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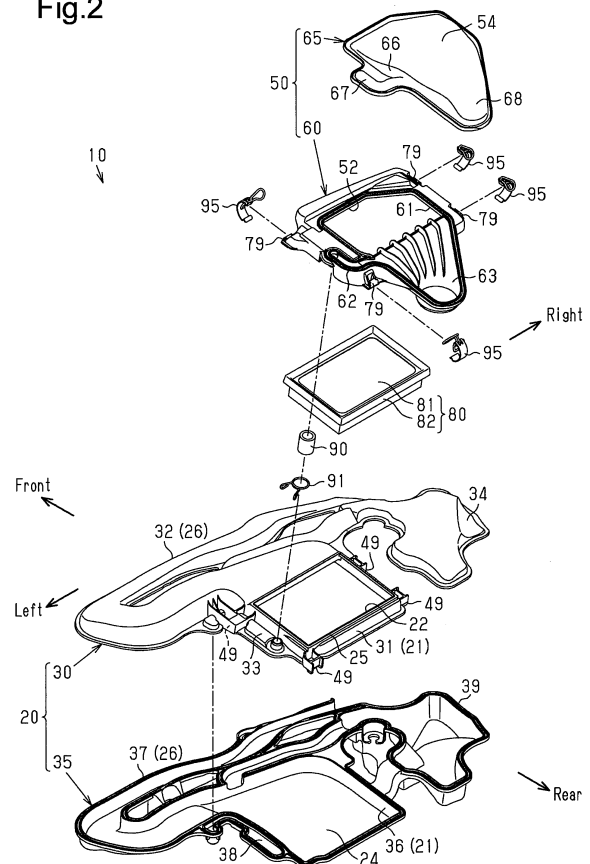
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(54) **AIR CLEANER FOR INTERNAL COMBUSTION ENGINE**

(57) An air cleaner for an internal combustion engine includes a case (20) including a case body (21) with an opening (22), and an inlet duct (26) formed integrally with the case body (21). The case (20) includes a first case molding (30) and a second case molding (35). The first case molding (30) includes an opening-side circumferential wall portion (31) surrounding the opening (22) of the case body (21), and a first inlet duct half (32) in a semi-cylindrical shape extending continuously with the opening-side circumferential wall portion (31). The second case molding (35) includes a bottom wall (24) of the case body (21), a bottom-wall-side circumferential wall portion (36) formed continuously with the bottom wall (24), and a second inlet duct half (37) in a semi-cylindrical shape extending continuously with the bottom-wall-side circumferential wall portion (36). The circumference of the opening-side circumferential wall portion (31) and the circumference of the bottom-wall-side circumferential wall portion (36) are joined to each other to form the case body (21). The circumference of the first inlet duct half (32) and the circumference of the second inlet duct half (37) are joined to each other to form the inlet duct (26).

Fig.2



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an air cleaner for an internal combustion engine.

[0002] In the air intake passage of an internal combustion engine, an air cleaner for filtering intake air is provided.

[0003] A conventional typical air cleaner includes a case having an opening and an inlet, a cap having an opening that faces the opening of the case and an outlet, and a filter element provided between the opening of the case and the opening of the cap. The inlet of the case is connected to an inlet duct that is separately provided from the case.

[0004] Japanese Laid-Open Patent Publication No. 2005-344555 describes an air cleaner that includes a cap provided integrally with an inlet duct. When the cap is attached to a case, the opening of the inlet duct on its downstream side and the opening of an inlet of the case communicate with each other.

[0005] In a conventional typical air cleaner, an inlet of a case is connected to an inlet duct separately provided from the case, so that a step is likely to be formed on the inner peripheral surface of the connected portion. This step may cause turbulence of airflow, resulting in an increase in pressure loss.

[0006] In the air cleaner described in Japanese Laid-Open Patent Publication No. 2005-344555, a step is likely to be formed on the inner peripheral surface of the connected portion of the opening of the inlet duct formed integrally with the cap on the downstream side of the inlet duct and the opening of the inlet of the case, so that airflow is disturbed. In addition, the inlet duct is formed integrally with the cap in the air cleaner described in the above document, so that there is a problem in that the cap needs to be opened and closed by lifting the inlet duct together with the cap when the filter element is replaced, thereby complicating the replacement operation.

SUMMARY OF THE INVENTION

[0007] It is an objective of the present invention to provide an air cleaner for an internal combustion engine, capable of reducing turbulence of airflow.

[0008] To achieve the foregoing objective, an air cleaner for an internal combustion engine is provided that includes a case including a case body with an opening, and an inlet duct formed integrally with the case body, a cap including an outlet, and an opening facing the opening of the case body, and a filter element provided between the opening of the case body and the opening of the cap. The case includes a first case molding and a second case molding. The first case molding includes an opening-side circumferential wall portion surrounding the opening of the case body, and a first inlet duct half in a semi-cylindrical shape extending continuously with the

opening-side circumferential wall portion. The second case molding includes a bottom wall of the case body, a bottom-wall-side circumferential wall portion formed continuously with the bottom wall, and a second inlet duct half in a semi-cylindrical shape extending continuously with the bottom-wall-side circumferential wall portion. The circumference of the opening-side circumferential wall portion and the circumference of the bottom-wall-side circumferential wall portion are joined to each other to form the case body. The circumference of the first inlet duct half and the circumference of the second inlet duct half are joined to each other to form the inlet duct.

[0009] With the above-described configuration, the inlet duct is formed integrally with the case body. Thus, unlike a conventional structure in which an inlet duct separately provided from a case is connected to an inlet of the case, no step is formed on the inner peripheral surface of the air intake passage due to the connection of the inlet duct and the inlet. Thus, the turbulence of airflow through the air intake passage is reduced.

[0010] In addition, the inlet duct is integrated with the case body, so that the cap can be opened and closed by lifting only the cap. Thus, the ease of replacement of the filter element does not deteriorate.

[0011] When an inlet duct is integrated with a case body, molding of a case becomes difficult if the inlet duct has a complex shape that is difficult to remove from the mold.

[0012] In this respect, with the above-described configuration, the case is formed by joining the first case molding, which includes the opening-side circumferential wall portion and the first inlet duct half, and the second case molding, which includes the bottom wall, the bottom-wall-side circumferential wall portion, and the second inlet duct half, to each other. This enables each of the case moldings to be easily molded, so that the case is formed easily.

[0013] With the present invention, the turbulence of airflow flowing through the air intake passage is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a perspective view illustrating the whole of an air cleaner for an internal combustion engine of an embodiment.

Fig. 2 is an exploded perspective view illustrating each of components constituting the air cleaner of the embodiment.

Fig. 3 is a sectional view taken along line 3-3 of Fig. 1.

Fig. 4 is a perspective view illustrating a case of the embodiment as viewed from its front side.

Fig. 5 is a perspective view illustrating a cap of the

embodiment as viewed from its front side.

Fig. 6 is a perspective view illustrating a first case molding of the embodiment as viewed from its reverse side.

Fig. 7 is a perspective view illustrating a second case molding of the embodiment as viewed from its front side.

Fig. 8 is a perspective view illustrating a first cap molding of the embodiment as viewed from its front side.

Fig. 9 is a perspective view illustrating the first cap molding of the embodiment as viewed from its reverse side.

Fig. 10 is a perspective view illustrating a second cap molding of the embodiment as viewed from its front side.

Fig. 11 is a perspective view illustrating the second cap molding of the embodiment as viewed from its reverse side.

Fig. 12 is an enlarged exploded perspective view illustrating each of components constituting the air cleaner of the embodiment, and a portion corresponding to a case passage and a cap passage in a return passage for blow-by gas.

Fig. 13 is an enlarged plan view of the air cleaner of the embodiment, illustrating a portion corresponding to the case passage and the cap passage.

Fig. 14 is a sectional view taken along line 14-14 of Fig. 13.

Fig. 15 is a sectional view taken along line 15-15 of Fig. 13.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] An air cleaner for an internal combustion engine (hereinafter, referred to as an air cleaner 10) according to one embodiment will now be described with reference to Figs. 1 to 15. The air cleaner 10 is installed in the engine compartment of an automobile.

[0016] Hereinafter, the front side and the rear side in the longitudinal direction of a vehicle are simply referred to as the front side and the rear side, respectively. In addition, the right side and the left side as viewed forward from behind the vehicle are simply referred to as the right side and the left side.

[0017] As illustrated in Figs. 1 to 3, the air cleaner 10 includes a case 20 formed integrally with an inlet duct

26, a cap 50 having an outlet 56, and a filter element 80. The filter element 80 is provided between an opening 22 that is formed in a rectangular shape in an upper portion of the case 20 and an opening 52 that faces the opening 22 and is formed in a rectangular shape in a lower portion of the cap 50.

<Case 20>

[0018] As illustrated in Figs. 3 and 4, the case 20 includes a case body 21 in a flat shape having a circumferential wall 23 surrounding the opening 22 and a bottom wall 24, an inlet duct 26 connected to the circumferential wall 23, and a resonator 48 connected to an intermediate portion of the inlet duct 26.

[0019] As illustrated in Fig. 3, a flange 25 is formed over the entire circumference opening 22.

[0020] As illustrated in Fig. 4, the left edge of the circumferential wall 23 is provided with a case passage 40 constituting a part of the return passage for returning blow-by gas from the internal combustion engine to the air intake passage.

[0021] The case body 21 is provided at its corners with respective four hooking portions 49, to each of which a clamp 95 (refer to Figs. 1 and 2) for fastening the case 20 and the cap 50 to each other is hooked.

[0022] As illustrated in Figs. 3 and 4, the inlet duct 26 includes a connection portion 261 and a bulging portion 262. The connection portion 261 is connected to the front face of the circumferential wall 23 of the case body 21, and extends along the circumferential direction of the case body 21. The bulging portion 262 bulges from the connection portion 261 toward the front side. The connection portion 261 is formed over the entire width of the front face of the circumferential wall 23.

[0023] The inlet duct 26 includes a first extension 27, a reversing portion 29, and a second extension 28. The first extension 27 extends from the bulging portion 262 toward the left side along the vehicle lateral direction. The reversing portion 29 is reversed from the first extension 27 toward the front side. The second extension 28 extends from the reversing portion 29 toward the right side along the vehicle lateral direction.

[0024] The inlet duct 26 of the present embodiment is formed such that the cross-sectional area of the flow channel of air gradually increases from the first extension 27 toward the connection portion 261.

[0025] The resonator 48 is connected to the front face of the bulging portion 262 of the inlet duct 26, and extends toward the right side to be positioned on the right side of the case body 21. The resonator 48 has an end projecting toward the rear side.

[0026] As illustrated in Figs. 4 and 12, the case passage 40 is formed from the rear edge of the first extension 27 of the inlet duct 26 to the left edge of the circumferential wall 23 of the case body 21.

[0027] As illustrated in Fig. 12, the case passage 40 includes an upstream-side vertical hole portion 41 ex-

tending vertically, a lateral hole portion 43, and a downstream-side vertical hole portion 44. The lateral hole portion 43 bends at an upper end of the upstream-side vertical hole portion 41, and extends along the rear edge of the first extension 27 and the left edge of the circumferential wall 23. The downstream-side vertical hole portion 44 bends at the downstream end, or the rear end of the lateral hole portion 43 and extends upward.

[0028] As illustrated in Figs. 4, 12, and 14, an upstream end 42 of the upstream-side vertical hole portion 41 is formed in a cylindrical shape and projects downward. A hose in the shape of a straight tube (not illustrated) is fitted onto the upstream end 42. The hose is connected to the cylinder head cover (not illustrated) positioned immediately below.

[0029] As illustrated in Figs. 4, 12, and 15, a downstream end 45 of the downstream-side vertical hole portion 44 is formed in a cylindrical shape and projects upward. A hose 90 in the shape of a straight tube is fitted onto the downstream end 45. The hose 90 is fixed to the downstream end 45 with a clip 91.

[0030] As illustrated in Figs. 2 to 4, the case 20 is formed by separate components, which are a first case molding 30 and a second case molding 35 provided below the first case molding 30.

[0031] As illustrated in Figs. 2, 4, and 6, the first case molding 30 includes an opening-side circumferential wall portion 31 surrounding the opening 22, a first inlet duct half 32 in a semi-cylindrical shape extending continuously with the opening-side circumferential wall portion 31, and a first resonator half 34 in a semi-cylindrical shape extending continuously with the first inlet duct half 32. The opening-side circumferential wall portion 31 is provided in its left edge with a first case passage forming portion 33. The first case molding 30 is formed as a single piece and made of hard plastic.

[0032] As illustrated in Figs. 2, 4, and 7, the second case molding 35 includes a bottom wall 24, a bottom-wall-side circumferential wall portion 36 formed continuously with the bottom wall 24, a second inlet duct half 37 in a semi-cylindrical shape extending continuously with the bottom-wall-side circumferential wall portion 36, and a second resonator half 39 in a semi-cylindrical shape extending continuously with the second inlet duct half 37. The bottom-wall-side circumferential wall portion 36 is provided in its left edge with a second case passage forming portion 38. The second case molding 35 is formed as a single piece and made of hard plastic.

[0033] As illustrated in Figs. 2 and 4, the circumference of the first case molding 30 and the circumference of the second case molding 35 are joined to each other by vibration welding to form the case 20.

[0034] That is, the circumference of the opening-side circumferential wall portion 31 and the circumference of the bottom-wall-side circumferential wall portion 36 are joined to each other to form the case body 21. The circumference of the first inlet duct half 32 and the circumference of the second inlet duct half 37 are joined to each

other to form the inlet duct 26. The circumference of the first resonator half 34 and the circumference of the second resonator half 39 are joined to each other to form the resonator 48 of a Helmholtz type.

[0035] In addition, the circumference of the first case passage forming portion 33 and the circumference of the second case passage forming portion 38 are joined to each other to form the case passage 40.

<Cap 50>

[0036] As illustrated in Figs. 3 and 5, the cap 50 includes a cap body 51 in a flat shape having a circumferential wall 53 surrounding the opening 52 and a top wall 54, and an outlet 56 formed integrally with the cap body 51.

[0037] As illustrated in Fig. 3, a flange 55 is formed over the entire circumference of the opening 52.

[0038] As illustrated in Fig. 5, the left edge of the circumferential wall 53 is provided with a cap passage 70 constituting a portion downstream of the case passage 40 in the return passage.

[0039] The cap body 51 is provided at its corners with respective four support portions 79 each of which supports the clamp 95 (refer to Figs. 1 and 2) such that the clamp 95 can be tilted.

[0040] As illustrated in Figs. 3 and 5, the outlet 56 is connected to the rear face of the circumferential wall 53 of the cap body 51 and projects rearward. The outlet 56 has a downstream end facing downward.

[0041] As illustrated in Figs. 5 and 12, the cap passage 70 is formed from the left edge of the cap body 51 to the left edge of the outlet 56.

[0042] As illustrated in Figs. 12 and 15, the cap passage 70 includes a vertical hole portion 71 that extends vertically, and a lateral hole portion 73 that bends at the upper end of the vertical hole portion 71 and extends rearward, and then bends and extends rightward. The lateral hole portion 73 has a downstream end 74 connected to the outlet 56.

[0043] As illustrated in Figs. 12 and 15, an upstream end 72 of the vertical hole portion 71 is formed in a cylindrical shape and projects downward.

[0044] As illustrated in Figs. 12 and 15, the downstream end 45 of the case passage 40 and the upstream end 72 of the cap passage 70 are positioned on the same axis. The hose 90 is fitted onto the upstream end 72 of the cap passage 70.

[0045] As illustrated in Figs. 2, and 6 to 8, the cap 50 is formed by separate components, which are a first cap molding 60 and a second cap molding 65 provided above the first cap molding 60.

[0046] As illustrated in Figs. 2, 8, and 9, the first cap molding 60 includes an opening-side circumferential wall portion 61 surrounding the opening 52, and a first outlet molding portion 63 extending rearward continuously with the opening-side circumferential wall portion 61. In addition, a first cap passage forming portion 62 is formed in

the left edge of each of the opening-side circumferential wall portion 61 and the first outlet molding portion 63.

[0047] The first cap molding 60 is provided with an outer peripheral wall 57 with which the cap body 51 is covered from its outer periphery. The outer peripheral wall 57 is provided with the support portion 79. The outer peripheral wall 57 is provided with a cutout portion 58 for exposing the upstream end 72 of the cap passage 70 to the outside. The first cap molding 60 is formed as a single piece and made of hard plastic.

[0048] As illustrated in Figs. 2, 10, and 11, the second cap molding 65 includes the top wall 54 of the cap body 51, a top-wall-side circumferential wall portion 66 formed continuously with the top wall 54, and a second outlet molding portion 68 extending rearward continuously with the top-wall-side circumferential wall portion 66. The top-wall-side circumferential wall portion 66 is provided in its left edge with a second cap passage forming portion 67. The second cap molding 65 is formed as a single piece and made of hard plastic.

[0049] As illustrated in Figs. 2 and 5, the circumference of the first cap molding 60 and the circumference of the second cap molding 65 are joined to each other by vibration welding to form the cap 50.

[0050] That is, the circumference of the opening-side circumferential wall portion 61 and the circumference of the top-wall-side circumferential wall portion 66 are joined to each other to form the cap body 51. The circumference of the first outlet molding portion 63 and the circumference of the second outlet molding portion 68 are joined to each other to form the outlet 56.

[0051] In addition, the circumference of the first cap passage forming portion 62 and the circumference of the second cap passage forming portion 67 are joined to each other to form the cap passage 70.

<Filter Element 80>

[0052] As illustrated in Figs. 2 and 3, the filter element 80 includes a filter portion 81 formed by folding a filter medium sheet such as nonwoven fabric and filter paper so as to form pleats, and an annular sealing portion 82 formed around the circumference of the filter portion 81. The sealing portion 82 is formed of an elastic member such as polyurethane with closed cells.

[0053] As illustrated in Fig. 3, the sealing portion 82 is held by the flange 25 of the case 20 and the flange 55 of the cap 50 to seal against the flange 55 of the cap 50.

[0054] In the air cleaner 10 described above, when the cap 50 is attached to the case 20, the hose 90 is fitted onto the upstream end 72 of the cap passage 70. This allows the case passage 40 and the cap passage 70 to communicate with each other.

[0055] The above-described air cleaner for an internal combustion engine achieves the following advantages.

(1) The case 20 of the air cleaner 10 of the internal combustion engine includes the first case molding

30 having the opening-side circumferential wall portion 31 surrounding the opening 22 of the case body 21, and the first inlet duct half 32 in a semi-cylindrical shape extending continuously with the opening-side circumferential wall portion 31. The case 20 also includes the second case molding 35 having the bottom wall 24 of the case body 21, the bottom-wall-side circumferential wall portion 36 formed continuously with the bottom wall 24, and the second inlet duct half 37 in a semi-cylindrical shape extending continuously with the bottom-wall-side circumferential wall portion 36. The circumference of the opening-side circumferential wall portion 31 and the circumference of the bottom-wall-side circumferential wall portion 36 are joined to each other to form the case body 21. The circumference of the first inlet duct half 32 and the circumference of the second inlet duct half 37 are joined to each other to form the inlet duct 26.

With the above-described configuration, the inlet duct 26 is formed integrally with the case body 21, so that no step is formed on the inner peripheral surface of the air intake passage due to connection of the inlet duct and the inlet, unlike a conventional structure in which an inlet duct separately provided from a case is connected to an inlet of the case. Thus, the turbulence of airflow is reduced.

In addition, the inlet duct 26 is integrated with the case body 21, so that the cap can be opened and closed by lifting only the cap 50. Thus, the ease of replacement of the filter element 80 does not deteriorate.

When the inlet duct 26 is integrated with the case body 21, molding of the case 20 becomes difficult if the inlet duct 26 has a complex shape that is difficult to remove from the mold.

In this respect, with the above-described configuration, the case 20 is formed by joining the first case molding 30 including the opening-side circumferential wall portion 31 and the first inlet duct half 32, and the second case molding 35 including the bottom wall 24, the bottom-wall-side circumferential wall portion 36, and the second inlet duct half 37, to each other. This enables each of the case moldings 30 and 35 to be easily molded to easily form the case 20. Thus, the ease of replacement and moldability of the filter element 80 are excellent, and turbulence of airflow is reduced.

(2) The inlet duct 26 includes the reversing portion 29.

In general, when the inlet duct 26 includes the reversing portion 29, removal from the mold along the extension direction of the reversing portion 29 may be difficult.

In this respect, with the above-described configuration, the inlet duct 26 is formed by separate components, which are the first inlet duct half 32 and the second inlet duct half 37. Thus, the case 20 formed

integrally with the inlet duct 26 can be easily formed.

(3) The inlet duct 26 includes the connection portion 261, which is connected to the front face of the circumferential wall 23 of the case body 21 and extends along the circumferential direction of the case body 21, the bulging portion 262 bulging from the connection portion 261 toward the front side, and the first extension 27, which is connected to one end of the bulging portion 262 in its circumferential direction and extends along the circumferential direction. A cross-sectional area of a flow channel of air gradually increases from the first extension 27 toward the connection portion 261.

With the above-described configuration, air is introduced into the case body 21 through the first extension 27, the bulging portion 262, and the connection portion 261, of the inlet duct 26. At this time, the cross-sectional area of the flow channel of air gradually increases from the first extension 27 toward the connection portion 261, so that a sudden decrease in pressure of air is prevented to reduce turbulence of airflow.

(4) The first case molding 30 is provided with the first resonator half 34 in a semi-cylindrical shape. The second case molding 35 is provided with the second resonator half 39 in a semi-cylindrical shape. The circumference of the first resonator half 34 and the circumference of the second resonator half 39 are joined to each other to form the resonator 48 of a Helmholtz type.

With the above-described configuration, the inlet duct 26 is formed integrally with the resonator 48, so that a separate process of attaching the resonator 48 to the inlet duct 26 is unnecessary.

(5) The case 20 is provided with the case passage 40, which constitutes a part of the return passage for returning blow-by gas from the internal combustion engine to the air intake passage. The cap 50 is provided with the cap passage 70, which constitutes a portion downstream of the case passage 40 in the return passage. The case passage 40 and the cap passage 70 are configured to communicate with each other when the case 20 and the cap 50 are attached to each other.

With the above-described configuration, when the case 20 and the cap 50 of the air cleaner 10 are attached to each other, the case passage 40 and the cap passage 70, each of which constitutes a part of the return passage for returning blow-by gas from the internal combustion engine to the air intake passage, communicate with each other.

This enables reduction in length of a hose constituting a part of the return passage of blow-by gas, so that a hose in a specific shape is unnecessary. Thus, the structure of the periphery of the air cleaner 10 can be simplified.

(6) The case passage 40 is formed in the edge of the case body 21. The cap passage 70 is formed in

the edge of the cap body 51.

With the above-described configuration, it is possible to properly avoid influence on the internal space of the case body 21, or the shape of the air intake passage due to providing of the case passage 40 in the case 20. In addition, it is possible to properly avoid influence on the internal space of the cap body 51, or the shape of the air intake passage due to providing of the cap passage 70 in the cap 50.

(7) The downstream end 45 of the case passage 40 and the upstream end 72 of the cap passage 70 are positioned on the same axis.

With the above-described configuration, when the opening 22 of the case 20 of the air cleaner 10 and the opening 52 of the cap 50 are attached to each other while facing each other, the case passage 40 and the cap passage 70 can easily communicate with each other. Thus, it is possible to facilitate the attachment work of the case 20 and the cap 50.

(8) The hose 90 in the shape of a straight tube is provided between the downstream end 45 of the case passage 40 and the upstream end 72 of the cap passage 70.

With the above-described configuration, the downstream end 45 of the case passage 40 and the upstream end 72 of the cap passage 70 communicate with each other through the hose 90 therebetween. The hose 90 in the shape of a straight tube also serves as a guide when the cap 50 is attached to the case 20, so that it is possible to facilitate the attachment work of the case 20 and the cap 50.

(9) The hose 90 is fixed to the downstream end 45 of the case passage 40.

When the cap 50 is removed from the case 20, the hose 90 may be detached from the case 20. In this case, when the cap 50 is attached to the case 20, the hose 90 needs to be attached to the downstream end 45 of the case passage 40 again, thereby complicating the attachment work.

In this respect, with the above-described configuration, the hose 90 is fixed to the downstream end 45 of the case passage 40, so that the hose 90 is not detached from the case 20 when the cap 50 is removed from the case 20. This eliminates the necessity for attaching the hose 90 to the downstream end 45 of the case passage 40 again when the cap 50 is attached to the case 20, so that it is possible to facilitate the attachment work of the cap 50 to the case 20.

(10) The cap 50 includes the outer peripheral wall 57, with which the cap body 51 is covered from its outer periphery. The outer peripheral wall 57 is provided with the cutout portion 58 for exposing the upstream end 72 of the cap passage 70 to the outside. It is conceivable that the support portion 79 of the clamp 95 for fastening the case 20 and the cap 50 to each other is formed in the outer peripheral wall 57, with which the cap body 51 is covered from its

outer periphery.

In this case, however, the upstream end 72 of the cap passage 70 is covered with the outer peripheral wall 57 from its outer periphery. Thus, it is difficult for an operator to visually check whether the upstream end 72 of the cap passage 70 is inserted into a predetermined position with respect to the hose 90 fixed to the downstream end 45 of the case passage 40.

In this respect, with the above-described configuration, the upstream end 72 of the cap passage 70 is exposed to the outside through the cutout portion 58, so that an operator can visually check that the upstream end 72 of the cap passage 70 is inserted into the predetermined position with respect to the hose 90.

(11) The downstream end 74 of the cap passage 70 is connected to the outlet 56.

When the downstream end 74 of the cap passage 70 is connected to the cap body 51, blow-by gas is returned into the cap body 51. Thus, when the cap body 51 is in a flat shape like the present embodiment, oil mist contained in blow-by gas is likely to collect on the filter portion 81 of the filter element 80, whereby the filter performance of the filter portion 81 may deteriorate.

In this respect, with the above-described configuration, the downstream end 74 of the cap passage 70 is connected to the outlet 56. This causes blow-by gas to flow toward a downstream side of the outlet 56, so that attachment of oil mist to the filter portion 81 of the filter element 80 is properly avoided.

(12) The case passage 40 includes the upstream-side vertical hole portion 41 extending upward from its upstream end 42, and the lateral hole portion 43, which bends at the upper end of the upstream-side vertical hole portion 41 and extends.

With the above-described configuration, as represented by the arrow of a broken line in Fig. 14, when passing through the bent portion between the upstream-side vertical hole portion 41 and the lateral hole portion 43 of the case passage 40, blow-by gas collides with a ceiling face 46 of the bent portion to facilitate separation of oil mist contained in the blow-by gas. Thus, it is possible to limit oil mist contained in blow-by gas, flowing into the air intake passage.

(13) The cap passage 70 includes the vertical hole portion 71 extending upward from its upstream end 72, and the lateral hole portion 73, which bends and extends from the upper end of the vertical hole portion 71.

With the above-described configuration, as represented by the arrow of a broken line in Fig. 15, when passing through the bent portion between the vertical hole portion 71 and the lateral hole portion 73 of the cap passage 70, blow-by gas collides with a ceiling face 75 of the bent portion to facilitate separation of oil mist contained in the blow-by gas. Thus, it is pos-

sible to reduce oil mist contained in blow-by gas, flowing into the air intake passage.

(14) The case 20 includes the first case molding 30 having the opening-side circumferential wall portion 31 and the first case passage forming portion 33, and the second case molding 35 having the bottom wall 24, the bottom-wall-side circumferential wall portion 36, and the second case passage forming portion 38. The circumference of the opening-side circumferential wall portion 31 and the circumference of the bottom-wall-side circumferential wall portion 36 are joined to each other to form the case body 21. The first case passage forming portion 33 and the second case passage forming portion 38 are joined to each other to form the case passage 40.

With the above-described configuration, the first case passage forming portion 33 and the second case passage forming portion 38 are joined to each other to form the case passage 40. Thus, even when removal from the mold is difficult due to the complicated shape of the case passage 40, the case 20 can be easily formed.

(15) The cap 50 includes the first cap molding 60, which has the opening-side circumferential wall portion 61 and the first cap passage forming portion 62, and the second cap molding 65, which has the top wall 54, the top-wall-side circumferential wall portion 66, and the second cap passage forming portion 67. The circumference of the opening-side circumferential wall portion 61 and the circumference of the top-wall-side circumferential wall portion 66 are joined to each other to form the cap body 51. The first cap passage forming portion 62 and the second cap passage forming portion 67 are joined to each other to form the cap passage 70.

With the above-described configuration, the first cap passage forming portion 62 and the second cap passage forming portion 67 are joined to each other to form the cap passage 70. Thus, even when removal from the mold is difficult due to the complicated shape of the cap passage 70, the cap 50 can be easily formed.

<Modifications>

[0056] The above-described embodiment may be modified as follows.

[0057] The inlet duct 26 and the resonator 48 also can be separately formed. In this case, the resonator may be connected to the inlet duct.

[0058] The inlet duct 26 is not limited to that including the reversing portion 29, the shape of the inlet duct 26 may be changed as necessary.

[0059] The first cap molding 60 and the second cap molding 65 are joined to each other to form the cap 50 in the above embodiment. However, the cap may be integrally molded.

[0060] The first case molding 30 and the second case

molding 35 are joined to each other by vibration welding in the above embodiment. However, the first case molding 30 and the second case molding 35 are joined to each other with an adhesive.

[0061] An air cleaner for an internal combustion engine includes a case (20) including a case body (21) with an opening (22), and an inlet duct (26) formed integrally with the case body (21). The case (20) includes a first case molding (30) and a second case molding (35). The first case molding (30) includes an opening-side circumferential wall portion (31) surrounding the opening (22) of the case body (21), and a first inlet duct half (32) in a semi-cylindrical shape extending continuously with the opening-side circumferential wall portion (31). The second case molding (35) includes a bottom wall (24) of the case body (21), a bottom-wall-side circumferential wall portion (36) formed continuously with the bottom wall (24), and a second inlet duct half (37) in a semi-cylindrical shape extending continuously with the bottom-wall-side circumferential wall portion (36). The circumference of the opening-side circumferential wall portion (31) and the circumference of the bottom-wall-side circumferential wall portion (36) are joined to each other to form the case body (21). The circumference of the first inlet duct half (32) and the circumference of the second inlet duct half (37) are joined to each other to form the inlet duct (26).

Claims

1. An air cleaner for an internal combustion engine, comprising:

a case (20) including a case body (21) with an opening (22), and an inlet duct (26) formed integrally with the case body (21);
a cap (50) including an outlet (56), and an opening (52) facing the opening (22) of the case body (21); and
a filter element (80) provided between the opening (22) of the case body (21) and the opening (52) of the cap (50), wherein
the case (20) includes a first case molding (30) and a second case molding (35),
the first case molding (30) includes

an opening-side circumferential wall portion (31) surrounding the opening (22) of the case body (21), and
a first inlet duct half (32) in a semi-cylindrical shape extending continuously with the opening-side circumferential wall portion (31),

the second case molding (35) includes

a bottom wall (24) of the case body (21),
a bottom-wall-side circumferential wall por-

tion (36) formed continuously with the bottom wall (24), and
a second inlet duct half (37) in a semi-cylindrical shape extending continuously with the bottom-wall-side circumferential wall portion (36),

the circumference of the opening-side circumferential wall portion (31) and the circumference of the bottom-wall-side circumferential wall portion (36) are joined to each other to form the case body (21), and
the circumference of the first inlet duct half (32) and the circumference of the second inlet duct half (37) are joined to each other to form the inlet duct (26).

2. The air cleaner for an internal combustion engine, according to claim 1,
wherein the inlet duct (26) includes a reversing portion (29) for reversing a flow channel of air.
3. The air cleaner for an internal combustion engine, according to claim 1 or 2,
wherein

the inlet duct (26) includes

a connection portion (261), which is connected to one face of a circumferential wall (23) of the case body (21) and extends along a circumferential direction of the case body (21),
a bulging portion (262) bulging from the connection portion (261) toward an outer periphery, and
an extension (27), which is connected to one end of the bulging portion (262) in the circumferential direction and extends along the circumferential direction, and

a cross-sectional area of a flow channel of air gradually increases from the extension (27) toward the connection portion (261).

4. The air cleaner for an internal combustion engine, according to any one of claims 1 to 3, wherein
the first case molding (30) is provided with a first resonator half (34) in a semi-cylindrical shape,
the second case molding (35) is provided with a second resonator half (39) in a semi-cylindrical shape, and
the circumference of the first resonator half (34) and the circumference of the second resonator half (39) are joined to each other to form a resonator (48) of a Helmholtz type.

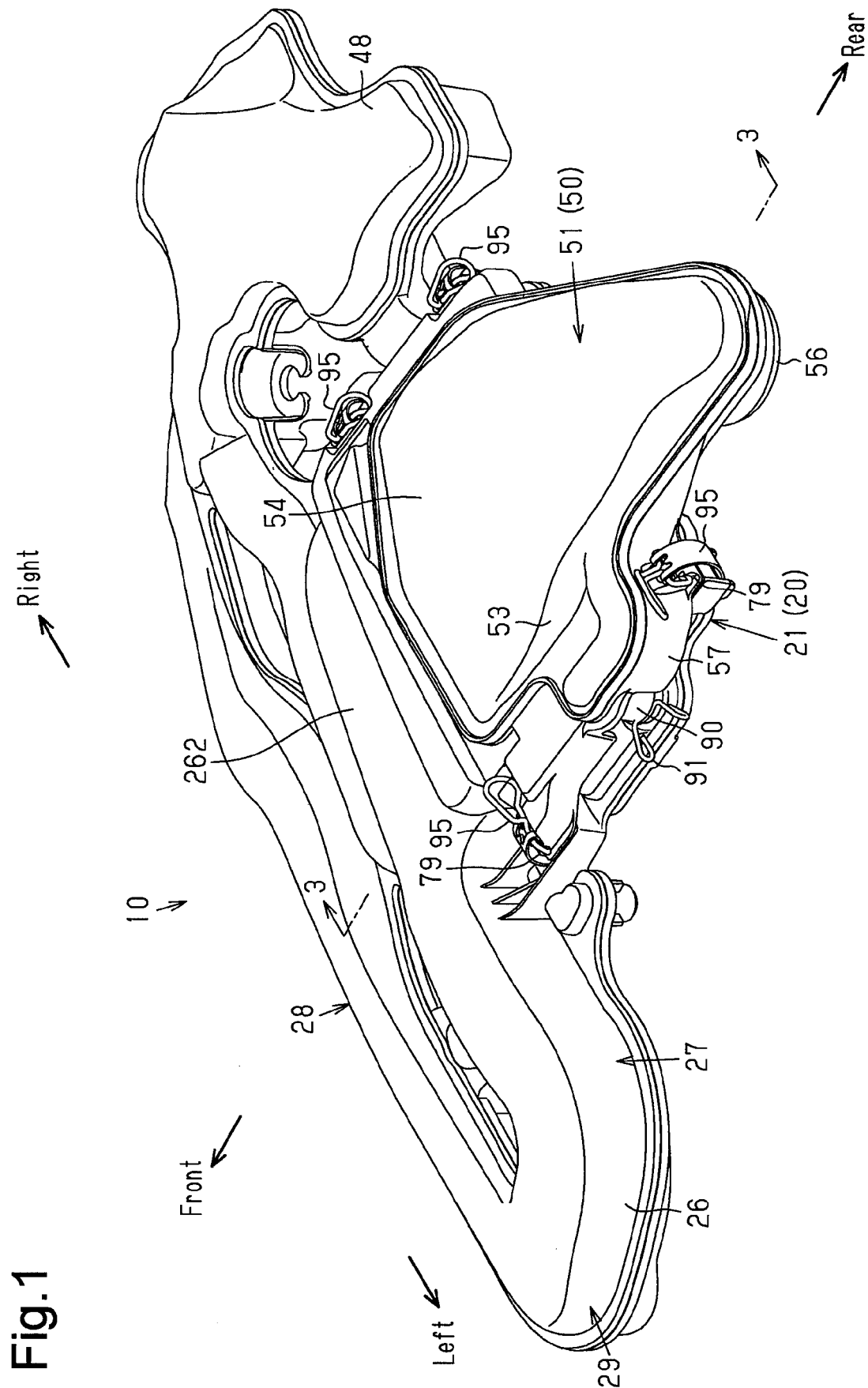
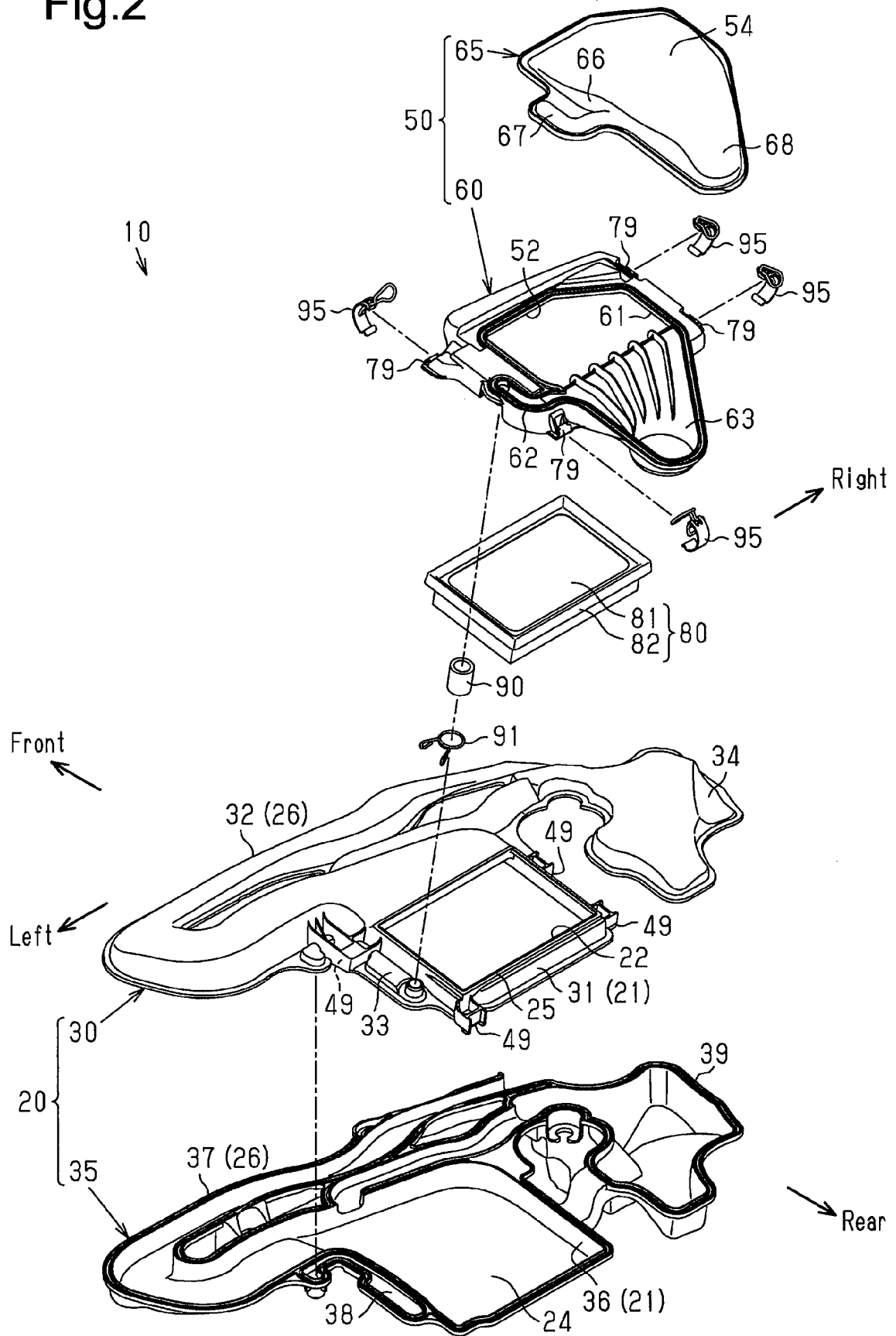


Fig. 1

Fig.2



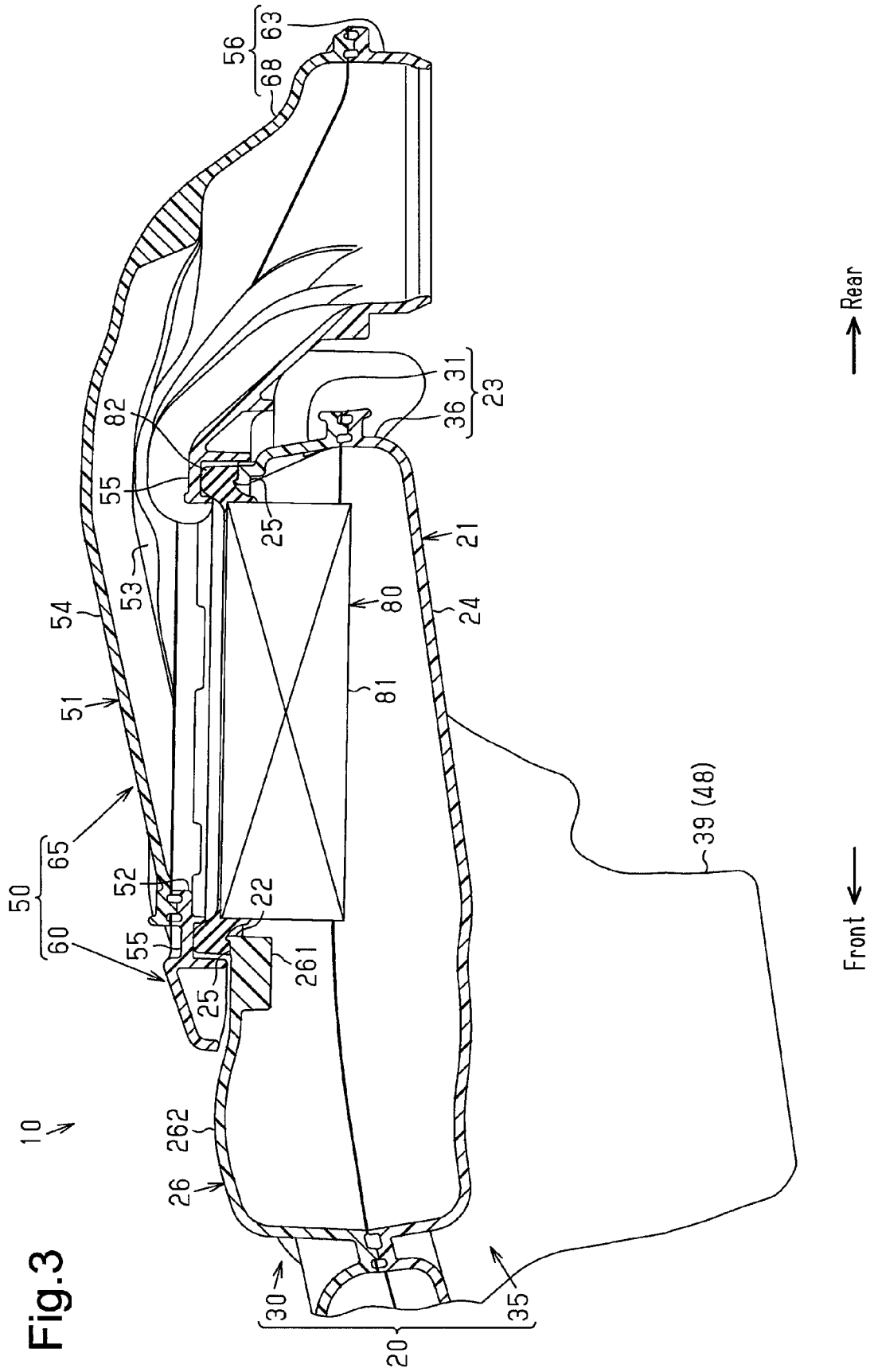


Fig.4

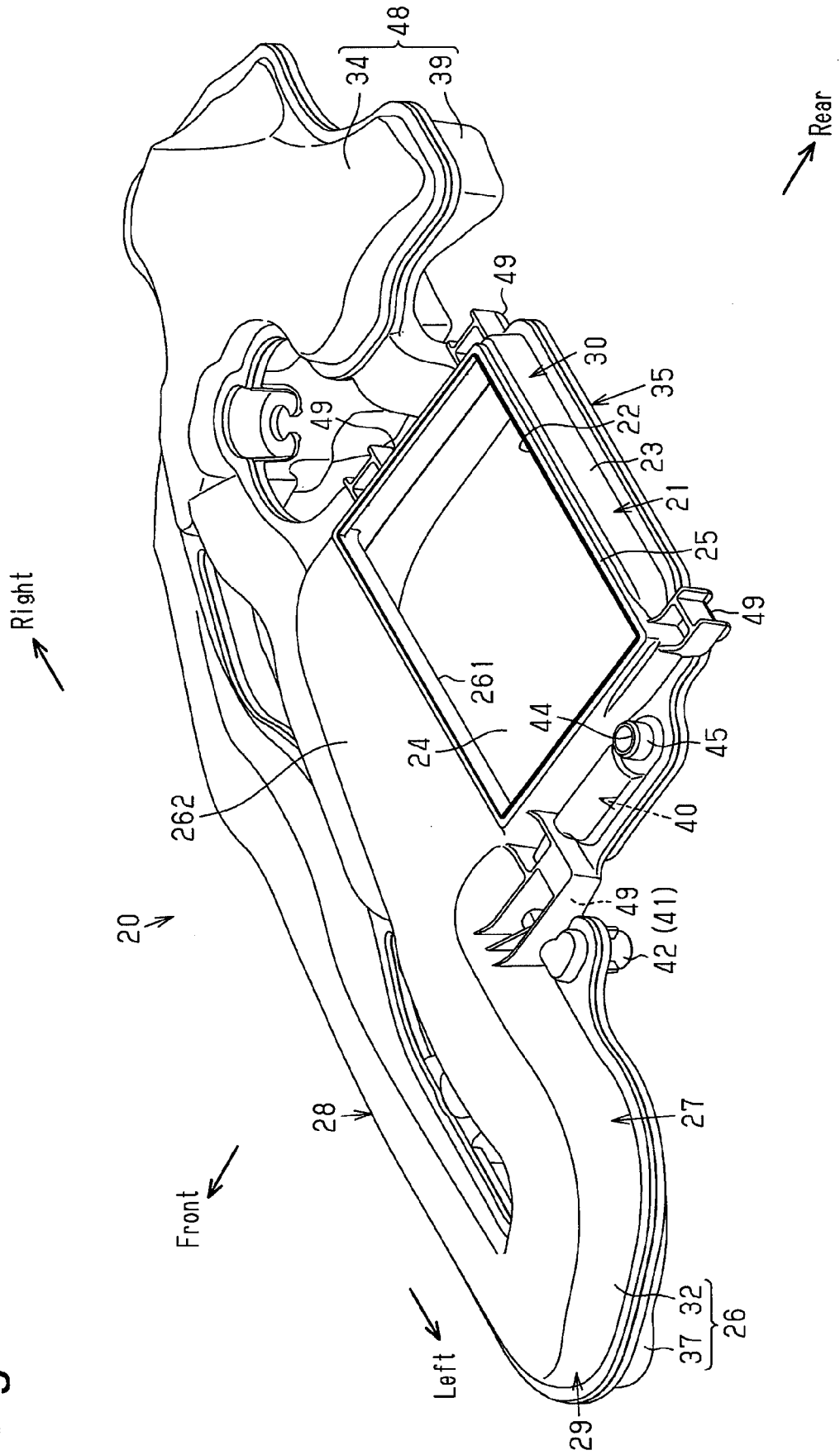


Fig.5

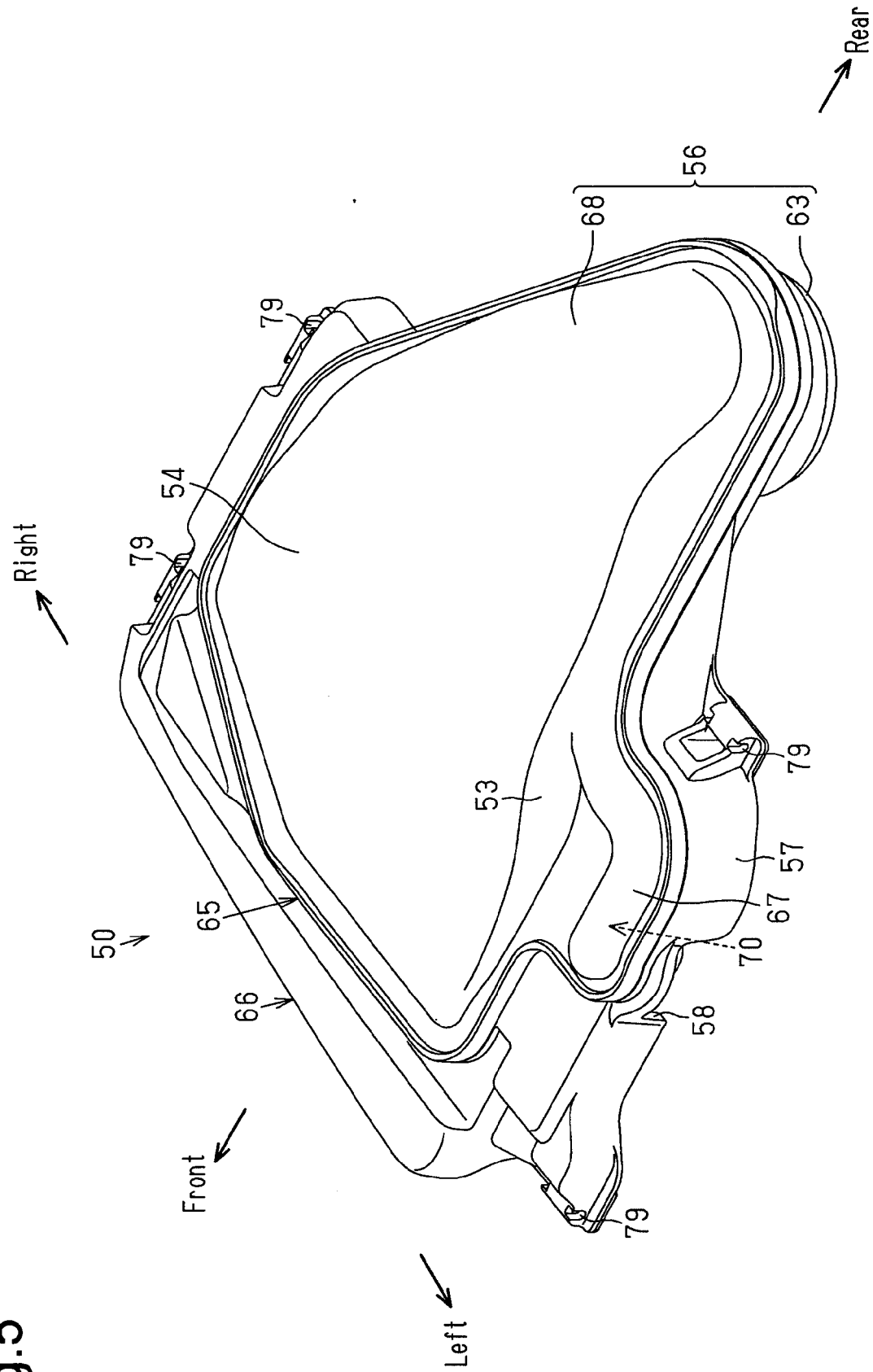


Fig.6

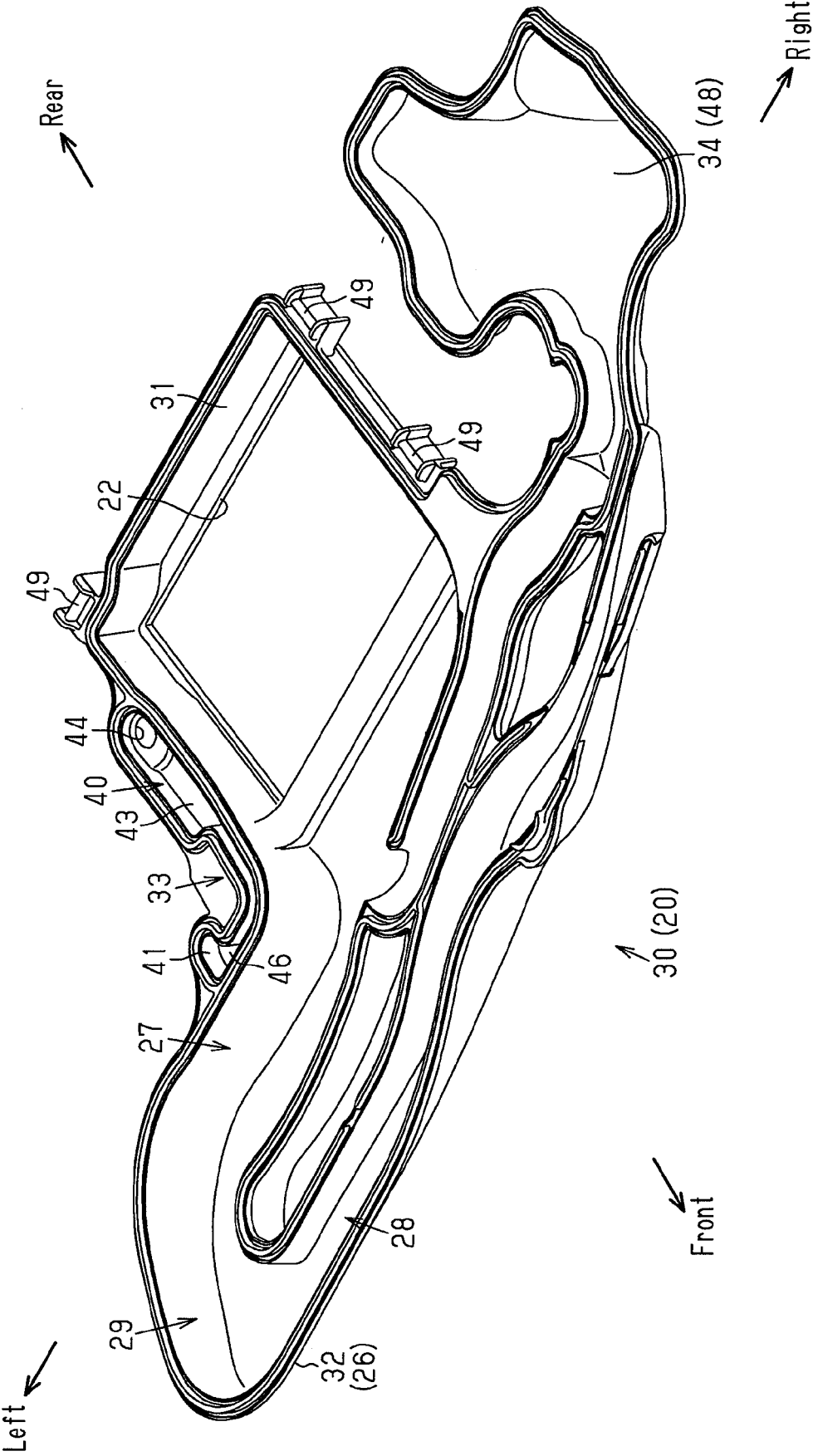


Fig.7

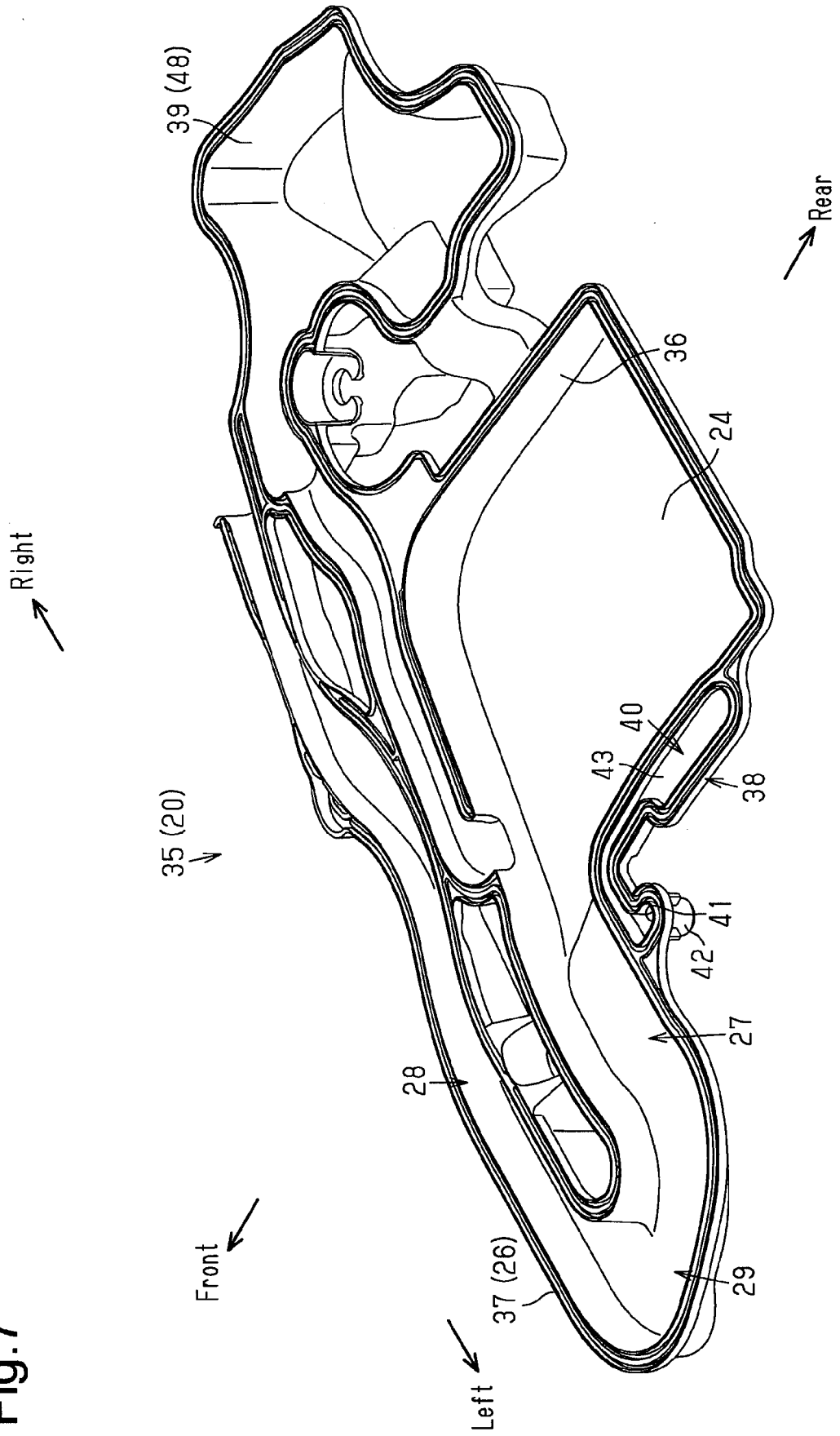


Fig.8

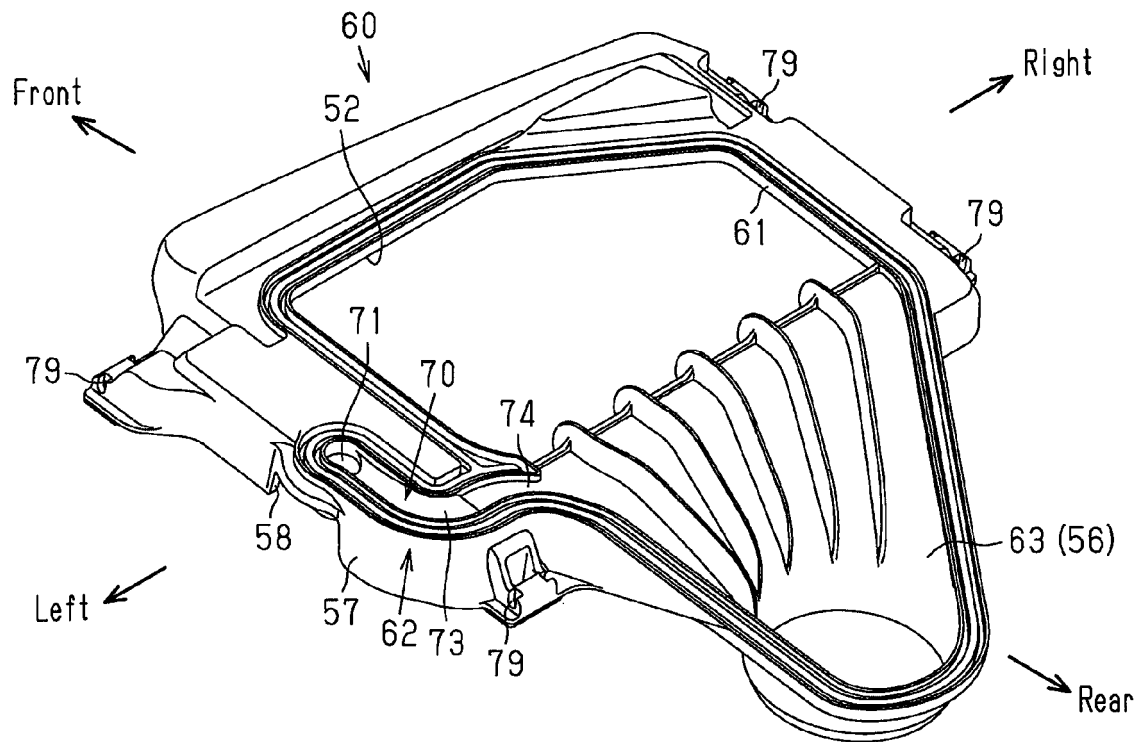


Fig.9

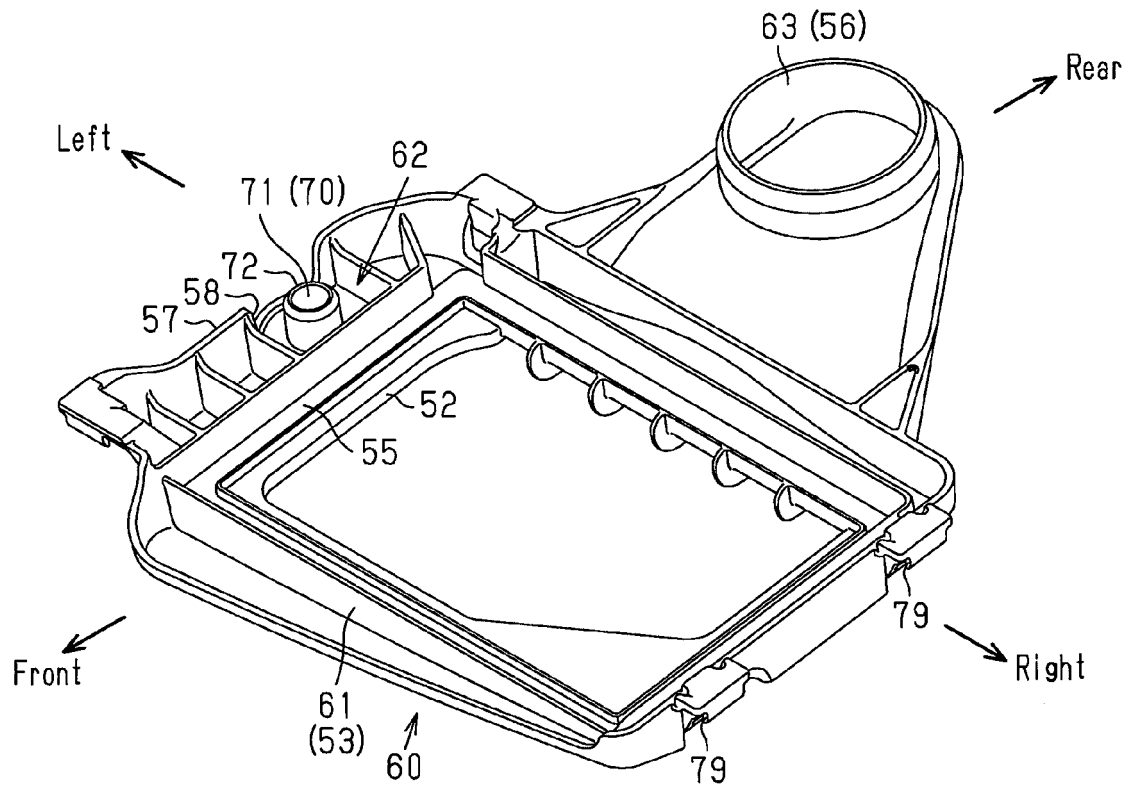


Fig.10

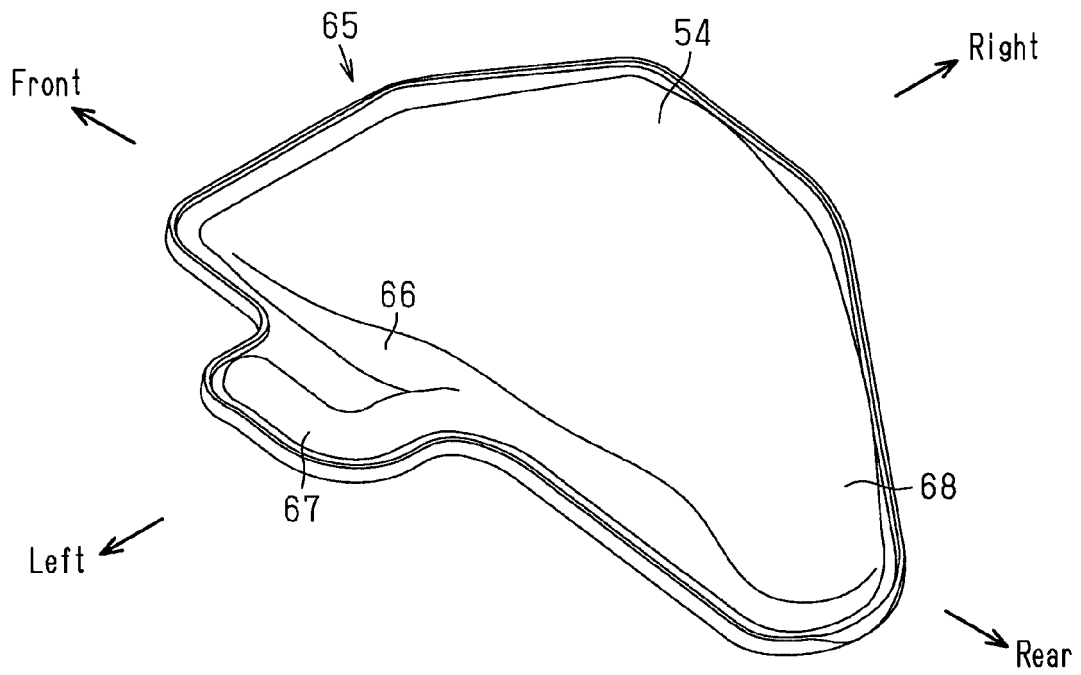


Fig.11

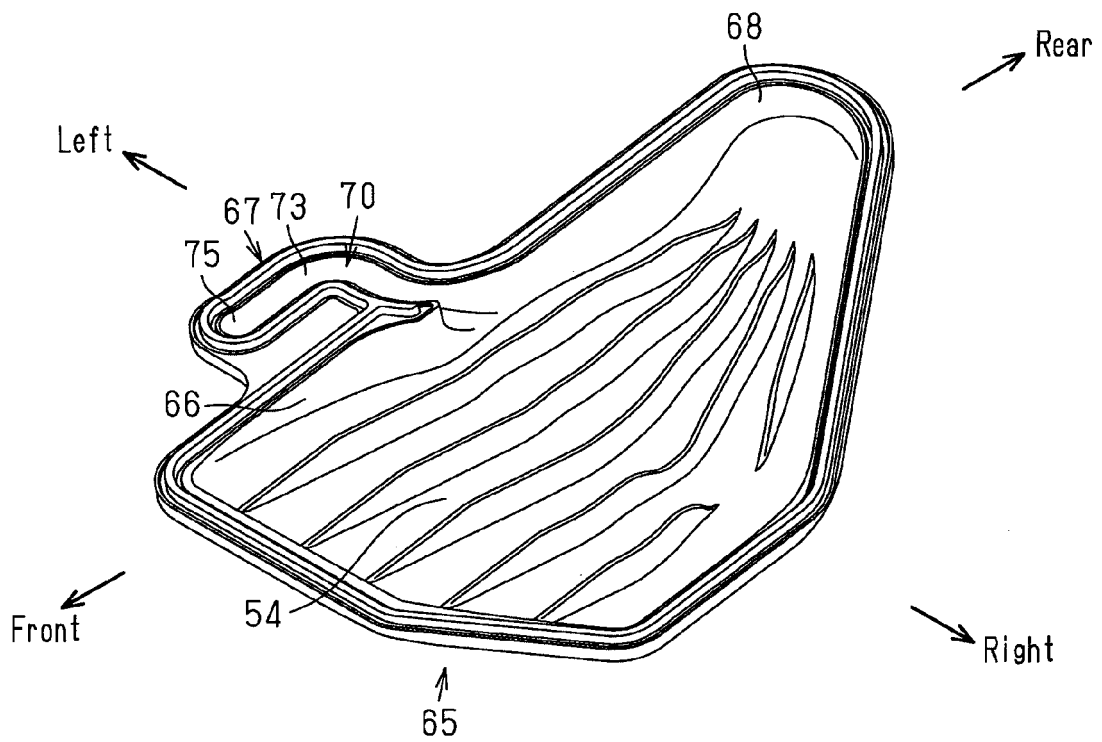


Fig.12

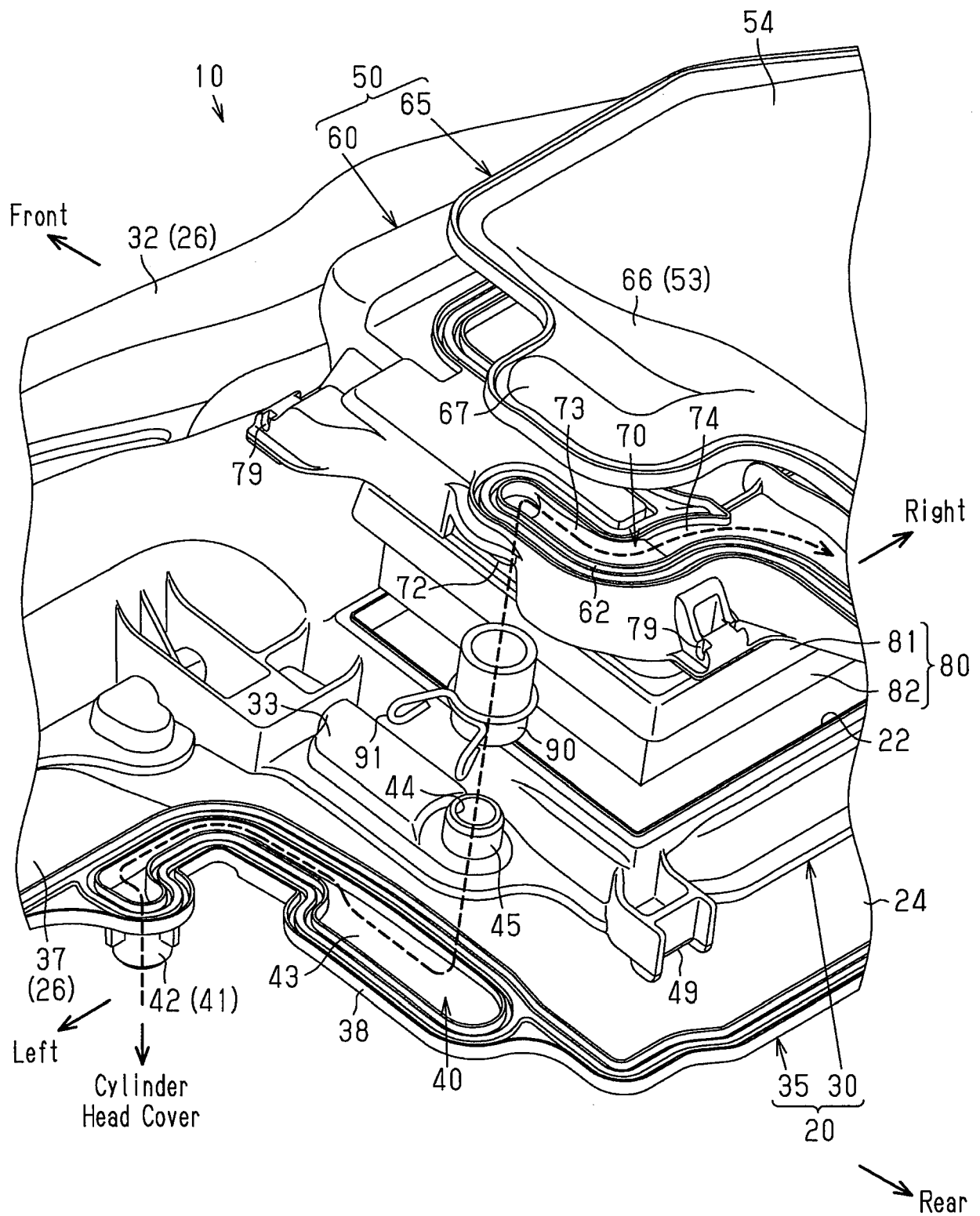


Fig.13

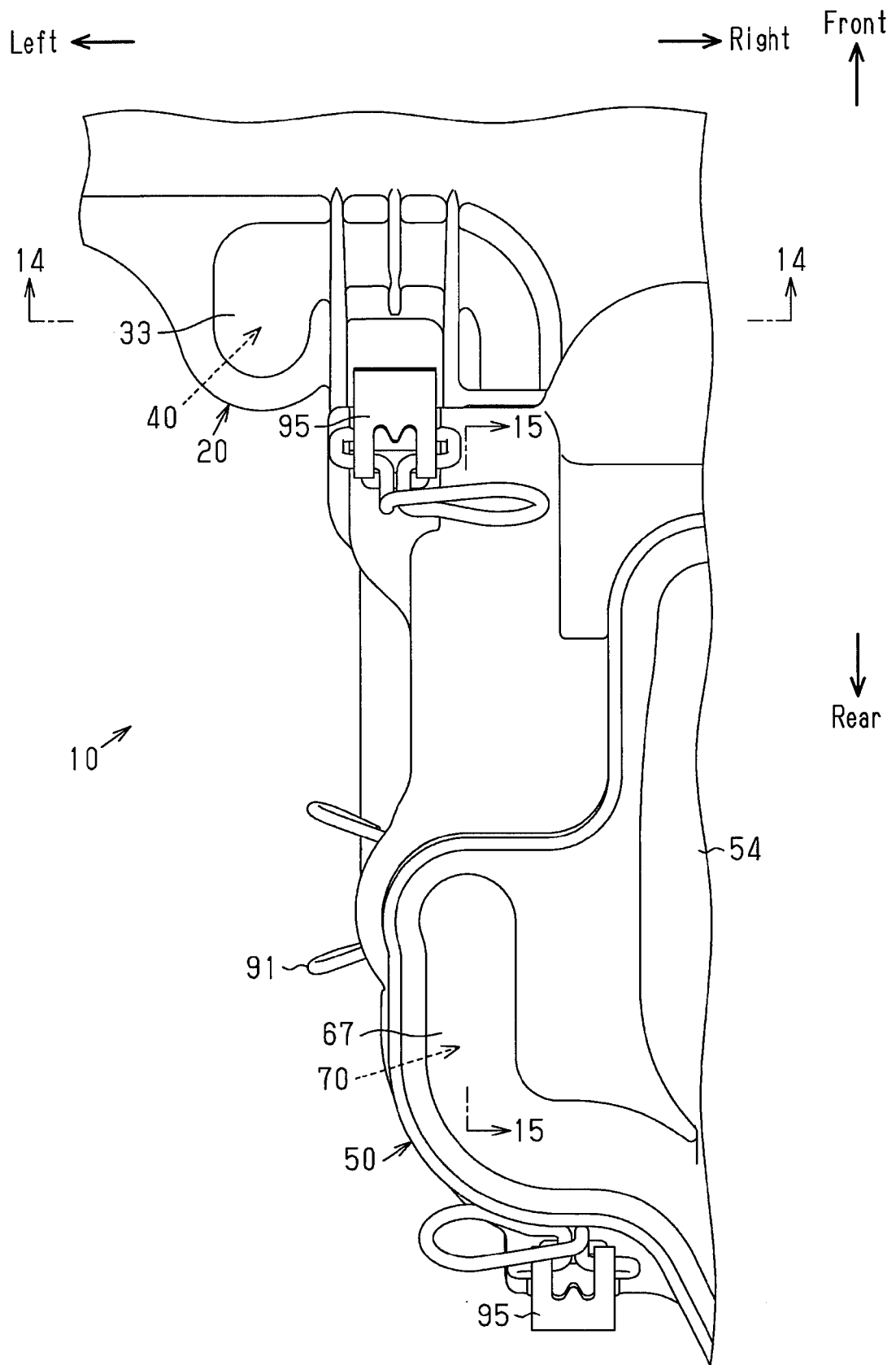


Fig.14

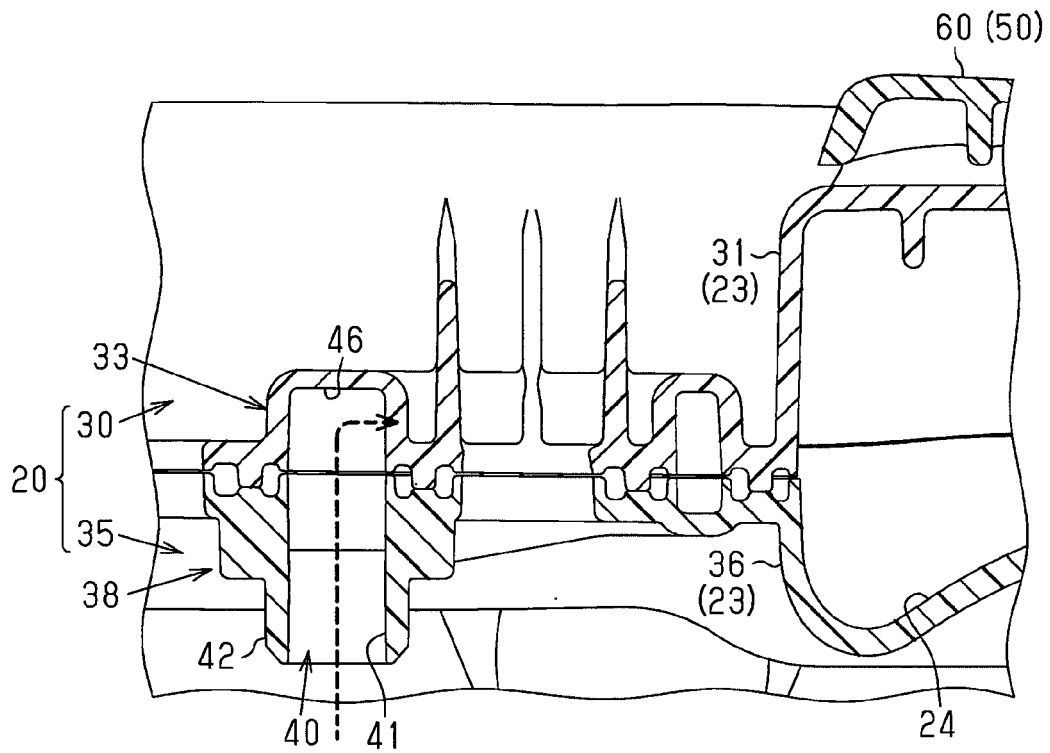
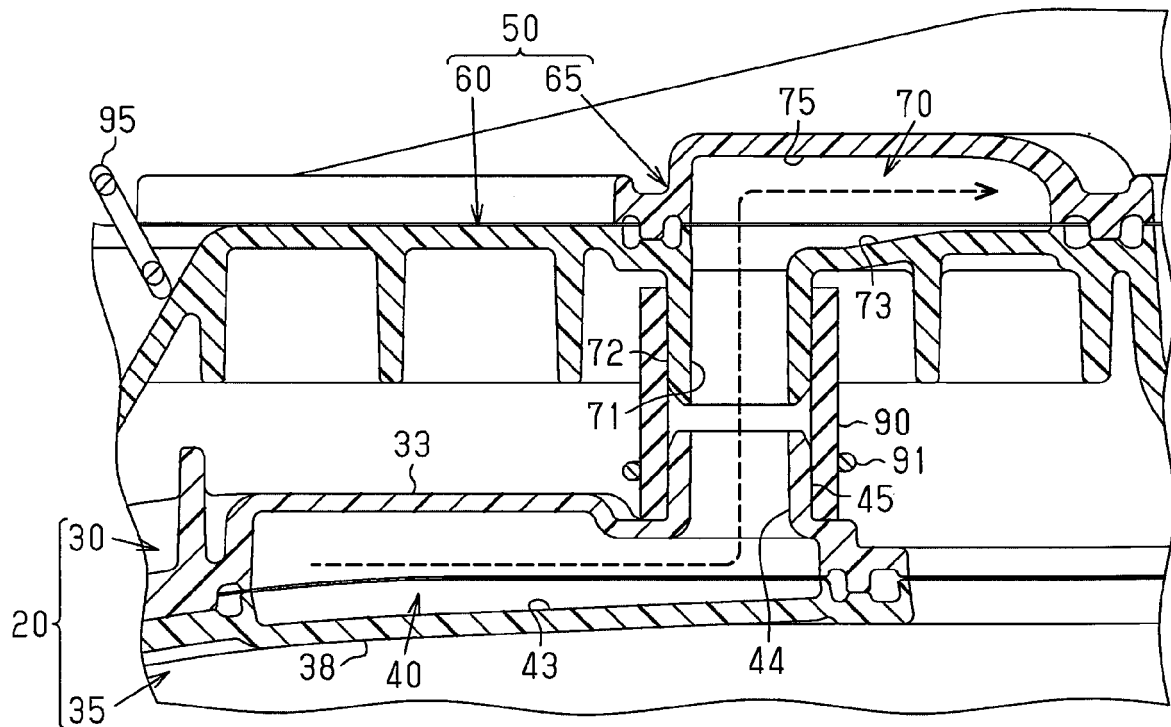


Fig.15





EUROPEAN SEARCH REPORT

Application Number
EP 17 20 6908

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 072 796 A1 (HONDA MOTOR CO LTD [JP]) 24 June 2009 (2009-06-24) * paragraphs [0039] - [0048], [0063] - [0065], [0078], [0082] - [0085]; figures 1-5 *	1-4	INV. F02M35/02 F02M35/024 F02M35/10 F02M35/12 F02M35/14
			TECHNICAL FIELDS SEARCHED (IPC)
			F02M
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 January 2018	Examiner Karstens, Thede
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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Patent documents cited in the description

- JP 2005344555 A [0004] [0006]