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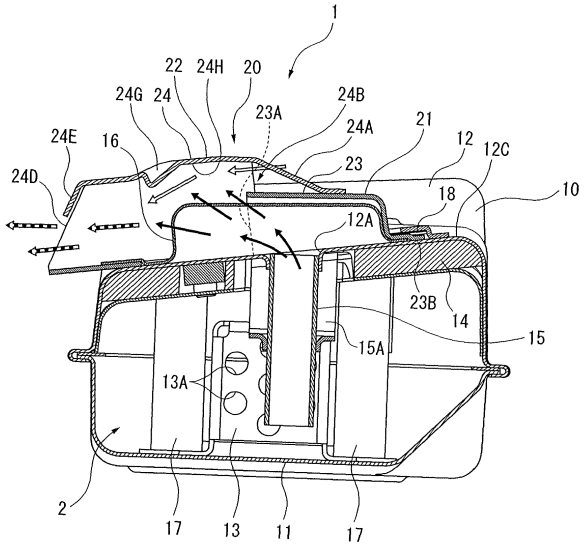
(54) MUFFLER

(57) A muffler for a small two-cycle engine includes: a muffler body (10) having an expansion chamber (2); an exhaust-gas guide member (21) covering an outlet (12A) for exhaust gas, the outlet (12A) being provided on the muffler body (10) and a cover hood (22) that covers a discharge port (23A) for exhaust gas, the discharge port (23A) being provided on the exhaust-gas guide member (21). A guide (23) that guides the exhaust gas in the exhaust-gas guide member (21) is gradually widened toward a top surface (24H) of the cover hood (22) as proceeding to the discharge port (23A).

FIG. 3



EP 2 031 198 A1

Description

Technical Field

[0001] The present invention relates to a muffler, and more particularly to a muffler for a small engine mounted on a portable work machine such as a blower, a chain saw, a cutoff saw, or a brushcutter.

Background Art

[0002] An engine blower, a chain saw and the like have been traditionally known as a portable work machine driven by an engine. The engine of such a portable work machine is driven at a position relatively close to an operator, and may be subjected to environmental regulations on temperature of exhaust gas from a muffler. Thus, it has been desired to discharge the exhaust gas at a low temperature. Specifically, temperature of exhaust gas from an engine cover that covers the engine and the muffler has been regulated.

[0003] In order to lower temperature of exhaust gas discharged from a muffler, outer air may be taken in by a jet flow of the exhaust gas to be mixed with the exhaust gas (for example, Patent Document 1). Specifically, an exhaust-gas guide member is provided on a surface of a muffler body for discharging exhaust gas from the muffler body in a predetermined direction. The exhaust-gas guide member is covered by a cover hood. Owing to an ejector effect of exhaust gas discharged from the exhaust-gas guide member, outer air is introduced into the cover hood to be mixed with the exhaust gas for lowering the exhaust gas temperature.

[0004] Patent Document 1: JP-A-53-44998

Disclosure of the Invention

Problems to Be Solved by the Invention

[0005] However, such an arrangement disclosed in Patent Document 1 has a problem that the cover hood for introducing outer air is enlarged, thus preventing downsizing of the muffler. Accordingly, it has been desired to facilitate downsizing of a muffler by devising an appropriate shape of a member that is capable of efficiently mixing exhaust gas and outer air.

[0006] An object of the invention is to provide a muffler capable of reliably lowering a temperature of exhaust gas by efficiently mixing the exhaust gas and outer air, and capable of being downsized as a whole.

Means for Solving the Problems

[0007] A muffler according to an aspect of the invention includes: a muffler body having an expansion chamber; an exhaust-gas guide member covering an outlet for exhaust gas, the outlet being provided on the muffler body; and a cover hood that covers a discharge port for the exhaust gas, the discharge port being provided on the exhaust-gas guide member, in which a guide that guides the exhaust gas in the exhaust-gas guide member is gradually widened toward a top surface of the cover hood as proceeding to the discharge port.

[0008] A muffler according to another aspect of the invention includes: a muffler body having an expansion chamber; an exhaust-gas guide member covering an outlet for exhaust gas, the outlet being provided on the muffler body; and a cover hood that covers a discharge port for the exhaust gas, the discharge port being provided on the exhaust-gas guide member, in which a distance between a center of the outlet and the discharge port is less than or equal to a height of an opening portion of the discharge port.

[0009] A muffler according to still another aspect of the invention includes: a muffler body having an expansion chamber; an exhaust-gas guide member covering an outlet for exhaust gas, the outlet being provided on the muffler body; a cover hood that covers a discharge port for the exhaust gas, the discharge port being provided on the exhaust-gas guide member; and a tail pipe mounted on the outlet in the expansion chamber, in which a height of an opening portion of the discharge port is less than or equal to an inner diameter of the tail pipe.

[0010] With such arrangements, since the guide of the exhaust-gas guide member is widened toward the top surface of the cover hood, or the dimensions of the primary parts are optimized, the exhaust gas from the discharge port can be reliably ejected toward the top surface and outer air introduced into the cover hood can be favorably mixed with the exhaust gas. Thus, it is not necessary to introduce a large amount of air into an enlarged cover hood. With the above arrangements, the outer air and the exhaust gas can be efficiently mixed and temperature of the exhaust gas can be favorably lowered while a muffler can be downsized as a whole.

[0011] In the above arrangements, the cover hood is provided with an outer-air mixing portion in which exhaust gas discharged from the discharge port and outer air introduced from an outside are mixed, and an opening area of the narrowest portion of a diameter-reduced portion provided in the outer-air mixing portion in a cross section crossing a flow direction of exhaust gas is four or more times larger than an opening area of the discharge port.

[0012] According to such arrangements, a sufficient amount of outer air can be introduced into the cover hood relative to an amount of the exhaust gas discharged from the exhaust-gas guide member for more reliably lowering the exhaust gas temperature.

[0013] In the above arrangements, a protrusion is provided adjacent to an exhaust port of the cover hood, the protrusion being protruding toward a center of the exhaust port in an in-plane direction.

[0014] According to such arrangements, since the exhaust gas from the exhaust port of the cover hood passes through the protrusion, a larger area of the exhaust gas can expose to the outer air for more efficiently lowering

the exhaust gas temperature.

Brief Description of Drawings

[0015]

Fig. 1 is an overall perspective view illustrating a muffler according to a first exemplary embodiment of the invention.
Fig. 2 is a cross sectional view taken along line II-II of the muffler shown in Fig. 1.
Fig. 3 is a cross sectional view taken along line III-III of the muffler shown in Fig. 1.
Fig. 4 illustrates an attachment of the muffler in an enlarged manner.
Fig. 5 illustrates the attachment shown in Fig. 4 as viewed from a front side.
Fig. 6 illustrates the attachment shown in Fig. 4 as viewed from a rear side.
Fig. 7 is a cross sectional view illustrating a primary part of the muffler.
Fig. 8 illustrates simulation results of exit temperature according to the first exemplary embodiment.
Fig. 9 is a cross sectional view illustrating a primary part of a muffler according to a second exemplary embodiment of the invention.
Fig. 10 illustrates an attachment shown in Fig. 9 as viewed from a front side.
Fig. 11 illustrates simulation results of exit temperature according to the second exemplary embodiment.
Fig. 12 is a front elevation illustrating a muffler according to a third exemplary embodiment of the invention.
Fig. 13 illustrates an attachment according to the third exemplary embodiment.
Fig. 14 is a cross sectional view of a primary part of the third exemplary embodiment.

Explanation of Codes

[0016] 1: muffler, 2: expansion chamber, 10: muffler body, 12A: outlet, 15: tail pipe, 21: exhaust-gas guide member, 22: cover hood, 23: guide, 23A: discharge port, 24: outer-air mixing portion, 24E: protrusion, 24F: diameter-reduced portion, 24H: top surface, D1: inner diameter, H1: height, L1: distance, S1, S2: opening area

Best Mode for Carrying Out the Invention

First Exemplary Embodiment

[0017] A first exemplary embodiment of the invention will be described below with reference to the attached drawings.
Fig. 1 is an overall perspective view illustrating a muffler 1 according to the first exemplary embodiment. Fig. 2 is a cross sectional view taken along line II-II of the muffler 1 shown in Fig. 1. Fig. 3 is a cross sectional view taken along line III-III of the muffler 1 shown in Fig. 1. Fig. 4 illustrates an attachment 20 of the muffler 1 in an enlarged manner. Fig. 5 illustrates the attachment 20 shown in Fig. 4 as viewed from a front side. Fig. 6 illustrates the attachment 20 shown in Fig. 4 as viewed from a rear side. As used herein, the front side means a front stream side in a flow direction of exhaust gas, and the rear side means a rear stream side in the flow direction of the exhaust gas.

[0018] The muffler 1 according to the exemplary embodiment is used for a small two-cycle engine mounted on an engine blower (not shown). The muffler 1 includes a box-shaped muffler body 10 in which an expansion chamber 2 is provided, and the attachment 20 attached on an outer surface of the muffler body 10.

[0019] The muffler body 10 includes a base cover 11 having an intake 11A into which exhaust gas is introduced from an engine. A cover member 12 is attached to the base cover 11 by caulking of a periphery thereof. A baffle 13, on which a plurality of circular holes 13A are formed, is provided in an inner side of the intake 11A. After the exhaust gas introduced from the intake 11A bumps into an opposed surface 13B of the baffle 13, the exhaust gas is dispersed through the circular holes 13A to be spread into the expansion chamber 2. A rear surface of the cover member 12 has a dual structure in which a heat-resistant muffling material 14 is provided.

[0020] Also, the cover member 12 has an outlet 12A for sending exhaust gas. The outlet 12A and the intake 11A are disposed not to be aligned in a thickness direction of the muffler body 10. One end of a tail pipe 15 is fixed to the outlet 12A via a bracket 15A.

[0021] A pair of bolt insertion holes 12B are provided on the cover member 12. A pair of communication holes (not shown) are formed on the base cover 11 respectively corresponding to the bolt insertion holes 12B. The bolt insertion holes 12B and communication holes are communicated with each other through a guide pipe 17 in the muffler body 10. The muffler 1 is fixed to the engine by a bolt inserted into the guide pipe 17.

[0022] An exhaust-gas guide member 21 covering the outlet 12A is integrated with a cover hood 22 covering the exhaust-gas guide member 21 to provide the attachment 20. The exhaust-gas guide member 21 is provided with a guide 23 bulging upward. A discharge port 23A is formed on one end of the guide 23.

[0023] A flange-shaped inserting portion 23B is provided on a circumference of the guide 23 A mounting piece 23C is provided consecutively with the inserting portion 23B on the front side of the discharge port 23A. A portion in front of the discharge port 23A defines an opening 23D in the same plane of the mounting piece 23C.

[0024] The cover hood 22 includes the discharge port 23A and an outer-air mixing portion 24 covering the front side of the discharge port 23A. A fixing piece 24A, an end of which is fixed to an upper surface of the guide 23, extends toward the rear side of the outer-air mixing por-

tion 24. A gap between the outer-air mixing portion 24 and the guide 23 defines an outer-air introduction gap 24B for introducing outer air into the outer-air mixing portion 24.

[0025] A mounting piece 24C having the same shape as the mounting piece 23C of the guide 23 is provided on both sides of the outer-air mixing portion 24. The mounting pieces 23C and 24C are fixed to each other by spot welding or the like. The mounting pieces 23C and 24C are provided with a semielliptical engaging portion 25 opened toward the rear side.

[0026] An exhaust port 24D for discharging exhaust gas after being mixed with outer air is provided on a front end of the outer-air mixing portion 24. A protrusion 24E is provided on an upper edge of the exhaust port 24D. The protrusion 24E is bent toward a center of an opening portion of the exhaust port 24D in an in-plane direction. However, a position of the protrusion 24E is not limited thereto. It is only required that the protrusion 24E is provided near the exhaust port 24D to close the exhaust port 24D. Also, a diameter-reduced portion 24F, a cross-sectional area of which is gradually reduced toward the front side, is provided in a middle of the outer-air mixing portion 24. A dent 24G depressed inward is provided on an upper surface of the diameter-reduced portion 24F.

[0027] By sliding the exhaust-gas guide member 21 and the cover hood 22, which are preliminarily integrated with each other to define the attachment 20, from the front side to the rear side, the inserting portion 23B is inserted to be fitted to a fitting portion 18 provided on a surface of the cover member 12 and the engaging portions 25 are respectively engaged with a screw 19 temporarily fixed to the cover member 12. The attachment 20 is fixed to the muffler body 10 by tightening the screw 19. At this time, a spark arrestor 16 is disposed within the exhaust-gas guide member 21 so that a part of the spark arrestor 16 is projected from the discharge port 23A.

[0028] A detailed arrangement of the attachment 20 will be described below with reference to Fig. 7.

In this exemplary embodiment, an attachment surface 12C on the cover member 12, to which the attachment 20 is attached, is slightly inclined from a direction orthogonal to an axis of the tail pipe 15 as shown in Fig. 7.

[0029] In such inclination direction, the thickness of the muffler body 10 is reduced toward the front side in the flow direction of exhaust gas. An angle of inclination defines a direction of exhaust gas vented from the exhaust port 24D, and any desired angle can be selected for carrying out the invention. Accordingly, the attachment surface 12C may not be inclined depending on arrangements. In other words, the attachment surface 12C may be orthogonal to the axis of the tail pipe 15.

[0030] In the exhaust-gas guide member 21, the guide 23 expands slightly upward toward a top surface 24H of the cover hood 22 as proceeding to the discharge port 23A. Incidentally, a width of the guide 23 is entirely constant (Fig. 4). Accordingly, exhaust gas can be reliably ejected from the discharge port 23A toward the top surface 24H of the cover hood 22.

[0031] The discharge port 23A is disposed slightly forward than the outlet 12A. A distance L1 between a center of the outlet 12A and the discharge port 23A on a surface parallel to the attachment surface 12C is set to be less than or equal to a height H1 from the attachment surface 12C to an inner upper circumference of the discharge port 23A ($L1/H1 \leq 1$). By such a setting, the exhaust gas discharged from the discharge port 23A can easily head for the top surface 24H.

[0032] Fig. 8 illustrates simulation results of exit temperature of exhaust gas based on an area ratio S1/S2 between opening areas S1 and S2 under two different conditions that L1/H1=1.14 and L1/H1=0.75. The opening area S1 is the narrowest portion in an inner space on a front end of the diameter-reduced portion 24F (for example, a portion taken along line VII-VII in Fig. 7, which is orthogonal to the flow direction of exhaust gas; except for a portion including the dent 24G). The opening area S2 is an area of the discharge port 23A of the guide 23.

[0033] The simulated exit temperatures are supposed to be measured on a position spaced apart from the exhaust port 24D by a predetermined distance. The simulation results show that the exit temperature under L1/H1=1.14 is higher than the exit temperature under L1/H1=0.75 at any area ratio.

[0034] Turning to Fig. 7, a distal end of the cover hood 22 protrudes from a side surface of the muffler body 10 so that exhaust gas vented from the exhaust port 24D is prevented from eddying such as rolling toward the side surface. Consequently, the exhaust gas can linearly flow outward. At this time, the protrusion 24E allows the exhaust gas discharged from the exhaust port 24D to be concave as viewed from a front face. Thus, a larger area of the exhaust gas can be exposed to outer air and temperature of the exhaust gas can be further lowered.

[0035] A flow of exhaust gas will be described below with reference to Fig. 3.

The exhaust gas spread into the expansion chamber 2 from the intake 11A (Fig. 2) is delivered to the exhaust-gas guide member 21 through the tail pipe 15 in order to be discharged from the discharge port 23A to the cover hood 22 of the exhaust-gas guide member 21. At this time, the exhaust gas from the discharge port 23A is ejected to be spread toward the top surface 24H of the cover hood 22 since a cross-sectional shape of the guide 23 is gradually widened toward the top surface 24H as proceeding to the end in the flow direction of the exhaust gas.

[0036] Subsequently, owing to an ejector effect caused when the exhaust gas is ejected from the discharge port 23A, outer air is introduced into the outer-air mixing portion 24 of the cover hood 22 through the outer-air introduction gap 24B formed between the exhaust-gas guide member 21 and the cover hood 22. The discharged exhaust gas and the introduced outer air are mixed in the outer-air mixing portion 24, and the mixed

exhaust gas is vented from the exhaust port 24D.

[0037] In the muffler 1 as described above, since the cross-sectional shape of the guide 23 formed on the exhaust-gas guide member 21 is gradually widened toward the top surface 24H of the cover hood 22, a flow of the exhaust gas discharged from the discharge port 23A can reliably head for an upper side of the cover hood 22. Thus, the exhaust gas and outer air introduced into the cover hood 22 can be efficiently mixed to effectively lower temperature of the exhaust gas. Additionally, the exhaust gas can be more reliably ejected toward the top surface 24H by setting a following condition: L1/H1≤1. Thus, the exhaust gas and the outer air can be further efficiently mixed to favorably lower the temperature of the exhaust gas.

[0038] Also, due to the dent 24G formed on the cover hood 22, the outer air flowing in an upper side of the cover hood 22 can head for a lower side, so that the outer air heading for the lower side and the exhaust gas heading for the upper side can be more favorably mixed. The diameter-reduced portion 24F formed on the cover hood 22 does not only increase speed of a flow of exhaust gas, but also facilitates to mix the exhaust gas and outer air. The exhaust gas and the outer air can be also favorably mixed in this respect.

[0039] Further, the attachment 20, in which the exhaust-gas guide member 21 and the cover hood 22 are integrated with each other, can be easily attached to and detached from the muffler body 10 in a slidable manner. Also, it is not required to fully detach the screw 19, which leads to easy attachment and detachment of the attachment 20. Thus, the spark arrestor 16 and the tail pipe 15 can be easily cleaned, which improves workability.

Second Exemplary Embodiment

[0040] As shown in Figs. 9 and 10, in the attachment 20 of a second exemplary embodiment, the height H1 of the discharge port 23A of the exhaust-gas guide member 21 is less than or equal to an inner diameter D1 of the tail pipe 15 (H1≤D1). Other arrangements of this exemplary embodiment are the same as those of the first exemplary embodiment. By such a setting, an ejecting speed of exhaust gas from the discharge port 23A is increased and outer air can be effectively introduced inside due to an improved ejector effect, which favorably lowers temperature of the exhaust gas.

[0041] In this exemplary embodiment, the opening area S1 that is the portion in the narrowest inner space on the front end of the diameter-reduced portion 24F (for example, a portion taken along line IX-IX in Fig. 9, which is orthogonal to the flow direction of exhaust gas; except for the portion including the dent 24G) is four times or more larger than the opening area S2 of the discharge port 23A of the guide 23 (S1/S2≥4). Consequently, the exhaust gas and outer air can be favorably mixed in the outer-air mixing portion 24, which effectively lowers temperature of the exhaust gas.

[0042] Fig. 11 shows simulation results of exit temperature of exhaust gas based on a dimension ratio L1/H1 between the distance L1 and the height H1, the dimension ratio L1/H made different by changing the distance L1, under three different conditions that H1=0.67×D1, H1=D1, and H1=1.3×D1. The results show that temperature of the exhaust gas under the condition H1=0.67×D1 is the lowest at any dimension ratio. In Fig. 9, the height H1 and the distance D1 satisfy a following relation: H1=0.88×D1.

[0043] Turning to Fig. 8, when the ratio S1/S2 between the opening areas S 1 and S2 is 4 or more, particularly under the condition L1/H1=0.75 (L1/H1≤1), exit temperature of the exhaust gas is 300°C or less, which is sufficiently low. Even under the condition L1/H1=1.25, when S1/S2 is 4 or more, low exit temperature can be maintained as compared with exit temperature when S1/S2 is 4 or less.

Third Exemplary Embodiment

[0044] Figs. 12 to 14 illustrate the muffler 1 and a primary part of the muffler 1 according to a third exemplary embodiment of the invention. In this exemplary embodiment, all conditions L1/H1≤1, H1≤D1, and S1/S2≥4 as described in the first and second exemplary embodiments are satisfied.

[0045] In the attachment 20, the mounting piece 23C of the exhaust-gas guide member 21 laterally extends from the muffler body 10 while the mounting piece 24C of the cover hood 22 does not extend so that a length of the cover hood 22 is shortened as a whole. Accordingly, the exhaust port 24D is closer to the outlet 12A as compared with that of the first and second exemplary embodiments. However, even with such an arrangement, since the mounting piece 23C laterally extends, exhaust gas discharged from the exhaust port 24D can be prevented from rolling, which allows a smooth discharge similar to the above exemplary embodiments.

[0046] Also, the cover hood 22 is pressed to be fixed to the exhaust-gas guide member 21 by caulking of a pair of folds 24I formed on the mounting piece 23C of the exhaust-gas guide member 21 while being fixed to the muffler body 10 together with the exhaust-gas guide member 21 by the screw 19 inserted into a through hole 24J. Similar to the first and second exemplary embodiments, the inserting portion 23B of the exhaust-gas guide member 21 is fitted to the fitting portion 18 and then the entire attachment 20 is fixed to the muffler body 10 by tightening the screw 19.

[0047] Further, a width of the outer-air mixing portion 24 of the cover hood 22 is constant in the flow direction of exhaust gas. The outer-air mixing portion 24 does not have a diameter-reduced portion as described in the first and second exemplary embodiments. Such a shape effectively suppresses a height of the cover hood 22 and satisfies a condition S1/S2≥4, which prevents the attachment 20 from being enlarged.

[0048] In this exemplary embodiment, it is confirmed that outer air can be favorably introduced inside due to an ejector effect of the attachment 20 even when the cover hood 22 does not have the diameter-reduced portion. Rather, since the dimensions H1, L1 and D1 and the opening areas S1 and S2 are all optimized in this exemplary embodiment, a more excellent ejector effect is exhibited, which allows to further lower temperature of exhaust gas as compared with the first and second exemplary embodiments.

[0049] It should be noted that, although the best structure, method and the like for implementing the invention have been described in the above description, the invention is not limited to the above description Specifically, while the invention has been described above with specific embodiments being particularly illustrated and mainly described, those skilled in the art may make various modifications to the above-described embodiments in terms of a shape, quantity or any other detailed configuration without departing from a scope of a technical idea and an object of the invention.

Thus, a shape, quantity and the like described above merely serve as exemplifying the invention for facilitating an understanding of the invention, and do not serve as any limitations on the invention, so that what is described by a name of a component for which the description of the shape, quantity and the like are partially or totally omitted is also included in the invention.

[0050] For example, although the shape of the guide 23 of the exhaust-gas guide member 21 is widened as proceeding to the discharge port 23A in the first and second exemplary embodiments, it is only required that a condition $L1/H1 \leq 1$ is satisfied in the first exemplary embodiment and that a condition $H1 \leq D1$ is satisfied in the second exemplary embodiment. The scope of the invention according to claim 2 or 3 includes the guide 23 having a constant shape in the flow direction of exhaust gas (i.e. a shape that is not widened as proceeding to the discharge port 23A). On the other hand, the scope of the invention according to claim 1 includes the guide 23 having a shape that is widened as proceeding to the discharge port 23A even when the condition $L1/H1 \leq 1$ or $H1 \leq D1$ is not satisfied.

Industrial Applicability

[0051] The invention is applicable as a muffler for a small engine mounted on a portable work machine such as a blower, a chain saw, a cutoff saw, or a brushcutter.

Claims

1. A muffler comprising:

a muffler body having an expansion chamber;
an exhaust-gas guide member covering an outlet for exhaust gas, the outlet being provided on the muffler body; and
a cover hood that covers a discharge port for the exhaust gas, the discharge port being provided on the exhaust-gas guide member, wherein
a guide that guides the exhaust gas in the exhaust-gas guide member is gradually widened toward a top surface of the cover hood as proceeding to the discharge port.

2. A muffler comprising:

a muffler body having an expansion chamber;
an exhaust-gas guide member covering an outlet for exhaust gas, the outlet being provided on the muffler body; and
a cover hood that covers a discharge port for the exhaust gas, the discharge port being provided on the exhaust-gas guide member, wherein
a distance between a center of the outlet and the discharge port is less than or equal to a height of an opening portion of the discharge port.

3. A muffler comprising:

a muffler body having an expansion chamber;
an exhaust-gas guide member covering an outlet for exhaust gas, the outlet being provided on the muffler body;
a cover hood that covers a discharge port for the exhaust gas, the discharge port being provided on the exhaust-gas guide member; and
a tail pipe mounted on the outlet in the expansion chamber, wherein
a height of an opening portion of the discharge port is less than or equal to an inner diameter of the tail pipe.

4. The muffler according to any one of claims 1 to 3, wherein
the cover hood is provided with an outer-air mixing portion in which exhaust gas discharged from the discharge port and outer air introduced from an outside are mixed, and
an opening area of the narrowest portion of a diameter-reduced portion provided in the outer-air mixing portion in a cross section crossing a flow direction of exhaust gas is four or more times larger than an opening area of the discharge port.

5. The muffler according to any one of claims 1 to 4, wherein
a protrusion is provided adjacent to an exhaust port of the cover hood, the protrusion being protruding toward a center of the exhaust port in an in-plane direction.

FIG. 1

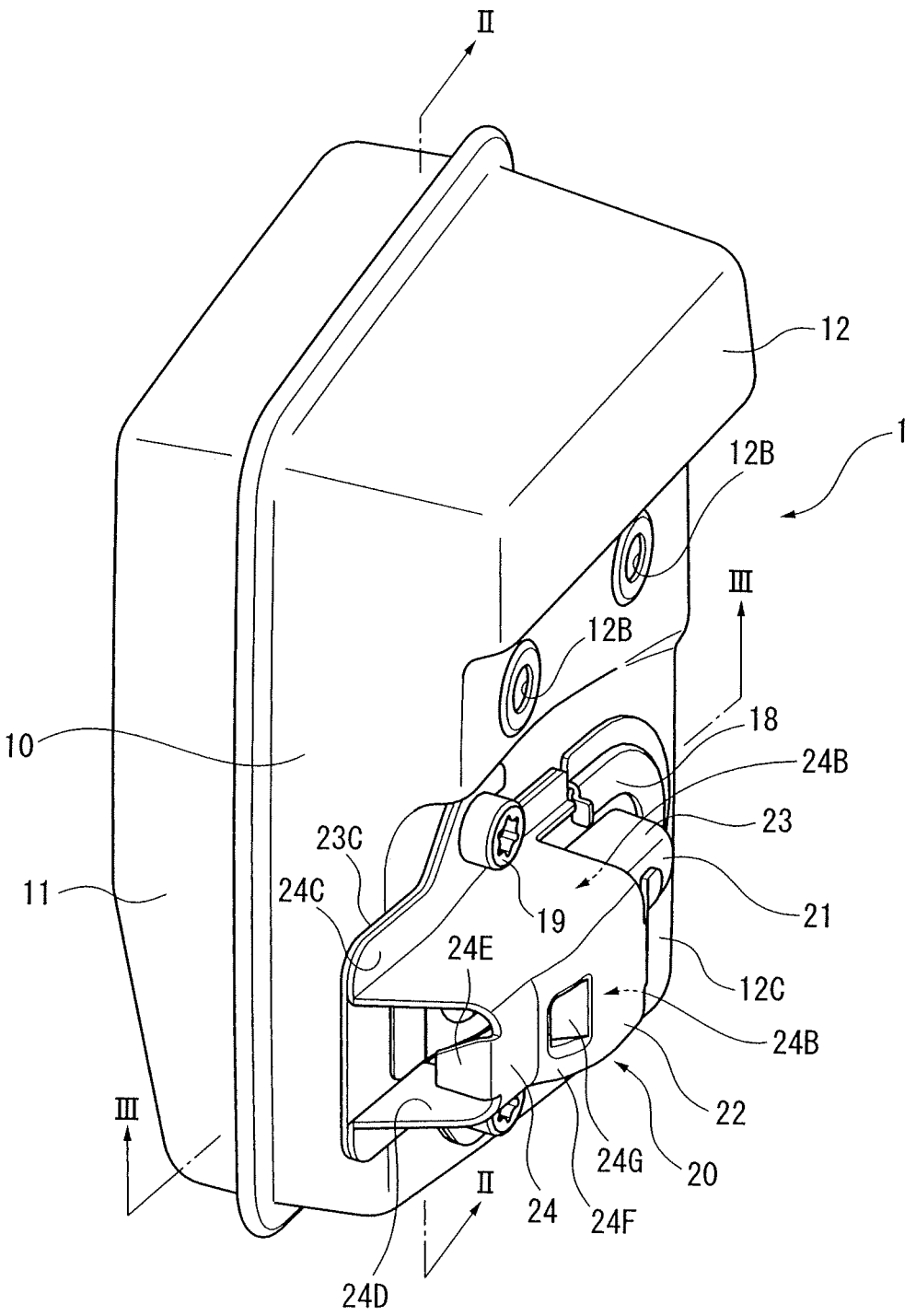

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FIG.2

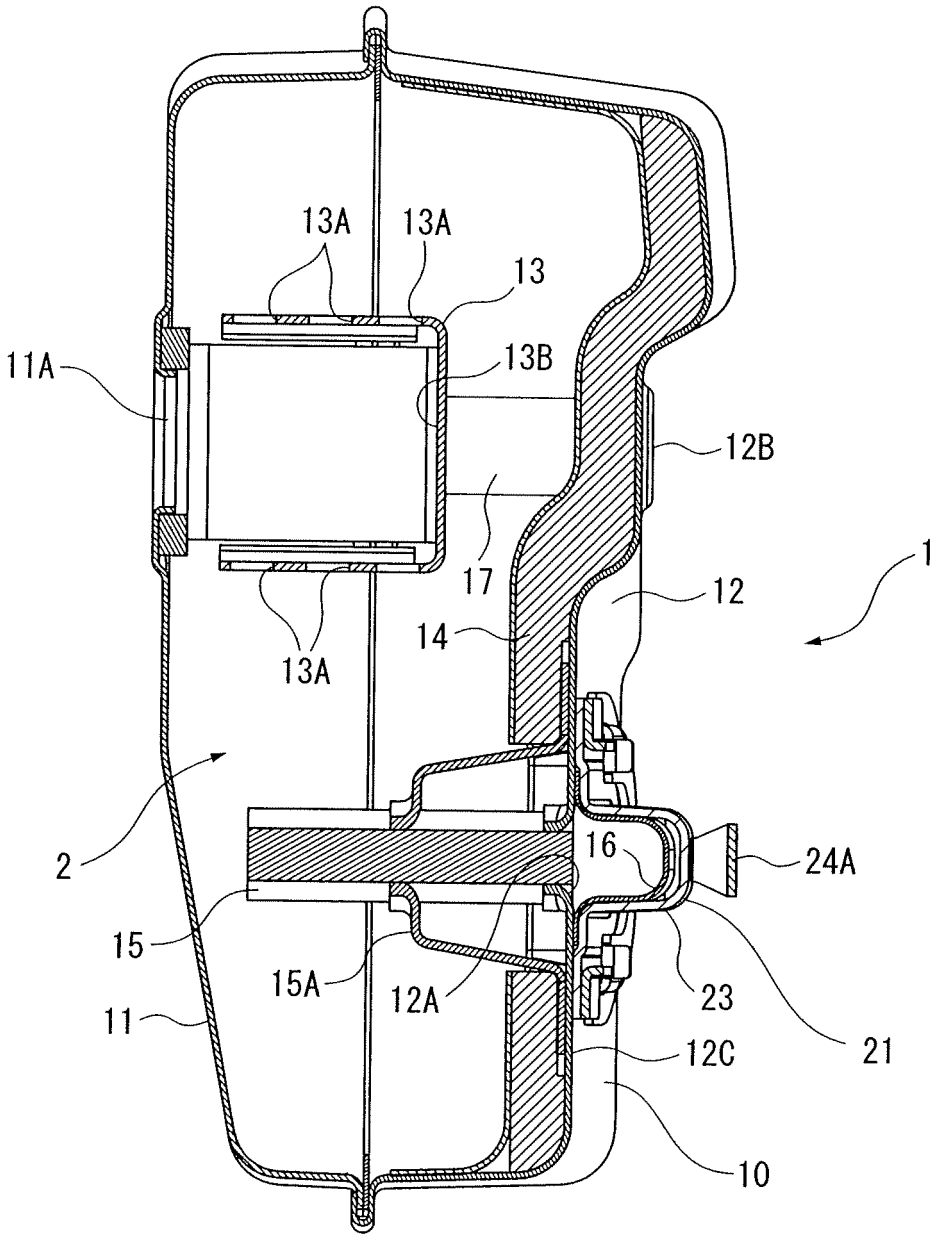
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FIG. 3

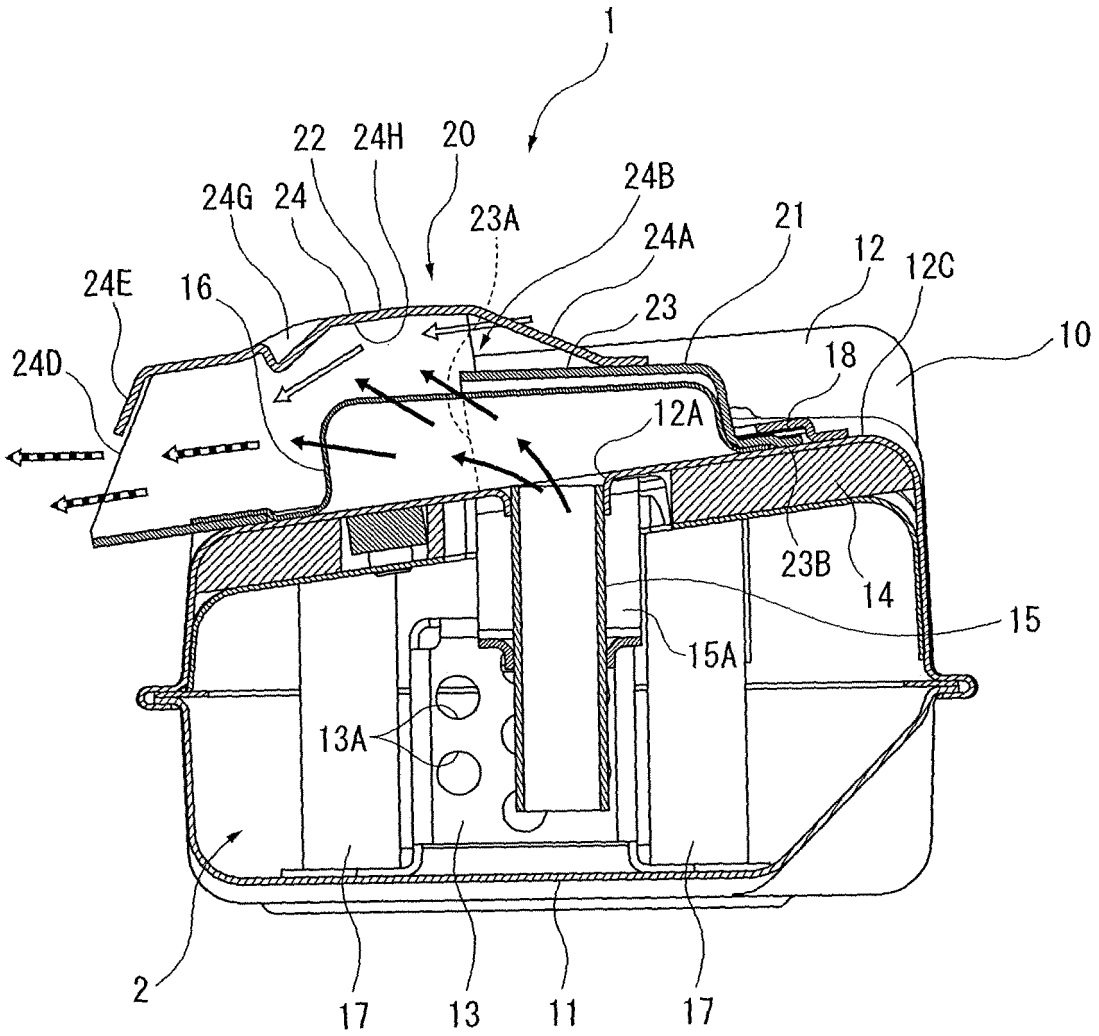
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FIG. 4

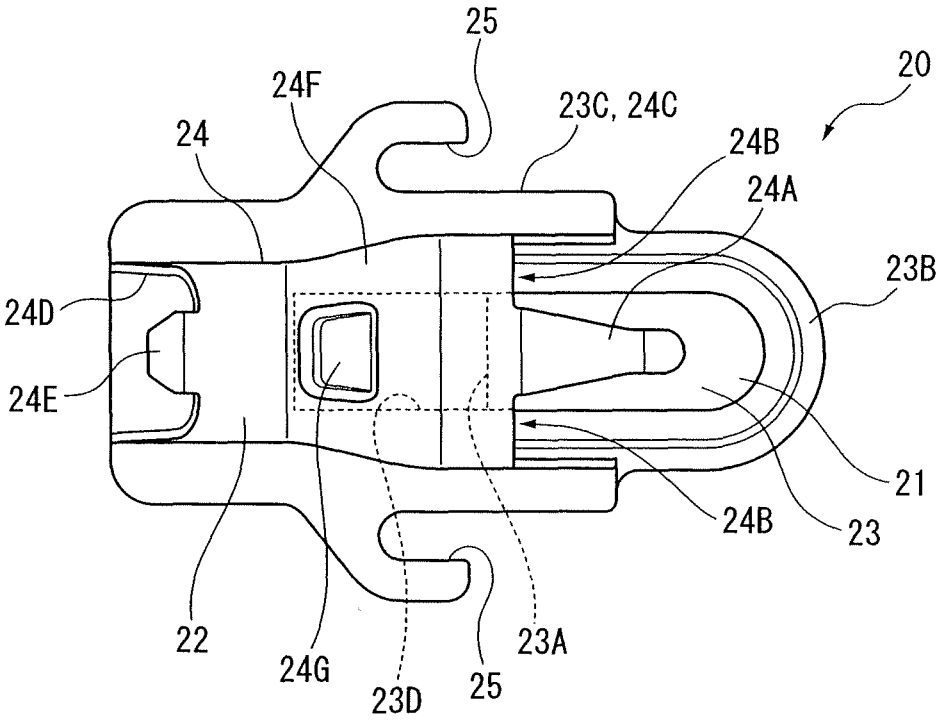
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FIG. 5

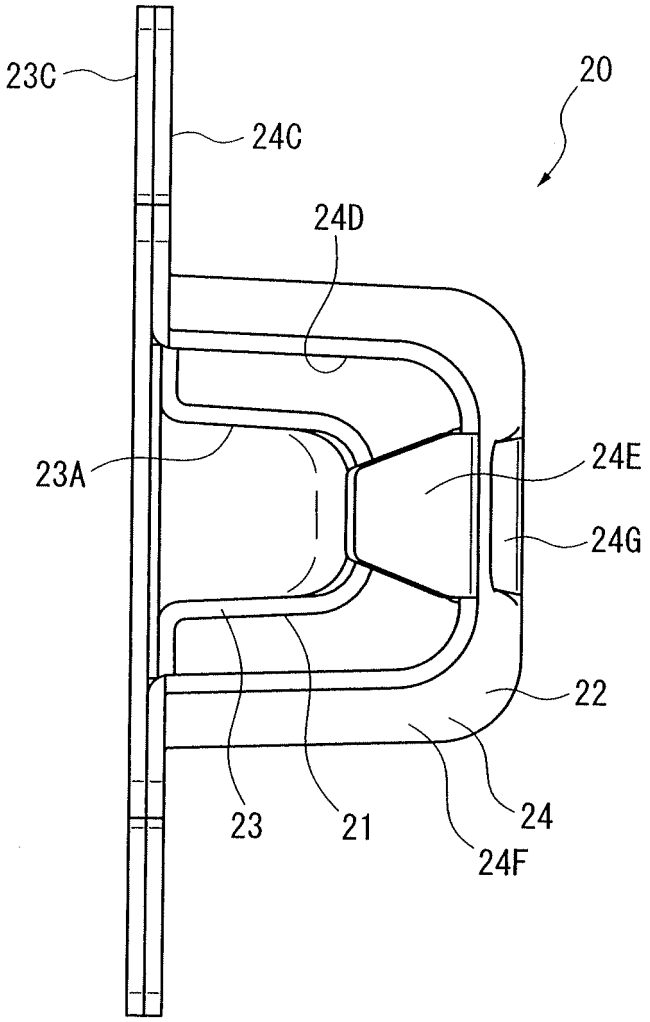


FIG. 6

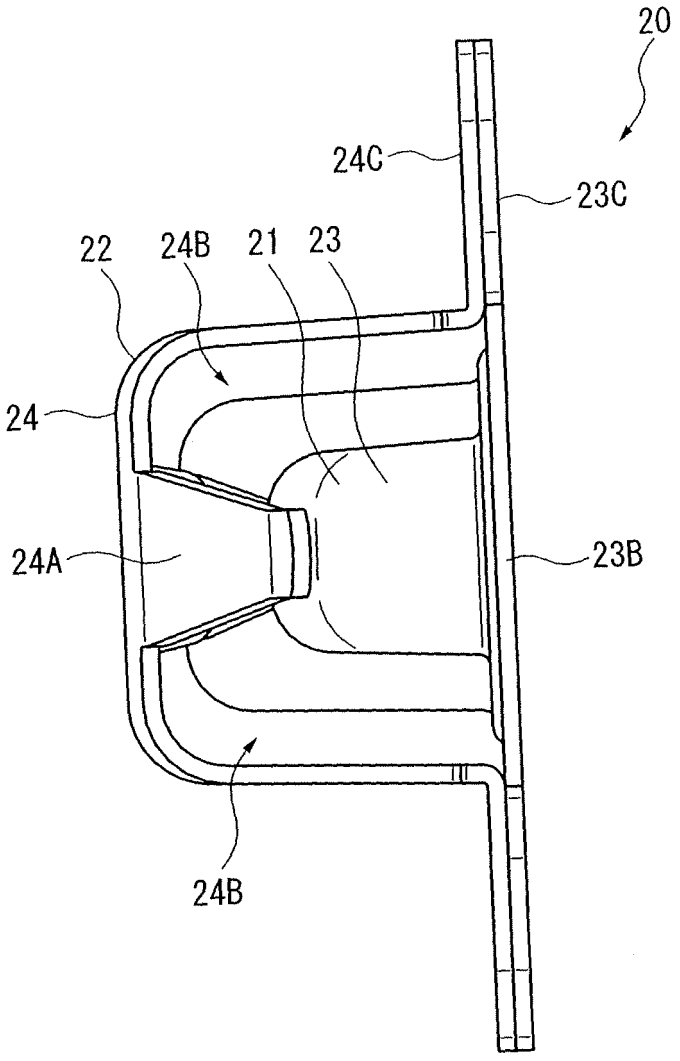
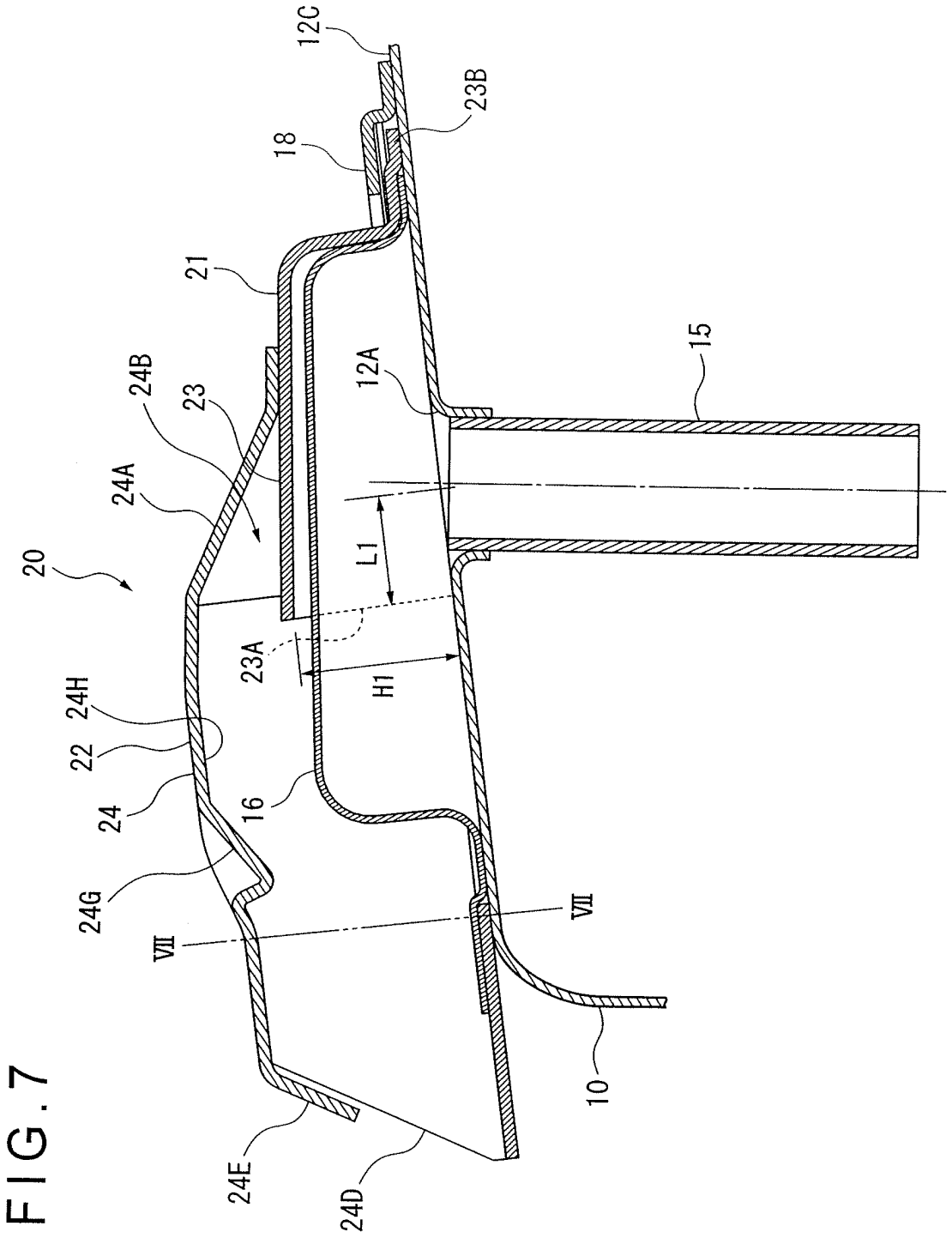


FIG. 7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20
L1
23A
H1
24H
22
24
16
24G
VII
VII
10
24E
24D

FIG. 8

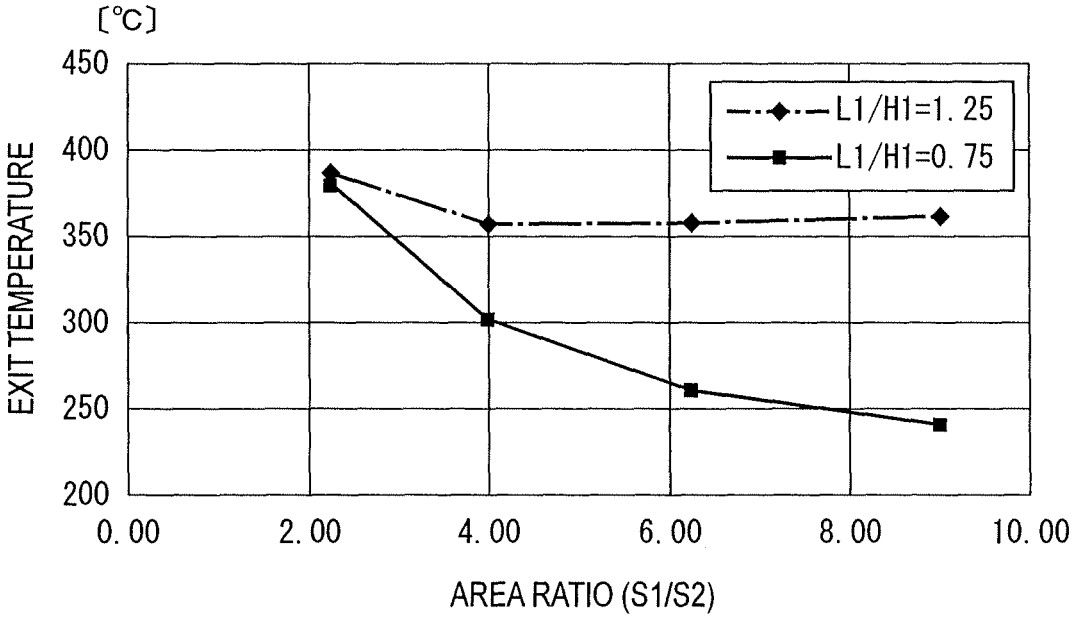

[℃]
450
400
350
300
250
200
EXIT TEMPERATURE
0.00
2.00
4.00
6.00
8.00
10.00
AREA RATIO (S1/S2)
L1/H1=1.25
L1/H1=0.75

FIG. 9

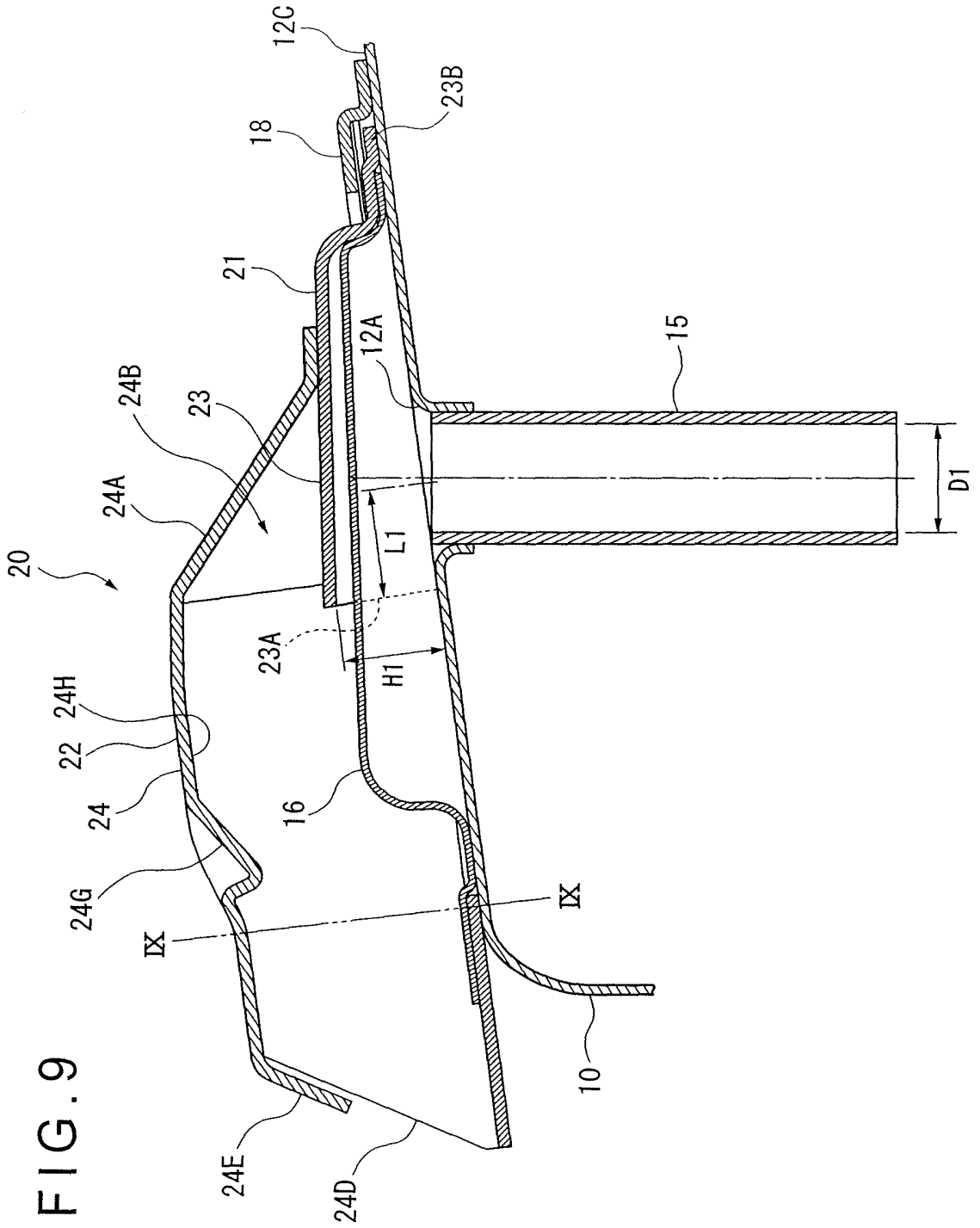

12C
23B
18
21
12A
15
24B
23
24A
20
D1
L1
23A
H1
24H
22
24
16
24G
IX
IX
10
24E
24D

FIG. 10

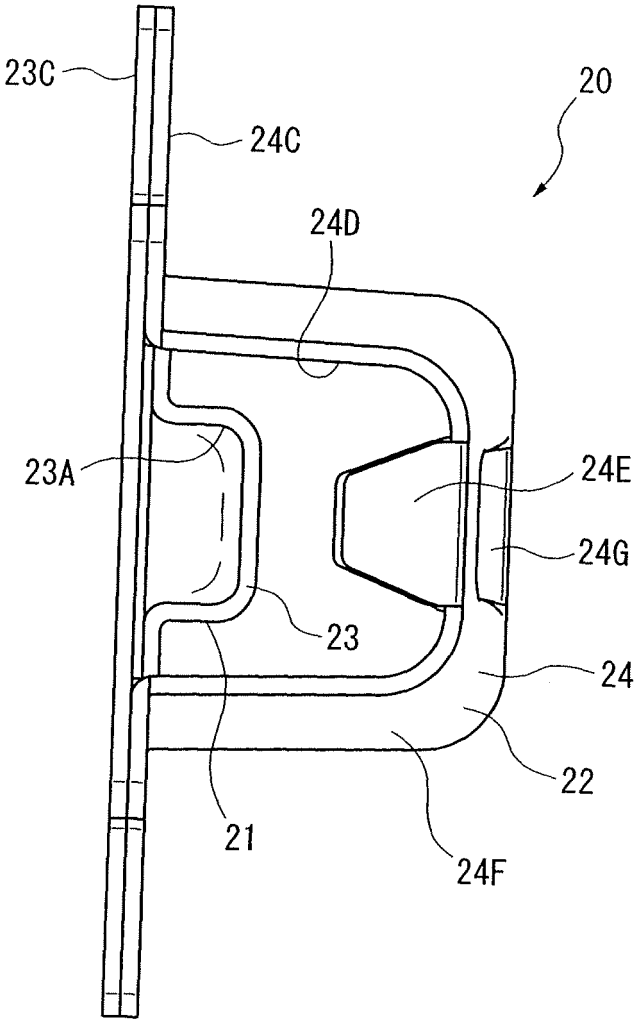


FIG. 11

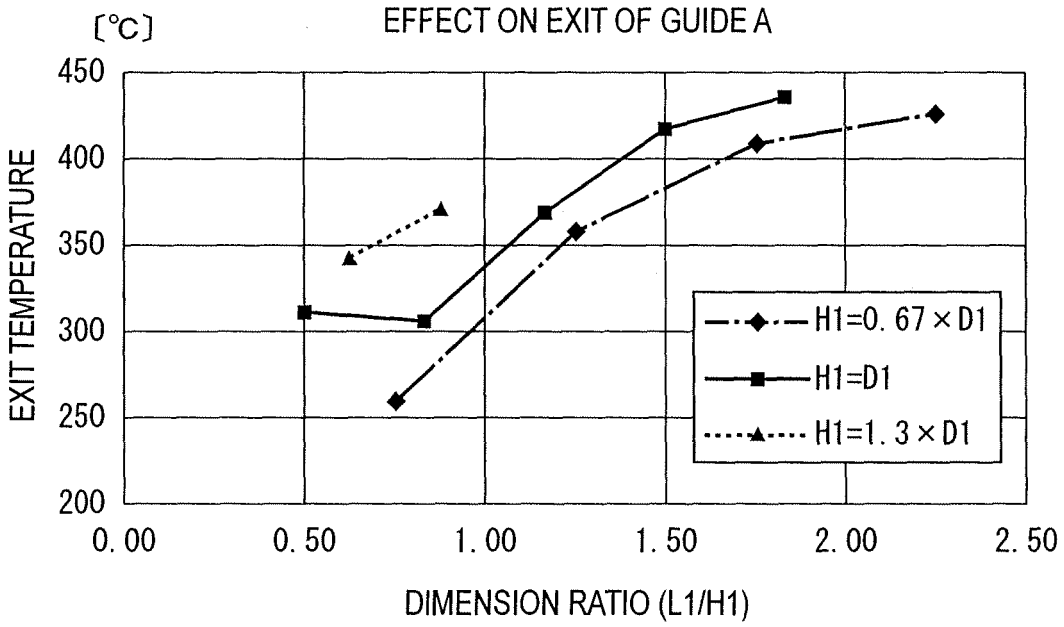

[°C]
EFFECT ON EXIT OF GUIDE A
450
400
350
300
250
200
EXIT TEMPERATURE
0.00
0.50
1.00
1.50
2.00
2.50
DIMENSION RATIO (L1/H1)
H1=0.67×D1
H1=D1
H1=1.3×D1

FIG. 12

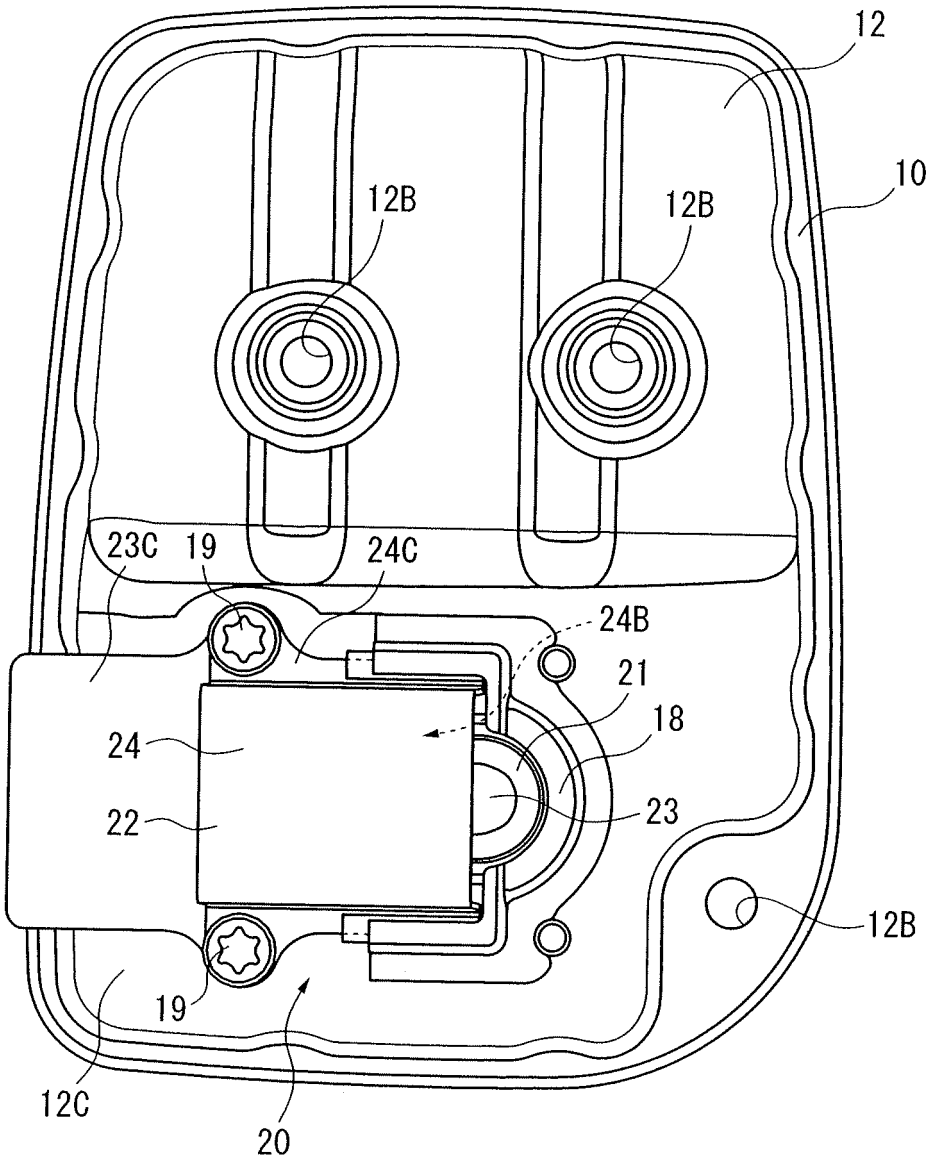


FIG. 13

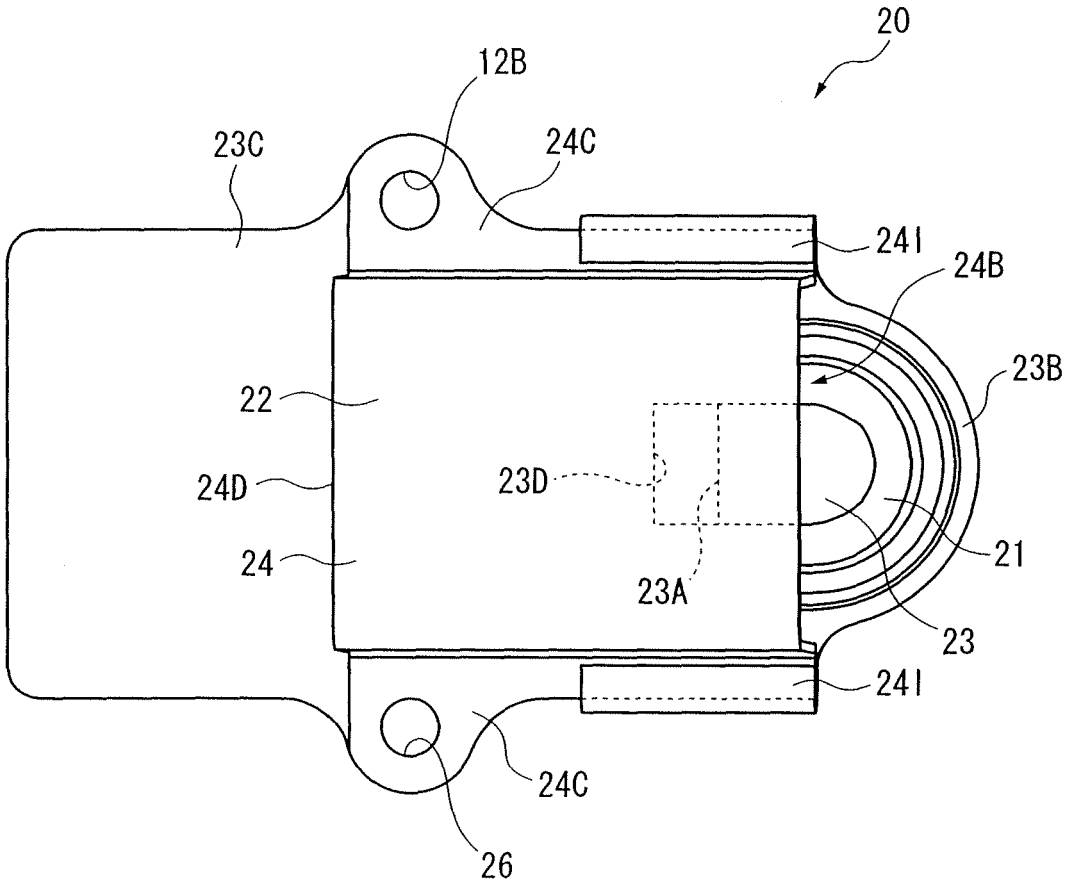
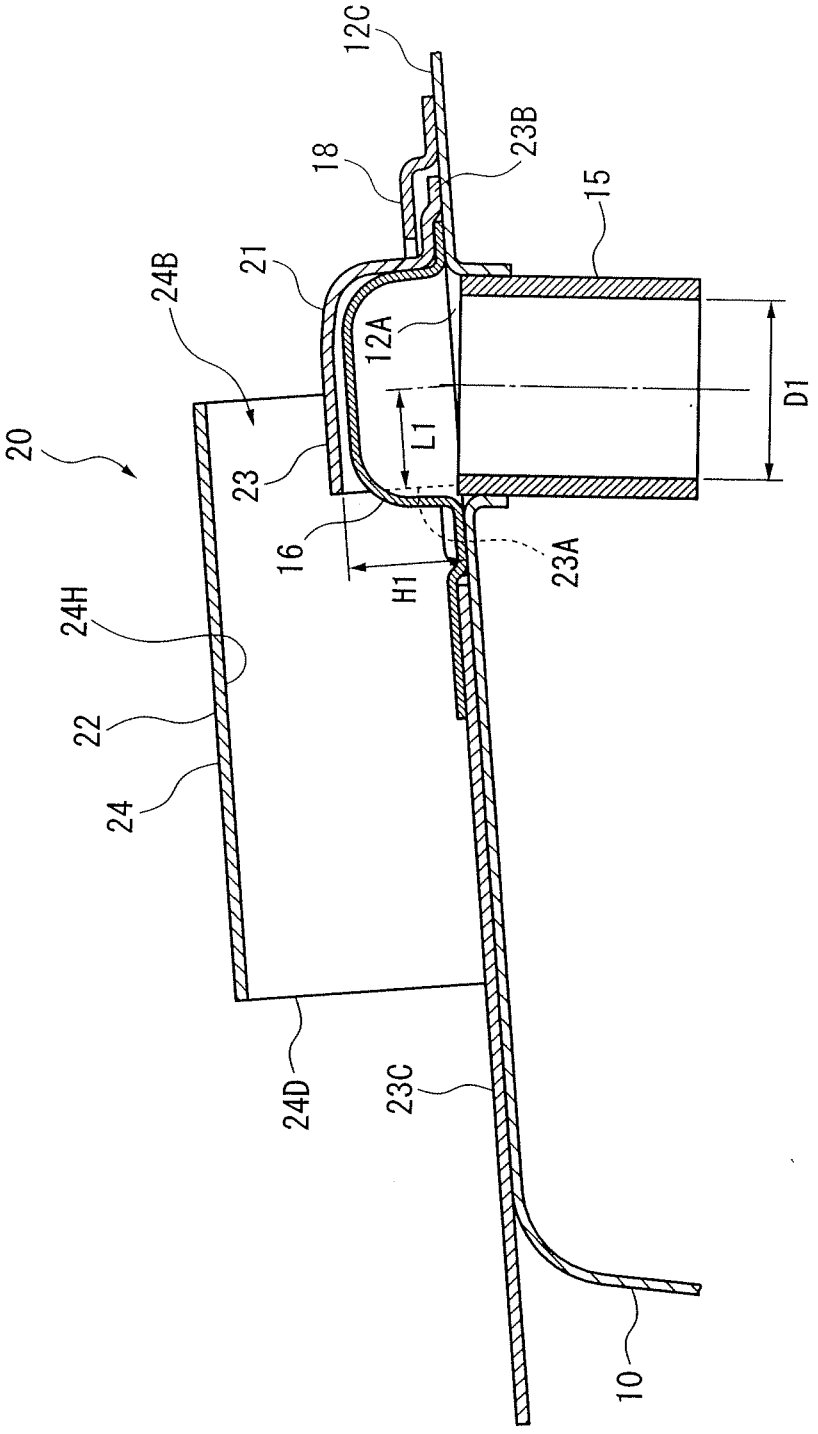


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/062253

A. CLASSIFICATION OF SUBJECT MATTER
F01N1/14(2006.01)i, *F01N1/08*(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)
F01N1/14, F01N1/08

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 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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.
X Y A	JP 53-044998 A (Andreas Stihl), 22 April, 1978 (22.04.78), Claims; page 2, upper right column, line 20 to lower left column, line 11; Figs. 1, 2 & US 4142607 A Column 1, lines 13 to 32; column 4, line 59 to column 6, line 54; Figs. 1, 2 & DE 2643240 A1 & FR 2365695 A1 & IT 1087401 A	2,3 1,4 5

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

* Special categories of cited documents:
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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
19 July, 2007 (19.07.07)	31 July, 2007 (31.07.07)
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/JP2007/062253

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 51-028508 Y2 (Toyo Kogyo Kabushiki Kaisha), 19 July, 1976 (19.07.76), Claims; column 2, line 31 to column 3, line 1; Fig. 2 & US 3857458 A Column 1, line 43 to column 2, line 3; column 4, lines 4 to 30; Fig. 5 & DE 2345803 A1	1,4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 53044998 A **[0004]**