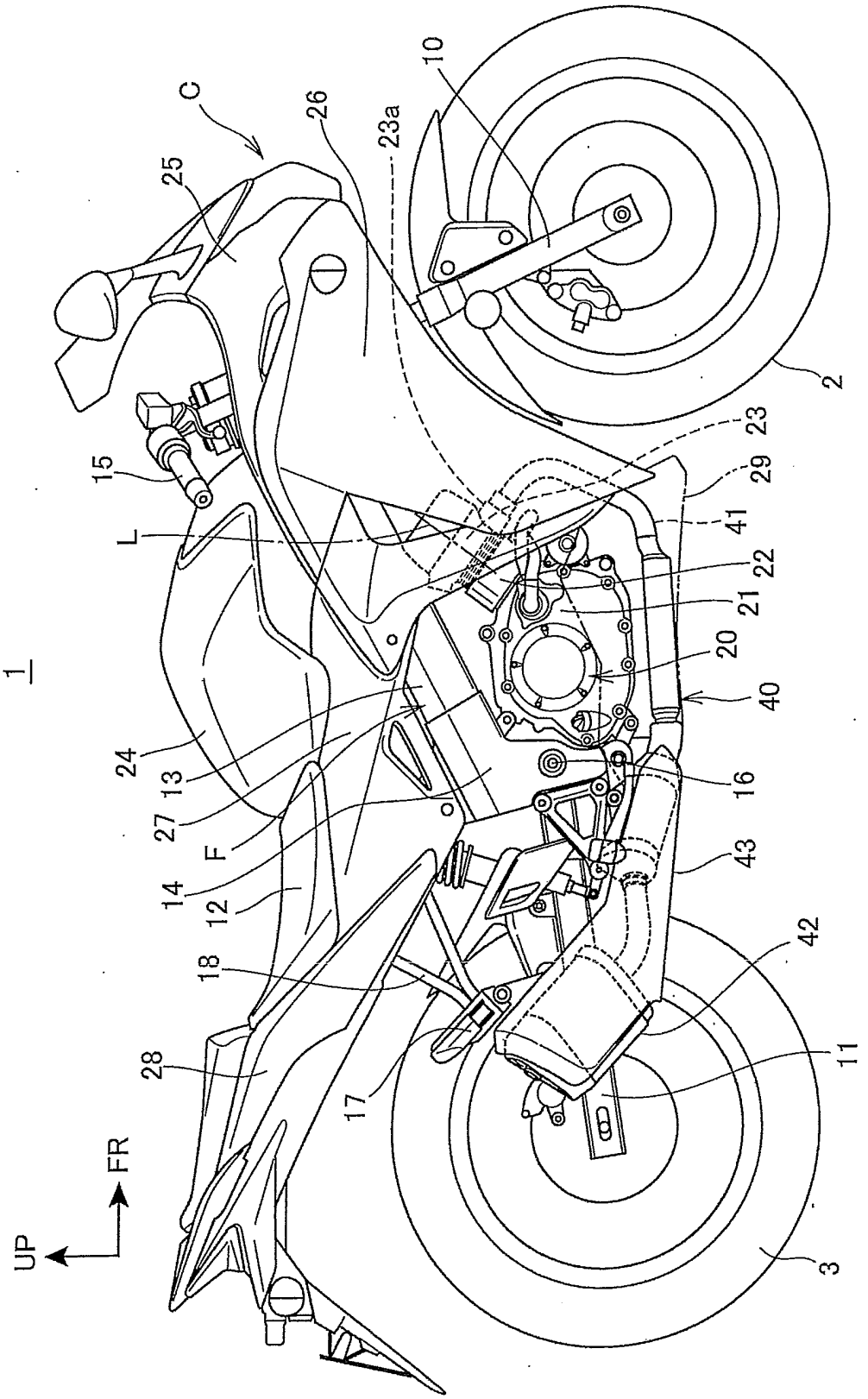
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FIG.2

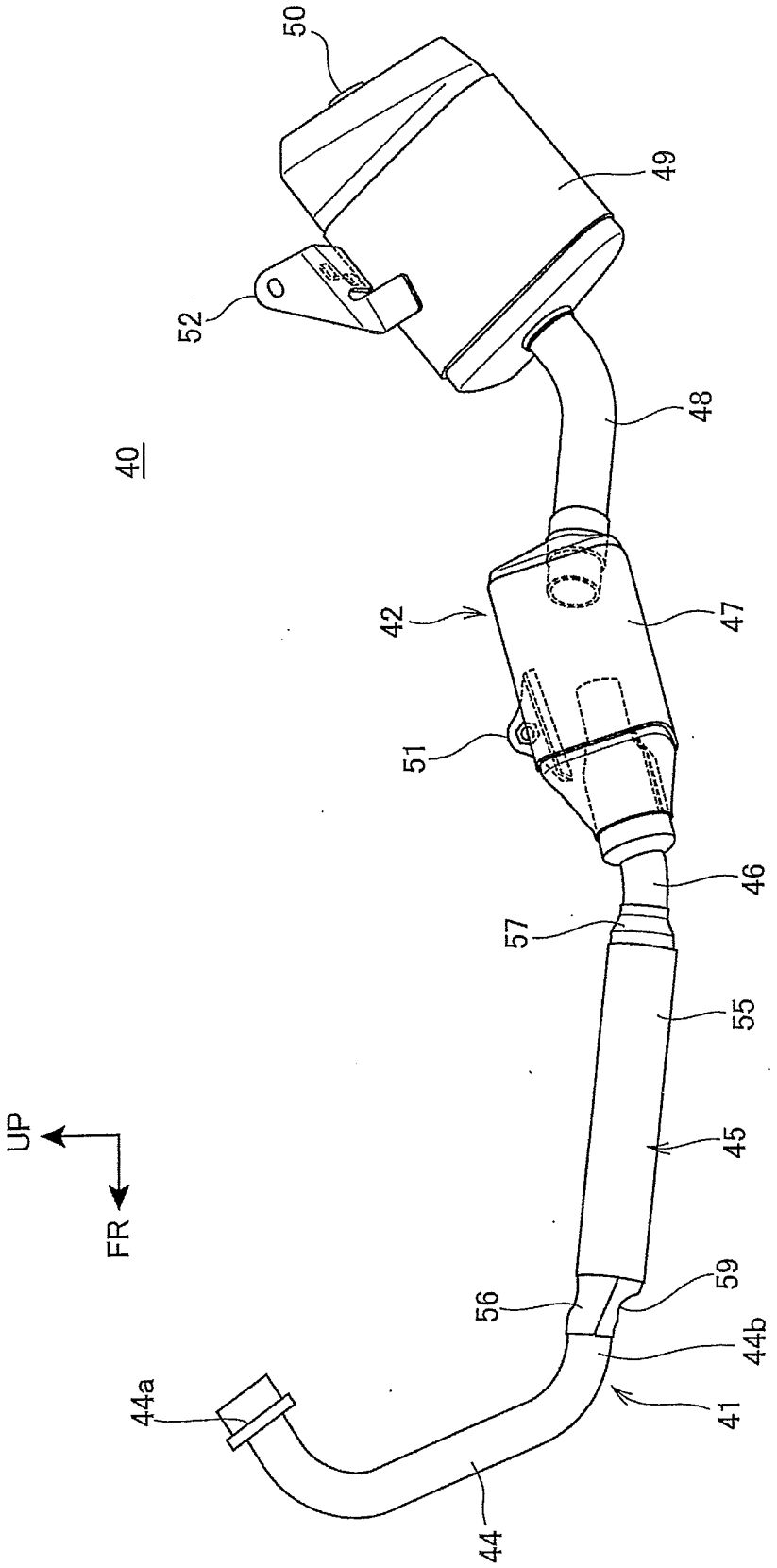
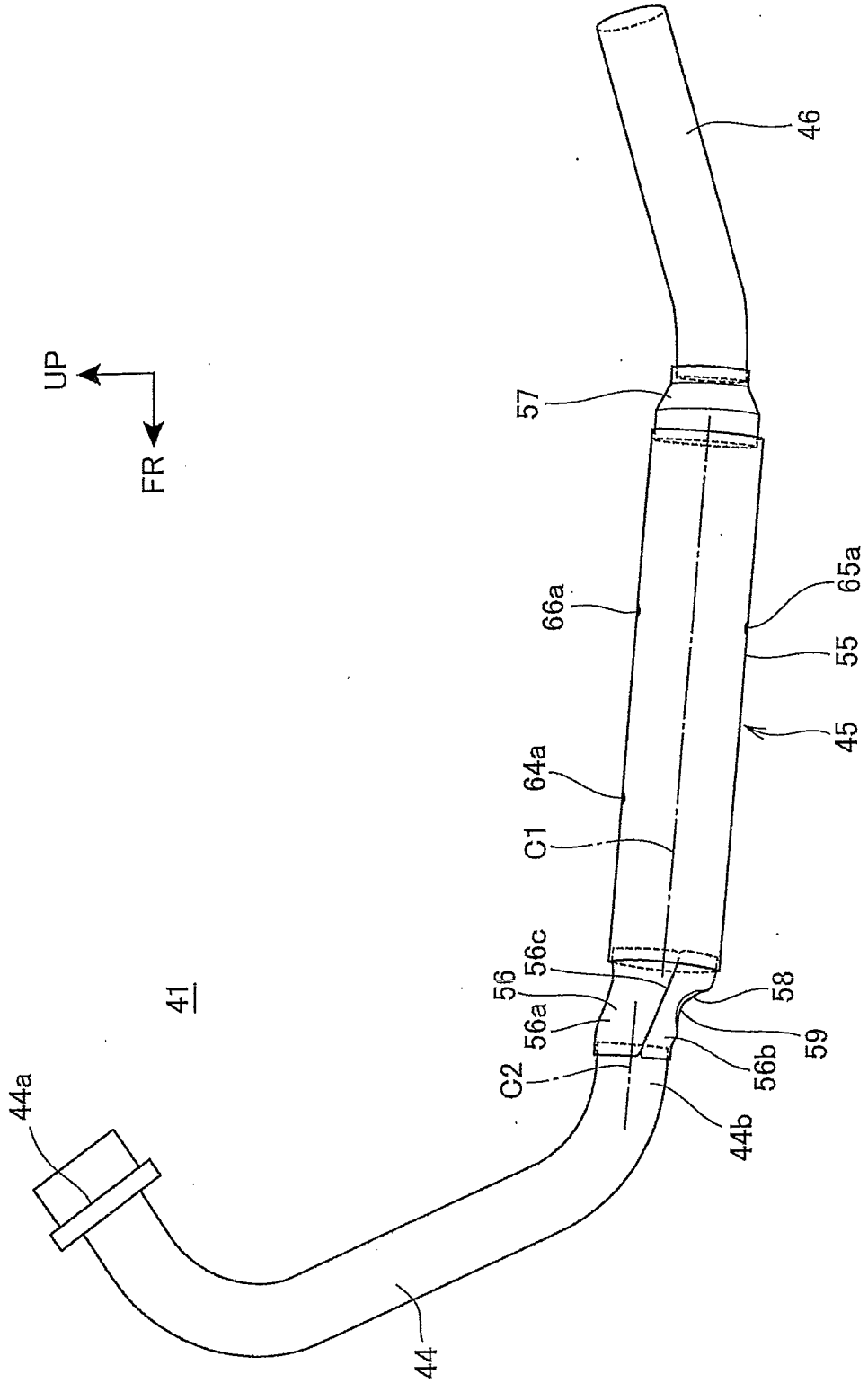


FIG.3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45
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C1
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56c
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C2
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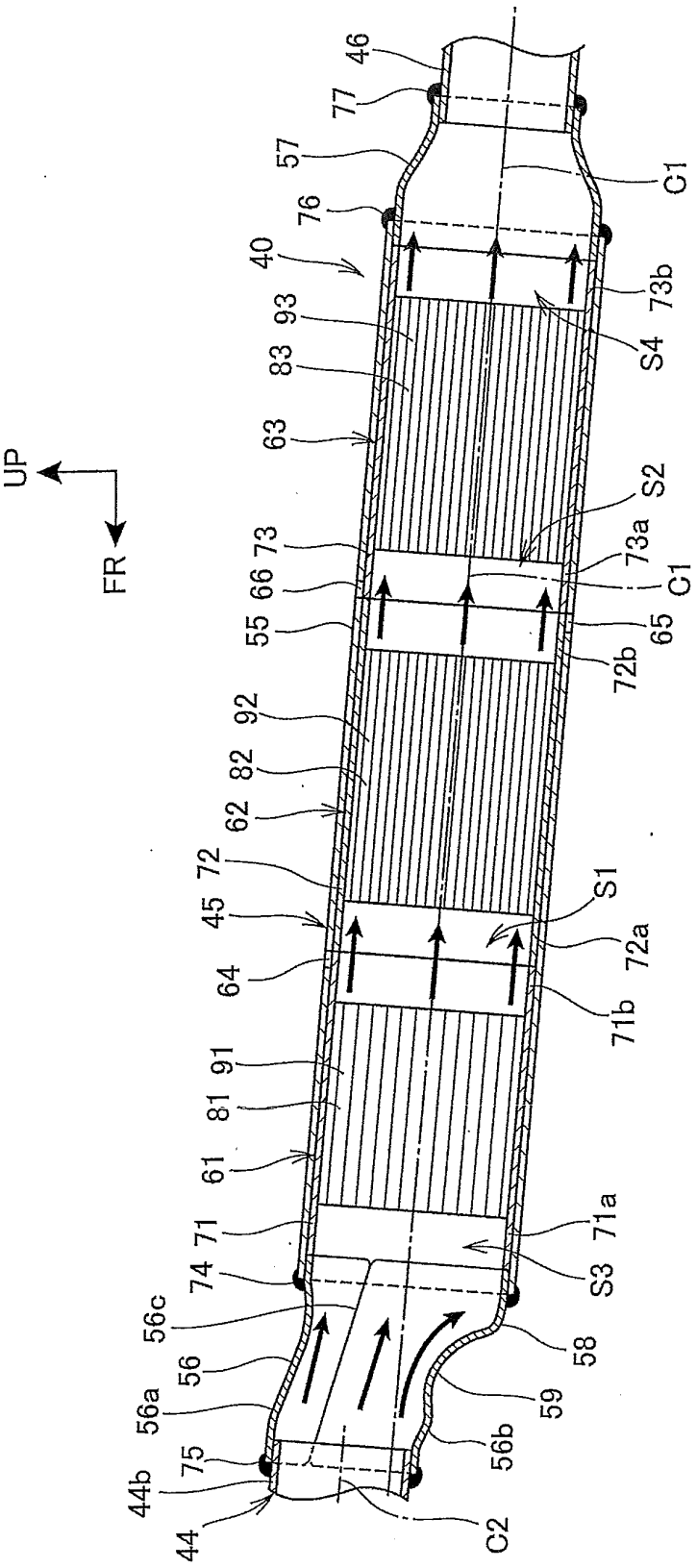
59
56b
44b

FIG.4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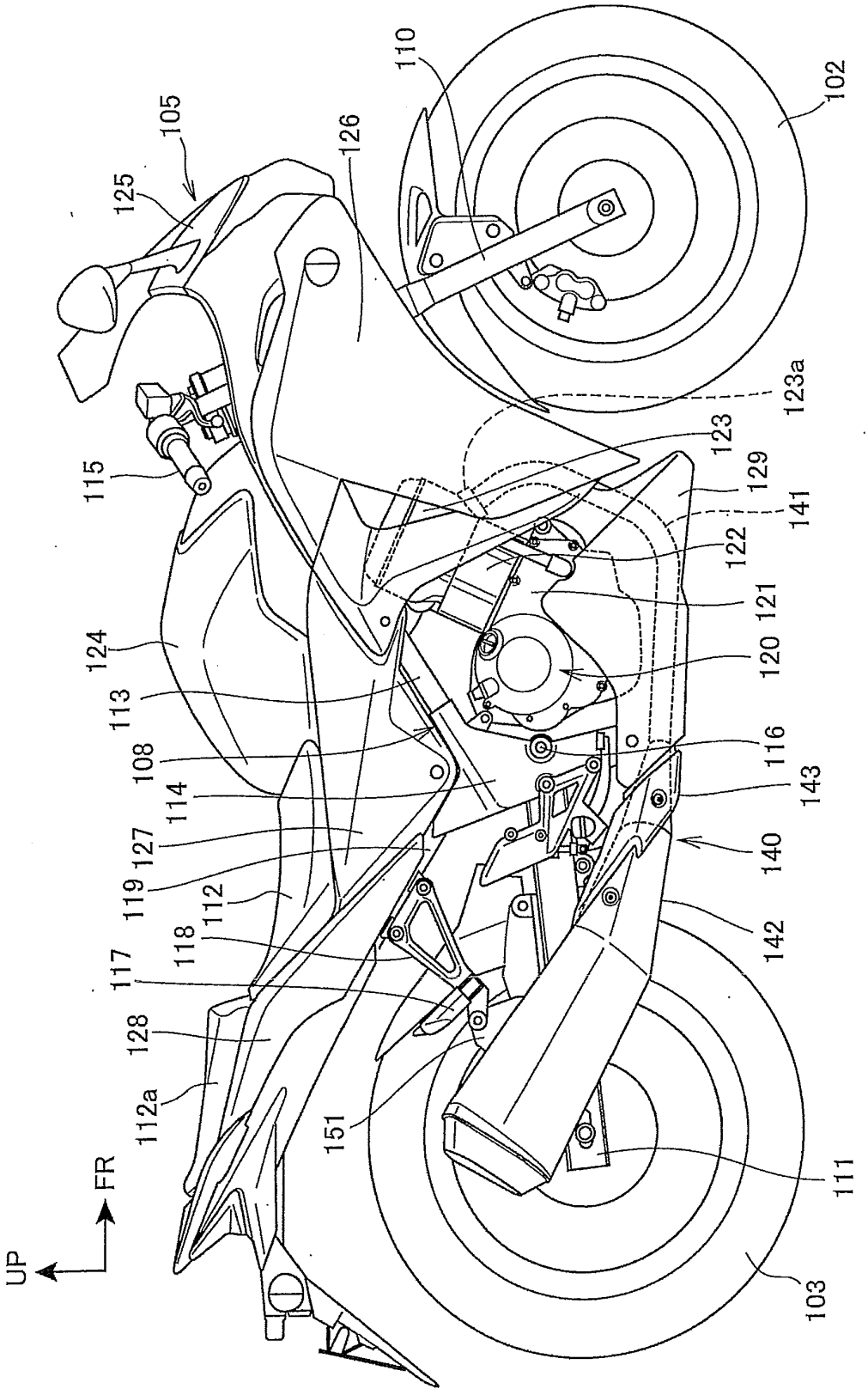
73a
66
C1
55
65
72b
92
82
62
72
S1
45
72a
64
71b
91
81
61
71
71a
74
S3
56c
58
56
56a
59
75
56b
44b
44
C2

FIG.5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FR
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102
105
126
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123a
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129
141
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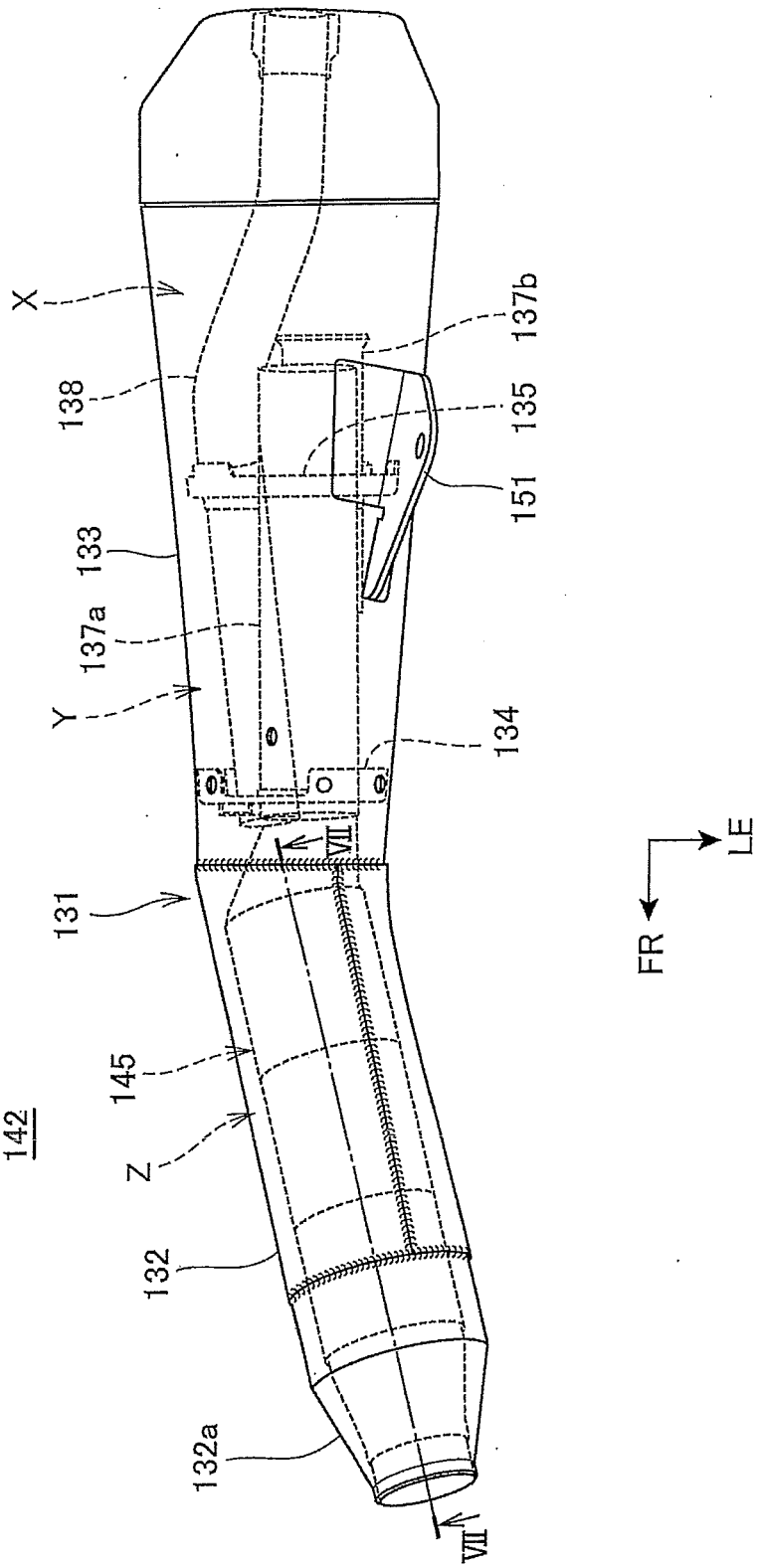
127
119
112
142
118
117
128
112a
151
111
103

FIG.6


X
138
137b
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151
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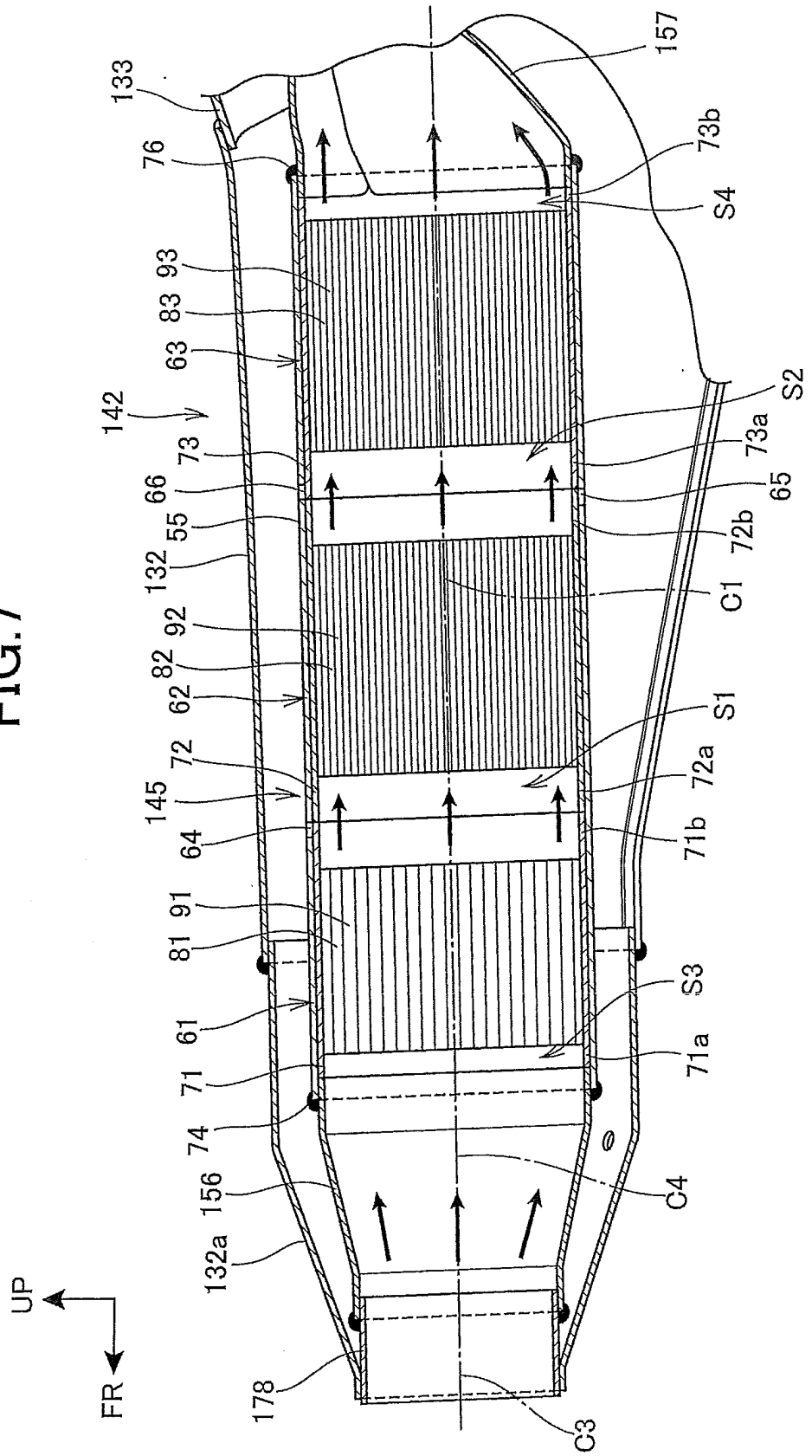
137a
Y
134
VIII
131
145
142
Z
132
132a
VIII
FR
LE

FIG.7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93
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142
73
66
55
132
92
82
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72
145
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81
61
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74
156
132a
178
157
73b
S4
S2
73a
65
72b
C1
S1
72a
71b
S3
71a
C4
C3
UP
FR

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/078844

A. CLASSIFICATION OF SUBJECT MATTER
F01N3/28(2006.01)i, *F01N3/24*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01N3/28, F01N3/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 6-79182 A (Toyota Motor Corp.), 22 March 1994 (22.03.1994), paragraphs [0021] to [0022]; fig. 4 (Family: none)	1,2,4-10 3
Y A	JP 11-501097 A (AB. Volvo), 26 January 1999 (26.01.1999), page 5, lines 7 to 12; fig. 1 & US 5996339 A & EP 812382 A & WO 1996/027078 A1 & DE 69613355 D & SE 504095 C & SE 9500748 A	1,2,4-10 3
Y A	JP 2005-248917 A (Honda Motor Co., Ltd.), 15 September 2005 (15.09.2005), paragraphs [0030] to [0038]; fig. 5 (Family: none)	1,2,4-10 3

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 December, 2013 (12.12.13)	24 December, 2013 (24.12.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/078844

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-82007 A (Calsonic Corp.), 26 March 1999 (26.03.1999), paragraph [0015]; fig. 2 (Family: none)	4-8,10
Y	JP 2006-142259 A (Calsonic Kansei Corp.), 08 June 2006 (08.06.2006), paragraphs [0017] to [0018]; fig. 1 to 2 (Family: none)	5-8,10
Y	JP 2007-263003 A (Calsonic Kansei Corp.), 11 October 2007 (11.10.2007), paragraphs [0002], [0011] to [0024]; fig. 1 to 4 (Family: none)	5-8,10
Y	JP 2011-74801 A (Honda Motor Co., Ltd.), 14 April 2011 (14.04.2011), paragraph [0030]; fig. 1 to 2 & US 2011/0073399 A1 & EP 2305547 A1 & CN 102030059 A	7,10
Y	JP 2010-37965 A (Honda Motor Co., Ltd.), 18 February 2010 (18.02.2010), paragraphs [0037] to [0038]; fig. 1 to 4 & CN 101639006 A	8,10
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 74293/1989(Laid-open No. 13418/1991) (Mazda Motor Corp.), 12 February 1991 (12.02.1991), specification, page 4, line 10 to page 5, line 7; fig. 1 (Family: none)	3
A	JP 2007-85242 A (Mazda Motor Corp.), 05 April 2007 (05.04.2007), fig. 1 (Family: none)	5

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2013030999 A **[0006]**