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(54) **Intake manifold for internal combustion engine**

Saugrohr für Verbrennungsmotoren

Collecteur d'admission pour moteur à combustion interne

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an intake manifold for an internal combustion engine.

[0002] Intake manifolds for an internal combustion engine of an automobile are well known, in which there are provided a surge tank and a plurality of branches which are connected to the surge tank and supplies air to cylinders of the engine.

[0003] Japanese Patent Provisional Publication No. 2003-139001 discloses an intake manifold with a resonator that is provided for the purpose of reducing noise in the intake manifold. The intake manifold includes an upper shell and a lower shell which are joined with each other by vibration welding to form a plurality of individual pipes for distributing intake air to the engine cylinders and a resonance space. The upper shell is formed with a plurality of openings and a cover is fixed by vibration welding to the upper shell so as to cover the openings. A reflection or resonator chamber is formed between the upper shell and the cover and communicated with the resonance space through the openings.

SUMMARY OF THE INVENTION

[0004] However, in the intake manifold of the above-described conventional art, only an outer peripheral edge of the cover is fixed to the upper shell of the intake manifold and a joint portion to be fixed to the upper shell by vibration welding has an evenly wide width. Therefore, in a case where the reflection chamber is enlarged in volume, a wall thickness of the cover should be increased or the cover should be provided with a rib in order to ensure rigidity of the cover. This leads to increase in weight of the intake manifold.

[0005] It is an object of the present invention to solve the above-described problem in the technologies of the conventional art and to provide an intake manifold including a resonator in which rigidity of the resonator can be ensured without causing increase in total weight of the intake manifold.

[0006] In one aspect of the present invention, there is provided an intake manifold for an internal combustion engine, the intake manifold comprising:

an intake manifold body including a collector and a plurality of branches which are connected to the collector in parallel to each other and joined with each other through a connecting wall between the adjacent branches, the branches being adapted to distribute intake air to cylinders of the engine; and

a resonator including a resonator body member that is fixed onto an outer surface of the intake manifold body, the resonator body member cooperating with the outer surface of the intake manifold body to define a space inside the resonator,

wherein the outer surface of the intake manifold body is formed into a wave shape that includes a crest formed at each of the branches and a valley formed at the connecting wall,

wherein each of the branches defines a branch passage therein and has a thickness larger than that of the connecting wall,

wherein the resonator includes a resonator neck and a resonator volume chamber within the space, the resonator volume chamber being communicated with the collector through the resonator neck,

wherein the resonator neck has a resonator neck passage formed between a pair of resonator neck walls which are opposed to each other and connected with the resonator body member and the outer surface of the intake manifold body, and the resonator neck is disposed above one of the branches and extends along the one of the branches.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a perspective view of an intake manifold for an internal combustion engine, according to the present invention.

[0008] FIG. 2 is an exploded perspective view of the intake manifold of a first embodiment of the present invention.

[0009] FIG. 3 is a cross-section of an essential part of the intake manifold of the first embodiment, taken substantially perpendicular to a longitudinal direction of branches of the intake manifold.

[0010] FIG. 4 is a perspective view of the essential part of the intake manifold of the first embodiment, showing an intake manifold body.

[0011] FIG. 5 is a perspective view of the essential part of the intake manifold of the first embodiment, showing a resonator body when viewed from a rear side thereof.

[0012] FIG. 6 is a cross-section of the essential part of the intake manifold of the first embodiment, taken in the longitudinal direction of the branches of the intake manifold.

[0013] FIG. 7 is a view similar to FIG. 6, but shows a second embodiment of the intake manifold of the present invention.

[0014] FIG. 8 is a view similar to FIG. 6, but shows a third embodiment of the intake manifold of the present invention.

[0015] FIG. 9 is a view similar to FIG. 4, but shows the third embodiment of the intake manifold of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Referring now to FIG. 1 to FIG. 6, there is shown an intake manifold for a multi-cylinder internal combustion engine of a vehicle, according to a preferred embodiment of the present invention. In this embodiment, the

intake manifold is applied to an in-line three-cylinder engine.

[0017] As shown in FIG. 1, intake manifold 1 includes three branches 2, 3, 4 that distribute intake air to three cylinders (not shown) of the engine, respectively, collector 5 that is disposed on an intake upstream side of branches 2, 3, 4, and resonator 6 that is communicated with collector 5. Intake manifold 1 is made of a resin material. Branches 2, 3, 4 are connected with collector 5 and extend in parallel to each other. Branches 2, 3, 4 are joined with each other through connecting walls 7, 8 that extend between adjacent two of branches 2, 3, 4. Specifically, adjacent branches 2 and 3 are joined with each other through connecting wall 7 that extends between branches 2 and 3, and adjacent branches 3 and 4 are joined with each other through connecting wall 8 that extends between branches 3 and 4. Intake air is introduced into an inside of intake manifold 1 through intake air inlet 9 that is disposed on an intake upstream side of collector 5. Intake air inlet 9 is opened to a mount surface of upstream-side flange 10 which is connected to an intake duct, not shown. Downstream-side flange 11 is formed at intake downstream ends of respective branches 2, 3, 4. Intake air outlets are opened to a mount surface of downstream-side flange 11 which is connected to a cylinder head, not shown. Upstream-side flange 10 and downstream-side flange 11 are formed in first intake manifold body member 12 of intake manifold body 15 as explained later.

[0018] As shown in FIG. 2, intake manifold 1 is substantially constituted of first intake manifold body member 12 as a lower shell, second intake manifold body member 13 as an upper shell and generally rectangular dish-shaped resonator body member 14. First intake manifold body member 12 and second intake manifold body member 13 cooperate with each other to form intake manifold body 15 that includes hollow collector 5 and hollow branches 2, 3, 4. Second intake manifold body member 13 and resonator body member 14 cooperate with each other to form resonator 6.

[0019] Intake manifold body 15 is formed by joining first intake manifold body member 12 and second intake manifold body member 13 with each other on a curved joint plane that extends along a curved profile of respective branches 2, 3, 4. Specifically, the curved joint plane extends in a longitudinal direction of branches 2, 3, 4 and in a direction of a row of branches 2, 3, 4 so as to continuously connect branches 2, 3, 4 to each other. The joint plane extends along central axes of branches 2, 3, 4 which extend in the longitudinal direction of branches 2, 3, 4. That is, the joint plane is designed to extend substantially along center lines of branch passages 16, 17, 18 which are formed in branches 2, 3, 4. In other words, before joining first intake manifold body member 12 and second intake manifold body member 13 with each other, intake manifold body 15 is split into first intake manifold body member 12 and second intake manifold body member 13 on the joint plane as a split plane.

[0020] Branches 2, 3, 4 are formed by first branch halves 2A, 3A, 4A of first intake manifold body member 12 and second branch halves 2B, 3B, 4B of second intake manifold body member 13 which are joined with each other on the joint plane. As shown in FIG. 3, branches 2, 3, 4 define branch passages 16, 17, 18, respectively, which extend in the longitudinal direction of branches 2, 3, 4. First branch halves 2A, 3A, 4A and second branch halves 2B, 3B, 4B have a generally half-ellipse shape in cross section. Connecting walls 7, 8 are formed by first connecting wall halves 7A, 8A of first intake manifold body member 12 and second connecting wall halves 7B, 8B of second intake manifold body member 13 which are jointed with each other on the joint plane.

[0021] As shown in FIG. 2, first intake manifold body member 12 includes upstream-side flange 10, downstream-side flange 11, first collector portion 5A of collector 5, first branch halves 2A, 3A, 4A of branches 2, 3, 4 and connecting wall halves 7A, 8A of connecting walls 7, 8. Upstream-side flange 10, downstream-side flange 11, first collector portion 5A of collector 5, first branch halves 2A, 3A, 4A and connecting wall halves 7A, 8A are integrally formed with first intake manifold body member 12. Each of first branch halves 2A, 3A, 4A has a trough-shaped opening that extends in a longitudinal direction of each of branch halves 2A, 3A, 4A. Connecting wall halves 7A and 8A extend between the adjacent branch halves 2A, 3A and the adjacent branch halves 3A and 4A, respectively.

[0022] First collector portion 5A of collector 5 serves as a major portion of collector 5. First collector portion 5A has a rectangular or elliptic opening on an upper surface thereof. As shown in FIG. 2, first branch halves 2A, 3A, 4A are connected with first collector portion 5A to thereby communicate the trough-shaped openings of first branch halves 2A, 3A, 4A with the opening of first collector portion 5A. The trough-shaped openings of first branch halves 2A, 3A, 4A are merged into the opening of first collector portion 5A. That is, first intake manifold body member 12 is configured to have a single opening that is continuously communicated with both first collector portion 5A and first branch halves 2A, 3A, 4A.

[0023] Second intake manifold body member 13 is also configured to have a single opening that is continuously communicated with both second collector portion 5B and second branch halves 2B, 3B, 4B and cover the single opening of first intake manifold body member 12. Specifically, as shown in FIG. 2 and FIG. 3, second intake manifold body member 13 includes second collector portion 5B of collector 5, second branch halves 2B, 3B, 4B of branches 2, 3, 4 and second connecting wall halves 7B, 8B of connecting walls 7, 8. Second collector portion 5B, second branch halves 2B, 3B, 4B and second connecting wall halves 7B, 8B are integrally formed with second intake manifold body member 13. Second collector portion 5B has an opening on a lower surface thereof which corresponds to the opening of first collector portion 5A. Each of second branch halves 2B, 3B, 4B has a

trough-shaped opening that extends in a longitudinal direction of each of second branch halves 2B, 3B, 4B. Connecting wall halves 7B and 8B extend between the adjacent branch halves 2B, 3B and the adjacent branch halves 3B and 4B, respectively. Second branch halves 2B, 3B, 4B are connected with second collector portion 5B to thereby communicate the trough-shaped openings of second branch halves 2B, 3B, 4B with the opening of second collector portion 5B. The trough-shaped openings of second branch halves 2B, 3B, 4B are merged into the opening of second collector portion 5B.

[0024] As shown in FIG. 2, first connecting flange 19 is formed along peripheral edges of the trough-shaped openings of first branch halves 2A, 3A, 4A and a peripheral edge of the opening of first collector portion 5A of first intake manifold body member 12. First connecting flange 19 has a substantially uniform width that extends along outer peripheral edges of the trough-shaped openings of first branch halves 2A and 4A and the peripheral edge of the opening of first collector portion 5A. First connecting flange 19 extends between opposed peripheral edges of the trough-shaped openings of the adjacent first branch halves 2A, 3A, 4A and forms first connecting wall halves 7A, 8A.

[0025] First projection 20 is formed on an upper surface of first connecting flange 19. First projection 20 projects from the upper surface of first connecting flange 19 and continuously extends along the peripheral edge of the opening of first collector portion 5A and the peripheral edges of the trough-shaped openings of first branch halves 2A, 3A, 4A of first intake manifold body member 12. First projection 20 that extends along the outside peripheral edges of the trough-shaped openings of first branch halves 2A and 4A and the peripheral edge of the opening of first collector portion 5A is located in a substantially middle position in the width direction of first connecting flange 19. First projection 20 has a strap-shaped top surface serving as a connection surface that is connected with a connection surface of second projection 22 of second connecting flange 21 of second intake manifold body member 13 by vibration welding as explained later. The connection surface of first projection 20 extends over the entire length of first projection 20.

[0026] Second connecting flange 21 is formed along peripheral edges of the trough-shaped openings of second branch halves 2B, 3B, 4B and a peripheral edge of the opening of second collector portion 5B of second intake manifold body member 13. Second connecting flange 21 has a substantially uniform width that extends along outer peripheral edges of the trough-shaped openings of second branch halves 2B and 4B and the peripheral edge of the opening of second collector portion 5B. Second connecting flange 21 extends between opposed peripheral edges of the trough-shaped openings of the adjacent second branch halves 2B, 3B, 4B and forms second connecting wall halves 7B, 8B.

[0027] Second projection 22 is formed on a lower or rear surface of second connecting flange 21 and located corresponding to first projection 20 of first intake manifold body member 12. Second projection 22 projects from the lower surface of second connecting flange 21 and continuously extends along the outer peripheral edges of the trough-shaped openings of second branch halves 2B and 4B and the peripheral edge of the opening of second collector portion 5B. Second projection 22 that extends along the outer peripheral edges of the trough-shaped openings of second branch halves 2B and 4B and the peripheral edge of the opening of second collector portion 5B is located in a substantially middle position in the width direction of second connecting flange 21. Second projection 22 has a strap-shaped top surface serving as a connection surface that extends over the entire length of second projection 22 and is connected with the connection surface of first projection 20 of first connecting flange 19 by vibration welding. First projection 20 and second projection 22 are connected with each other through the vibration-welded connection surfaces.

[0028] First intake manifold body member 12 and second intake manifold body member 13 are joined with each other by connecting first projection 20 and second projection 22 with each other by vibration welding while applying a suitable pressure thereto in a mutually abutting state.

[0029] Branches 2, 3, 4 define branch passages 16, 17, 18 on the inside thereof and have a vertical dimension or thickness larger than that of connecting walls 7, 8. The vertical dimension or thickness of branches 2, 3, 4 is a distance that extends between outer surfaces of first branch halves 2A, 3A, 4A and outer surfaces of second branch halves 2B, 3B, 4B which are opposed to each other in a vertical direction perpendicular to the joint plane of first intake manifold body member 12 and second intake manifold body member 13. The vertical dimension or thickness of connecting walls 7, 8 is a distance that extends between outer surfaces of first connecting wall halves 7A, 8A and outer surfaces of second connecting wall halves 7B, 8B. Therefore, intake manifold body 15 has an outer surface formed into a wave shape that includes three crests formed at branches 2, 3, 4 and two valleys formed at connecting walls 7, 8. Specifically, the crests are formed by the outer surfaces of second branch halves 2B, 3B, 4B and the valleys are formed by the outer surfaces of second connecting wall halves 7B, 8B.

[0030] As shown in FIG. 2 to FIG. 4, second intake manifold body member 13 has third projection 23 on an outer surface thereof that forms a part of the outer surface of intake manifold body 15. Specifically, second intake manifold body member 13 includes support wall 13a for supporting resonator body member 14 which is connected with peripheral side wall 24 of resonator body member 14 and forms a peripheral side wall of resonator 6. Second intake manifold body member 13 further includes a wall that is opposed to a top wall of resonator body member 14 and forms a bottom wall of resonator 6. Support wall 13a extends from the outer surface of second intake manifold body member 13 toward peripheral side wall 24

of resonator body member 14 in a direction substantially perpendicular to the joint plane of first intake manifold body member 12 and second intake manifold body member 13. Support wall 13a is configured to have a generally rectangular shape in top plan view corresponding to peripheral side wall 24 of resonator body member 14. Third projection 23 projects from a tip end of support wall 13a toward an end of peripheral side wall 24 of resonator body member 14 in the direction substantially perpendicular to the joint plane of first intake manifold body member 12 and second intake manifold body member 13. Third projection 23 continuously extends over an entire periphery of support wall 13a.

[0031] Resonator body member 14 is fixed onto the outer surface of second intake manifold body member 13. Resonator body member 14 includes fourth projection 25 that projects from the end of peripheral side wall 24 toward third projection 23 of second intake manifold body member 13 and continuously extends over an entire periphery of peripheral side wall 24. Second intake manifold body member 13 and resonator body member 14 are joined with each other by connecting third projection 23 and fourth projection 25 with each other by vibration welding while applying a suitable pressure to third projection 23 and fourth projection 25 in a mutually abutting state. Hermetically sealed space 26 is thus formed inside resonator 6 and defined between an inside surface of resonator body member 14 and the outer surface of second intake manifold body member 13 which is opposed to the inside surface of resonator body member 14 as shown in FIG. 3. Space 26 is communicated with an inside space of collector 5 via communication hole 27 that extends through second intake manifold body member 13 as shown in FIG. 4.

[0032] Resonator 6 that is formed by second intake manifold body member 13 and resonator body member 14 is a so-called Helmholtz resonator. Resonator 6 includes resonator neck 30 and resonator volume chamber 31 that is communicated with collector 5 through resonator neck 30. Resonator neck 30 and resonator volume chamber 31 are formed within space 26 between the outer surface of second intake manifold body member 13 and the inside surface of resonator body member 14. Resonator neck 30 has elongated resonator neck passage 29 that is formed between a pair of resonator neck walls 28, 28. Resonator neck walls 28, 28 are opposed to each other and extend parallel to each other in the longitudinal direction of branch half 3B.

[0033] As shown in FIG. 6, resonator neck passage 29 has one end at which communication hole 27 is disposed. Resonator neck passage 29 is communicated with the inside space of collector 5 through communication hole 27. The other end of resonator neck passage 29 is opened into resonator volume chamber 31. Resonator neck 30 is disposed on one of branches 2, 3, 4 and extends along the one of branches 2, 3, 4. In this embodiment, resonator neck 30 is located on central branch 3 and extends along central branch 3. A cross section and a length of resonator neck passage 29 and a volume of resonator volume chamber 31 may be suitably set on the basis of a required resonance frequency of resonator 6. Dimensions of various portions of resonator body member 14 may be suitably modified on the basis of the required resonance frequency of resonator 6. A configuration of an outer surface of resonator 6 is not limited to such a wave form as that of the outer surface of intake manifold body 15 and may be formed into other shapes. In this embodiment, the outer surface of resonator 6 is formed into a relatively flat surface.

[0034] Each of resonator neck walls 28, 28 is connected with resonator body member 14 and the outer surface of second intake manifold body member 13. Resonator neck wall 28 is formed by joining rib 32 of second intake manifold body member 13 which extends on the outer surface of second intake manifold body member 13 in the longitudinal direction of branch half 3B, with rib 33 of resonator body member 14 which extends on an inside surface of the top wall of resonator body member 14 corresponding to rib 32. Specifically, as shown in FIG. 2 and FIG. 3, rib 32 extends in the longitudinal direction of branch half 3B and extends from an outer surface of branch half 3B toward the inside surface of the top wall of resonator body member 14 in the direction substantially perpendicular to the joint plane of first intake manifold body member 12 and second intake manifold body member 13. Rib 32 has grooved portion 34 on a tip end portion thereof which extends over an entire length of rib 32 in the longitudinal direction. As shown in FIG. 6 and FIG. 3, rib 33 extends in the longitudinal direction of branch 3 and extends from the inside surface of the top wall of resonator body member 14 toward the outer surface of branch half 3B in the direction substantially perpendicular to the joint plane of first intake manifold body member 12 and second intake manifold body member 13. Rib 33 has fifth projection 35 that projects from a tip end of rib 33 so as to be engaged with bottom 34a of grooved portion 34 of rib 32. Rib 32 and rib 33 are joined with each other by connecting grooved portion 34 and fifth projection 35 with each other by vibration welding while applying a suitable pressure to grooved portion 34 and fifth projection 35 in a mutually engaged state. Thus, resonator neck wall 28 is formed.

[0035] Resonator neck wall 28 includes a first connecting portion at which rib 32 of second intake manifold body member 13 and rib 33 of resonator body member 14 are joined with each other by vibration welding. That is, the first connecting portion is formed by connecting fifth projection 35 of resonator body member 14 with bottom 34a of grooved portion 34 of rib 32 by vibration welding. The first connecting portion is smaller in width that extends in a direction crossing the row of branches 2, 3, 4, than a second connecting portion at which third projection 23 of second intake manifold body member 13 and fourth projection 25 of peripheral side wall 24 of resonator body member 14 are joined with each other by vibration welding. In other words, the width of fifth projection 35 of rib

33 is smaller than the respective widths of third projection 23 of second intake manifold body member 13 and fourth projection 25 of resonator body member 14. Further, the width of fifth projection 35 of rib 33 is smaller than the width of second projection 22 of second intake manifold body member 13.

[0036] In the first embodiment explained above, the pair of resonator neck walls 28, 28 that form resonator neck 30 of resonator body member 14 serve as an intermediate pillar that is located at a middle portion of resonator body member 14. with the provision of resonator neck walls 28, 28, rigidity of resonator body member 14 can be enhanced without causing increase in wall thickness of resonator body member 14, namely, increase in weight of resonator body member 14.

[0037] Further, resonator neck 30 is located above the crest formed by the outer surface of central branch 3, thereby facilitating reduction in the cross section of resonator neck passage 29 in resonator neck 30. This provides advantage, especially, upon setting the resonance frequency to low frequency.

[0038] Resonator neck walls 28, 28 disposed within space 26 between the outer surface of second intake manifold body member 13 and resonator body member 14 are exposed to a uniform pressure from both a side of resonator volume chamber 31 and a side of resonator neck passage 29. On the other hand, peripheral side wall 24 of resonator body member 14 which is connected with the outer surface of intake manifold body 15 is exposed to atmospheric pressure from the outside of resonator 6 and also exposed to a pressure within space 26 which is different from the outside atmospheric pressure, from the inside of resonator 6. Therefore, peripheral side wall 24 of resonator body member 14 undergoes a stress larger than that acts on resonator neck walls 28, 28 due to the differential pressure. That is, the stress that acts on resonator neck walls 28, 28 is smaller than the stress that acts on peripheral side wall 24 of resonator body member 14. Accordingly, the stress that acts on the first connection portion of resonator neck walls 28, 28 which is formed by vibration welding becomes smaller than the stress that acts on the second connecting portion between the outer surface of second intake manifold body member 13 and peripheral side wall 24 of resonator body member 14 which is formed by vibration welding.

[0039] For the above-explained reason, the width of the first connecting portion between fifth projection 35 of rib 33 and grooved portion 34 of rib 32 can be smaller than the width of the second connecting portion between third projection 23 of second intake manifold body member 13 and fourth projection 25 of resonator body member 14. That is, the first connecting portion of respective resonator neck walls 28, 28 which is to be formed by vibration welding can be reduced in size as compared to the second connecting portion. Further, since a pressure or load that is required for holding rib 32 of second intake manifold body member 13 and rib 33 of resonator body member 14 in contact with each other when subjecting rib 32 and rib 33 to vibration welding can be lessened by the shape rigidity of resonator body member 14 and the outer surface of intake manifold body 15, it is not necessary to hold resonator body member 14 and intake manifold body 15 by a welding jig. Further, a welding flange that is required to use the welding jig can be omitted from resonator body member 14 and intake manifold body 15. This serves for reducing the weight of intake manifold body 1 and improving freedom in molding design of intake manifold 1. Further, owing to omission of the welding flange, the volume of resonator volume chamber 31 can be increased and a resonator having a lower frequency can be formed.

[0040] Further, resonator neck 30 and resonator volume chamber 31 of resonator 6 are formed by utilizing the outer surface of intake manifold body 15 in cooperation with resonator body member 14. That is, second intake manifold body member 13 forms the bottom wall and the peripheral side wall of resonator 6 in cooperation with resonator body member 14. This serves for reducing a wall that forms resonator 6 and thereby enhancing reduction in size and weight of intake manifold 1 as a whole.

[0041] Furthermore, in the first embodiment, the wave-shaped outer surface of intake manifold body 15 is covered with resonator body member 14 that has a relatively flat outer surface. Accordingly, the appearance of intake manifold 1 can be improved as well as the appearance of an engine room.

[0042] Referring to FIG. 7, a second embodiment of the intake manifold of the present invention will be explained hereinafter. The second embodiment differs from the first embodiment in that partition walls 42 and 43 are provided within resonator neck 30 of intake manifold 41. Like reference numerals denote like parts and therefore detailed explanations therefor are omitted.

[0043] As shown in FIG. 7, resonator neck 30 includes partition wall 42 that extends from second intake manifold body member 13 as viewed on a lower side in FIG. 7 toward resonator body member 14 as viewed on an upper side in FIG. 7, and partition wall 43 that extends from resonator body member 14 toward second intake manifold body member 13. Partition wall 42 is disposed adjacent to communication hole 27 on a side of the one end of resonator neck passage 29 and extends from the outer surface of second intake manifold body member 13 toward the inside surface of resonator body member 14. Partition wall 42 is inclined toward the other end of resonator neck passage 29. Partition wall 43 is located in a position displaced from partition wall 42 toward the other end of resonator neck passage 29 in the longitudinal direction of resonator neck passage 29. Partition wall 43 extends from the inside surface of resonator body member 14 toward the outer surface of second intake manifold body member 13.

[0044] These partition walls 42 and 43 are arranged to allow resonator neck passage 29 to meander within resonator neck 30 such that resonator neck passage 29 has a length longer than a length of resonator neck 30.

In this embodiment, the intake air flow flowing and passing through resonator neck passage 29 within resonator neck 30 meanders as indicated by broken line P in FIG. 7. In other words, partition walls 42 and 43 cooperate with each other to provide a so-called labyrinth structure of resonator neck passage 29.

[0045] In the Helmholtz resonator, it is necessary to downsize the resonator volume chamber in order to stabilize the pressure within the intake manifold at an early stage. It is also necessary to reduce the cross section of the resonator neck in order to avoid deterioration in distribution of intake air in the intake manifold. Therefore, generally, tuning of resonance frequency of the Helmholtz resonator is conducted by increasing the length of the resonator neck, i.e., the length of the resonator neck passage provided within the resonator neck. The increased length of the resonator neck causes a complicated layout and construction of the resonator.

[0046] However, in the second embodiment, the length of resonator neck passage 29 within resonator neck 30 can be increased without changing the length of resonator neck 30. Accordingly, it is possible to design resonator neck 30 depending on resonance frequency without causing a relatively complicated layout and construction of resonator 6 and provide resonator 6 with a compact size. As a result, freedom of design of resonator 6 and intake manifold 41 can be enhanced.

[0047] The number of the partition walls that are provided on second intake manifold body member 13 and resonator body member 14, respectively, are not limited only to that in the second embodiment. Second intake manifold body member 13 and resonator body member 14 may be provided with a plurality of the partition walls, respectively. In such a case, the partition walls should be alternately arranged on the side of second intake manifold body member 13 and on the side of resonator body member 14. The total number of the partition walls may be an even number or an odd number if a meandering flow of intake air is produced within resonator neck passage 29. Further, only one partition wall may be provided on either one of second intake manifold body member 13 and resonator body member 14 within resonator neck 30.

[0048] Further, a length of a predetermined region of resonator neck passage 29 in which an S-shaped meandering flow is produced can be increased to a maximum by controlling a substantial cross section of the predetermined region of resonator neck passage 29 to a constant value, so that a whole length of resonator neck passage 29 within resonator neck 30 can be increased to a maximum. Here, the predetermined region of resonator neck passage 29 is a portion of resonator neck passage 29 which extends from communication hole 27 to clearance A defined between a tip end of partition wall 43 and the outer surface of second intake manifold body member 13. The substantial cross section of the predetermined region is a remainder of an actual cross section of resonator neck passage 29 which is formed by excluding a portion as a so-called dead space where there is generated substantially no flow of fluid such as air when the fluid passes through the predetermined region, from the actual cross section.

[0049] Referring to FIG. 8 and FIG. 9, a third embodiment of the intake manifold of the present invention will be explained hereinafter. The third embodiment differs from the first embodiment in that resonator neck 30 and resonator neck passage 29 are disposed on not central branch 3 but side branch 2. As shown in FIG. 8, in intake manifold 51, resonator neck 30 and resonator neck passage 29 within resonator neck 30 is located on branch 2 and extends along branch 2. Specifically, rib 32 with grooved portion 34 extends from an outer surface of branch half 2B of second intake manifold body member 13 in the longitudinal direction of branch half 2B and extends toward the inside surface of the top wall of resonator body member 14. On the other hand, as shown in FIG. 9, rib 33 with fifth projection 35 extends from the inside surface of the top wall of resonator body member 14. Rib 33 extends toward the outer surface of second intake manifold body member 13 so as to correspond to rib 32. Rib 32 and rib 33 are connected with each other to form resonator neck wall 28 by joining fifth projection 35 of rib 33 with bottom 34a of grooved portion 34 of rib 32 by vibration welding as explained in the first embodiment. Resonator neck 30 includes resonator neck wall 28 and a wall that is formed by third projection 23 of second intake manifold body member 13 and fourth projection 25 of the peripheral side wall 24 of resonator body member 14. Resonator neck passage 29 is formed between resonator neck wall 28 and the wall that is formed by third projection 23 and fourth projection 25. The wall formed by third projection 23 and fourth projection 25 serves as one of the pair of resonator neck walls 28, 28 in intake manifold 1 of the first embodiment. That is, in intake manifold 51 of this embodiment, one of the pair of resonator neck walls 28, 28 in intake manifold 1 of the first embodiment is omitted.

[0050] With the above construction of intake manifold 51 of the third embodiment, the production cost and the weight of intake manifold 51 can be reduced.

[0051] This application is based on prior Japanese Patent Application No. 2007-169867 filed on June 28, 2007, the entire content of which is hereby incorporated by reference.

[0052] Although the invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art in light of the above teachings. The scope of the invention is defined with reference to the following claims.

Claims

1. An intake manifold for an internal combustion en-

gine, the intake manifold comprising:

an intake manifold body (15) including a collector (5) and a plurality of branches (2, 3, 4) which are connected to the collector in parallel to each other and joined with each other through a connecting wall (7, 8) between the adjacent branches, the branches being adapted to distribute intake air to cylinders of the engine; and
a resonator (6) including a resonator body member (14) that is fixed onto an outer surface of the intake manifold body, the resonator body member cooperating with the outer surface of the intake manifold body to define a space (26) inside the resonator (6),
wherein the outer surface of the intake manifold body (15) is formed into a wave shape that includes a crest formed at each of the branches and a valley formed at the connecting wall,
wherein each of the branches (2, 3, 4) defines a branch passage therein and has a thickness larger than that of the connecting wall,
wherein the resonator (6) includes a resonator neck (30) and a resonator volume chamber (31) within the space (26), the resonator volume chamber being communicated with the collector (5) through the resonator neck, **characterised in that**
the resonator neck (30) has a resonator neck passage (29) formed between a pair of resonator neck walls (28) which are opposed to each other and connected with the resonator body member (14) and the outer surface of the intake manifold body (15), and the resonator neck is disposed above one of the branches and extends along the one of the branches.

2. The intake manifold as claimed in claim 1, wherein the resonator neck (30) comprises a partition wall (42, 43) that allows the resonator neck passage (29) to meander in the resonator neck such that the resonator neck passage has a length longer than that of the resonator neck.

3. The intake manifold as claimed in claim 1 or 2, wherein the intake manifold body (15) comprises a rib (32) that projects from the outer surface of the intake manifold body toward an inside surface of the resonator body member, the resonator body member (14) comprises a further rib (33) that projects from the inside surface of the resonator body member toward the outer surface of the intake manifold body and a peripheral side wall (24) that extends along an outer peripheral edge of the resonator body member toward the outer surface of the intake manifold body, and each of the resonator neck walls (28) includes a first connecting portion at which the rib (32) of the intake manifold body (15) and the further rib (33) of the resonator body member (14) are joined with each other, wherein the first connecting portion is smaller in width that extends in a direction crossing the branches than a second connecting portion at which the peripheral side wall (24) of the resonator body member and the outer surface of the intake manifold body are joined with each other.

4. The intake manifold as claimed in one of claims 1 to 3, wherein the resonator (6) is a Helmholtz resonator.

5. The intake manifold as claimed in one of claims 1 to 4, wherein the first connecting portion and the second connecting portion are formed by vibration welding.

6. The intake manifold as claimed in claim 1, wherein the resonator neck passage (29) has one end communicated with an inside space of collector (5) through a communication hole (27) that extends through the intake manifold body member (15), and the other end opened into the resonator volume chamber (31).

7. The intake manifold as claimed in claim 3, wherein the rib (32) of the intake manifold body (15) comprises a grooved portion (34) and the further rib (33) of the resonator body member (14) comprises a projection (35) that is engaged with the grooved portion and connected with the grooved portion, the grooved portion (34) and the projection (35) being disposed at the first connecting portion.

8. The intake manifold as claimed in claim 3, wherein the intake manifold body comprises a projection (23) that projects from the outer surface of the intake manifold body and the resonator body member comprises a further projection (25) that projects from the peripheral side wall and is connected with the projection (23) of the intake manifold body, the projection (23) of the intake manifold body and the further projection (25) of the peripheral side wall (24) of the resonator body member being disposed at the second connecting portion.

9. The intake manifold as claimed in claim 8, wherein the intake manifold body comprises a support wall (13a) for supporting the resonator body member, the support wall extending from the outer surface of the intake manifold body toward the peripheral side wall (24) of the resonator body member, the projection (23) of the intake manifold body projecting from an end of the support wall.

10. The intake manifold as claimed in one of claims 1 to 9, wherein the intake manifold body (15) comprises a first intake manifold body member (12) and a second intake manifold body member (13) which are

joined with each other on a joint plane extending along a curved profile of the branches (2, 3, 4).

Patentansprüche

1. Ansaugkrümmer für einen Verbrennungsmotor, wobei der Ansaugkrümmer umfasst:

   einen Ansaugkrümmerkörper (15), der einen Sammler (5) und eine Vielzahl von Verzweigungen (2, 3, 4) enthält, die parallel zueinander mit dem Sammler verbunden sind und über eine Verbindungswand (7, 8) zwischen den benachbarten Verzweigungen miteinander verbunden sind, wobei die Verzweigungen so eingerichtet sind, dass sie Ansaugluft auf Zylinder des Motors verteilen; und
   einen Resonator (6), der ein Resonator-Körperelement (14) enthält, das an einer Außenfläche des Ansaugkrümmer-Körpers befestigt ist, wobei das Resonator-Körperelement mit der Außenfläche des Ansaugkrümmer-Körpers zusammenwirkt und einen Raum (26) im Inneren des Resonators (6) begrenzt,
   wobei die Außenfläche des Ansaugkrümmer-Körpers (15) in einer Wellenform ausgebildet ist, die einen Berg, der an jeder der Verzweigungen ausgebildet ist, und ein Tal enthält, das an der Verbindungswand ausgebildet ist,
   wobei jede der Verzweigungen (2, 3, 4) einen Verzweigungsdurchlass darin aufweist und eine Dicke hat, die größer ist als die der Verbindungswand,
   wobei der Resonator (6) einen Resonator-Hals (30) sowie eine Resonator-Volumenkammer (31) innerhalb des Raums (26) enthält und die Resonator-Volumenkammer mit dem Sammler (5) über den Resonator-Hals in Verbindung steht, **dadurch gekennzeichnet, dass**
   der Resonator-Hals (30) einen Resonator-Halsdurchlass (29) aufweist, der zwischen einem Paar Resonator-Halswänden (28) ausgebildet ist, die einander gegenüberliegende und mit dem Resonator-Körperelement (14) sowie der Außenfläche des Ansaugkrümmer-Körpers (15) verbunden sind, und der Resonator-Hals oberhalb einer der Verzweigungen angeordnet ist und an einer der Verzweigungen entlang verläuft.

2. Ansaugkrümmer nach Anspruch 1, wobei der Resonator-Hals (30) eine Trennwand (42, 43) umfasst, die zulässt, dass der Resonator-Halsdurchlass (29) mäanderförmig in dem Resonator-Hals verläuft, so dass der Resonator-Halsdurchlass eine Länge hat, die länger ist als die des Resonator-Halses.

3. Ansaugkrümmer nach Anspruch 1 oder 2, wobei der Ansaugkrümmer-Körper eine Rippe (32) umfasst, die von der Außenfläche des Ansaugkrümmer-Körpers zu einer Innenfläche des Resonator-Körperelementes vorsteht, das Resonator-Körperelement (14) eine weitere Rippe (33), die von der Innenfläche des Resonator-Körperelementes zu der Außenfläche des Ansaugkrümmer-Körpers hin vorsteht, sowie eine Umfangsseitenwand (24) umfasst, die an einem Außenumfangsrand des Resonator-Körperelementes entlang zu der Außenfläche des Ansaugkrümmer-Körpers hin verläuft, und jede der Resonator-Halswände (28) einen ersten Verbindungsabschnitt enthält, an dem die Rippe (32) des Ansaugkrümmer-Körpers (15) und die weitere Rippe (33) des Resonator-Körperelementes (14) miteinander verbunden sind, wobei der erste Verbindungsabschnitt eine geringere Breite, die sich einer Richtung erstreckt, die die Verzweigungen schneidet, hat als ein zweiter Verbindungsabschnitt, an dem die Umfangsseitenwand (24) des Resonator-Körperelementes und die Außenfläche des Ansaugkrümmer-Körpers miteinander verbunden sind.

4. Ansaugkrümmer nach einem der Ansprüche 1 bis 3, wobei der Resonator (6) ein Helmholtz-Resonator ist..

5. Ansaugkrümmer nach einem der Ansprüche 1 bis 4, wobei der erste Verbindungsabschnitt und der zweite Verbindungsabschnitt durch Vibrationsschweißen ausgebildet werden.

6. Ansaugkrümmer nach Anspruch 1, wobei ein Ende des Resonator-Halsdurchlasses (29) mit einem Innenraum des Sammlers (5) über ein Verbindungsloch (27) in Verbindung steht, das durch das Ansaugkrümmer-Körperelement (15) hindurch verläuft, und sich das andere Ende in die Resonator-Volumenkammer (31) hinein öffnet.

7. Ansaugkrümmer nach Anspruch 3, wobei die Rippe (32) des Ansaugkrümmer-Körpers (15) einen eingekerbten Abschnitt (34) umfasst und die weitere Rippe (33) des Resonator-Körperetementes (14) einen Vorsprung (35) umfasst, der mit dem eingekerbten Abschnitt in Eingriff und mit dem eingekerbten Abschnitt verbunden ist, und der eingekerbte Abschnitt (34) sowie der Vorsprung (35) an dem ersten Verbindungsabschnitt angeordnet sind.

8. Ansaugkrümmer nach Anspruch 3, wobei der Ansaugkrümmer-Körper einen Vorsprung (23) umfasst, der von der Außenfläche des Ansaugkrümmer-Körpers vorsteht, und das Resonator-Körperelement einen weiteren Vorsprung (25) umfasst, der von der Umfangsseitenwand vorsteht und mit dem Vorsprung (23) des Ansaugkrümmer-Körpers ver-

bunden ist, und der Vorsprung (23) des Ansaugkrümmer-Körpers sowie der weitere Vorsprung (25) der Umfangsseitenwand (24) des Resonator-Körperelementes an dem zweiten Verbindungsabschnitt angeordnet sind.

9. Ansaugkrümmer nach Anspruch 8, wobei der Ansaugkrümmer-Körper eine Stützwand (13a) umfasst, die das Resonator-Körperelement stützt, sich die Stützwand von der Außenfläche des Ansaugkrümmer-Körpers auf die Umfangsseitenwand (24) des Resonator-Körperelementes zu erstreckt und der Vorsprung (23) des Ansaugkrümmer-Körpers von einem Ende der Stützwand vorsteht.

10. Ansaugkrümmer nach einem der Ansprüche 1 bis 9, wobei der Ansaugkrümmer-Körper (15) ein erstes Ansaugkrümmer-Körperelement (12) und ein zweites Ansaugkrümmer-Körperelement (13) umfasst, die an einer Verbindungsebene miteinander verbunden sind, die sich entlang eines gekrümmten Profils der Verzweigungen (2, 3, 4) erstreckt.

Revendications

1. Collecteur d'admission pour un moteur à combustion interne, le collecteur d'admission comprenant :

un corps de collecteur d'admission (15) incluant un collecteur (5) et plusieurs branches (2, 3, 4) qui sont reliées au collecteur en parallèle les unes aux autres et jointes les unes aux autres par l'intermédiaire d'une paroi de connexion (7, 8) entre les branches adjacentes, les branches étant conçues pour distribuer de l'air d'admission aux cylindres du moteur ; et
un résonateur (6) incluant un élément de corps de résonateur (14) qui est fixé sur une surface extérieure du corps de collecteur d'admission, l'élément de corps de résonateur coopérant avec la surface extérieure du corps de collecteur d'admission pour définir un espace (26) à l'intérieur du résonateur (6),
dans lequel la surface extérieure du corps de collecteur d'admission (15) est formée en une forme d'ondulation qui inclut une crête formée au niveau de chacune des branches et une vallée formée au niveau de la paroi de connexion,
dans lequel chacune des branches (2, 3, 4) définit un passage de branche en son sein et possède une épaisseur plus grande que celle de la paroi de connexion,
dans lequel le résonateur (6) inclut un collet de résonateur (30) et une chambre de volume de résonateur (31) à l'intérieur de l'espace (26), la chambre de volume de résonateur communiquant avec le collecteur (5) par l'intermédiaire du collet de résonateur, **caractérisé en ce que** le collet de résonateur (30) a un passage de collet de résonateur (29) formé entre un couple de parois de collet de résonateur (28) qui sont opposées l'une à l'autre et reliées à l'élément de corps de résonateur (14) et à la surface extérieure du corps de collecteur d'admission (15), et le collet de résonateur est disposé au-dessus d'une des branches et s'étend le long de celle-ci.

2. Collecteur d'admission selon la revendication 1, dans lequel le collet de résonateur (30) comprend une paroi de séparation (42, 43) qui permet au passage de collet de résonateur (29) de serpenter dans le collet de résonateur de sorte que le passage de collet de résonateur possède une longueur plus grande que celle du collet de résonateur.

3. Collecteur d'admission selon la revendication 1 ou 2, dans lequel le corps de collecteur d'admission (15) comprend une nervure (32) qui dépasse de la surface extérieure du corps de collecteur d'admission vers une surface intérieure de l'élément de corps de résonateur, l'élément de corps de résonateur (14) comprend une nervure supplémentaire (33) qui dépasse de la surface intérieure de l'élément de corps de résonateur vers la surface extérieure du corps de collecteur d'admission et une paroi latérale périphérique (24) qui s'étend le long d'un bord périphérique extérieur de l'élément de corps de résonateur vers la surface extérieure du corps de collecteur d'admission, et chacune des parois de collet de résonateur (28) inclut une première partie de connexion au niveau de laquelle la nervure (32) du corps de collecteur d'admission (15) et la nervure supplémentaire (33) de l'élément de corps de résonateur (14) sont jointes l'une à l'autre, dans lequel la première partie de connexion est plus petite dans une largeur qui s'étend dans une direction croisant les branches qu'une seconde partie de connexion au niveau de laquelle la paroi latérale périphérique (24) de l'élément de corps de résonateur et la surface extérieure du corps de collecteur d'admission sont jointes l'une à l'autre.

4. Collecteur d'admission selon l'une des revendications 1 à 3, dans lequel le résonateur (6) est un résonateur de Helmholtz.

5. Collecteur d'admission selon l'une des revendications 1 à 4, dans lequel la première partie de connexion et la seconde partie de connexion sont formées par soudage par vibration.

6. Collecteur d'admission selon la revendication 1, dans lequel le passage de collet de résonateur (29) présente une extrémité communiquant avec un espace intérieur de collecteur (5) par l'intermédiaire

d'un orifice de communication (27) qui s'étend à travers l'élément de corps de collecteur d'admission (15), et l'autre extrémité étant ouverte dans la chambre de volume de résonateur (31).

7. Collecteur d'admission selon la revendication 3, dans lequel la nervure (32) du corps de collecteur d'admission (15) comprend une partie cannelée (34) et la nervure supplémentaire (33) de l'élément de corps de résonateur (14) comprend une partie en saillie (35) qui est en prise avec la partie cannelée et reliée à la partie cannelée, la partie cannelée (34) et la partie en saillie (35) étant disposées au niveau de la première partie de connexion.

8. Collecteur d'admission selon la revendication 3, dans lequel le corps de collecteur d'admission comprend une partie en saillie (23) qui dépasse de la surface extérieure du corps de collecteur d'admission et l'élément de corps de résonateur comprend une partie en saillie supplémentaire (25) qui dépasse de la paroi latérale périphérique et est reliée à la partie en saillie (23) du corps de collecteur d'admission, la partie en saillie (23) du corps de collecteur d'admission et la partie en saillie supplémentaire (25) de la paroi latérale périphérique (24) de l'élément de corps de résonateur étant disposées au niveau de la seconde partie de connexion.

9. Collecteur d'admission selon la revendication 8, dans lequel le corps de collecteur d'admission comprend une paroi de support (13a) pour supporter l'élément de corps de résonateur, la paroi de support s'étendant depuis la surface extérieure du corps de collecteur d'admission vers la paroi latérale périphérique (24) de l'élément de corps de résonateur, la partie en saillie (23) du corps de collecteur d'admission dépassant d'une extrémité de la paroi de support.

10. Collecteur d'admission selon l'une des revendications 1 à 9, dans lequel le corps de collecteur d'admission (15) comprend un premier élément de corps de collecteur d'admission (12) et un second élément de corps de collecteur d'admission (13) qui sont joints l'un à l'autre sur un plan commun s'étendant le long d'un profil incurvé des branches (2, 3, 4).

FIG.1

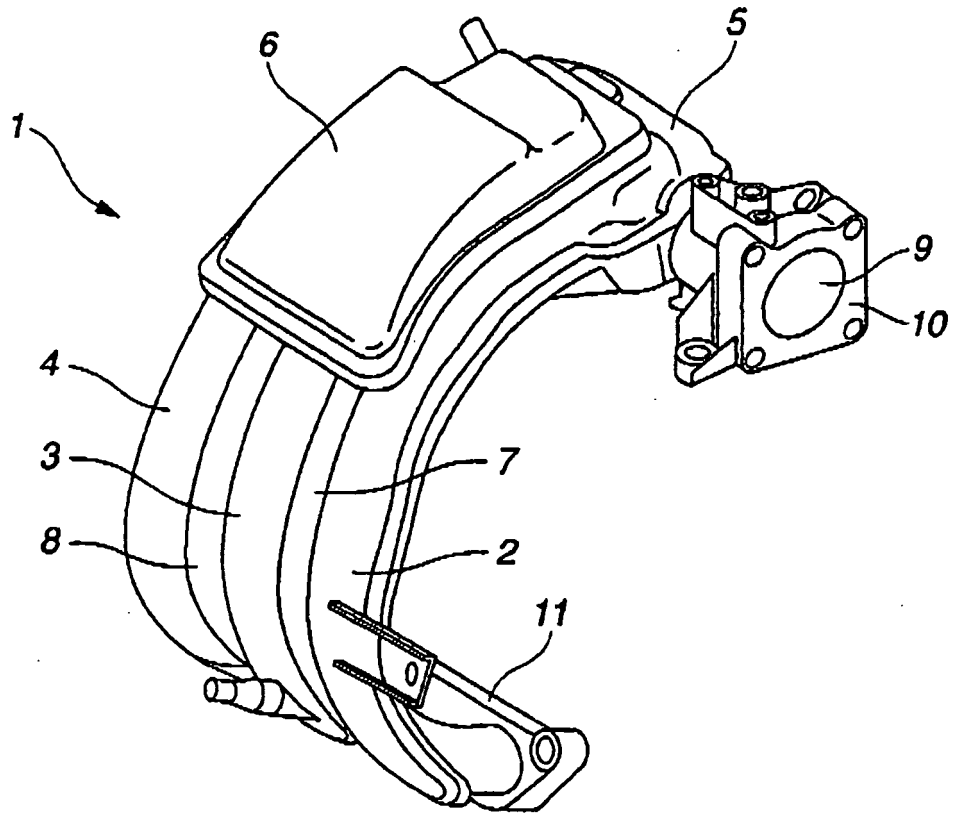


FIG.2

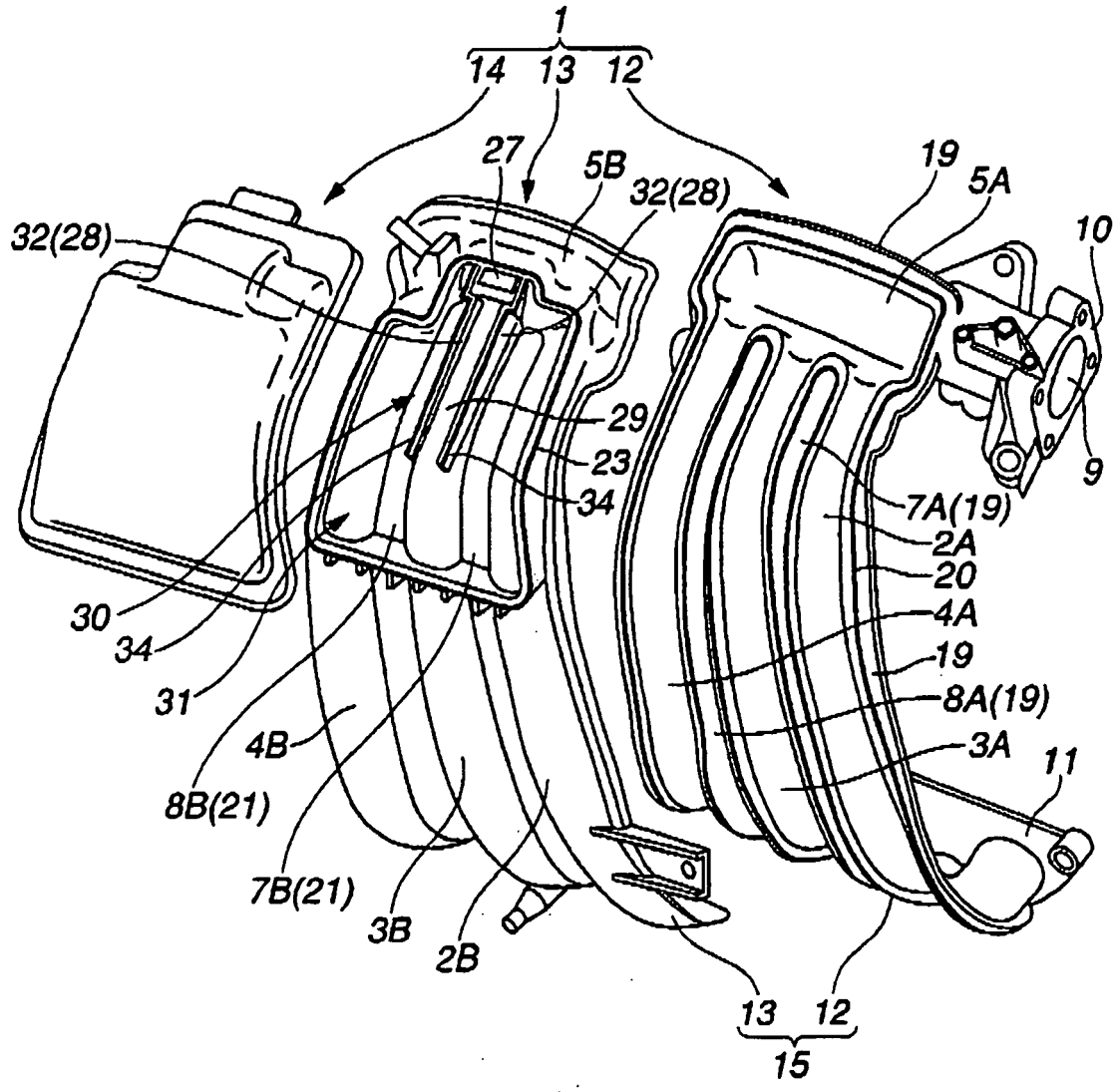

1
14
13
12
27
5B
32(28)
19
5A
10
32(28)
29
23
34
7A(19)
2A
20
4A
19
8A(19)
3A
11
9
30
34
31
4B
8B(21)
7B(21)
3B
2B
13
12
15

FIG.3

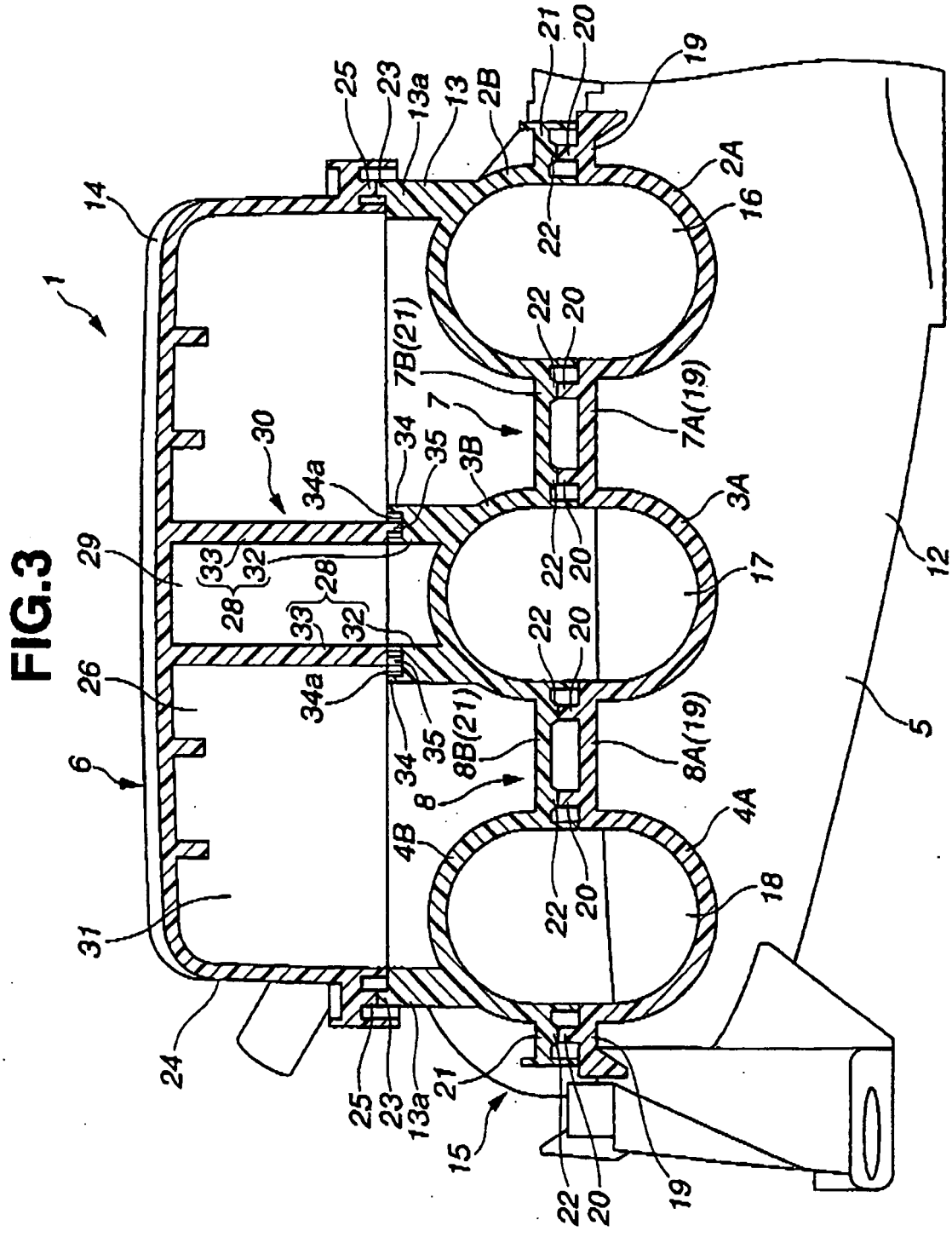

1
14
25
23
13a
13
2B
21
20
19
2A
16
22
7B(21)
7
7A(19)
30
34
35
3B
34a
3A
17
12
29
33
32
28
26
6
8B(21)
8A(19)
8
4B
4A
18
5
31
24
15

FIG.4

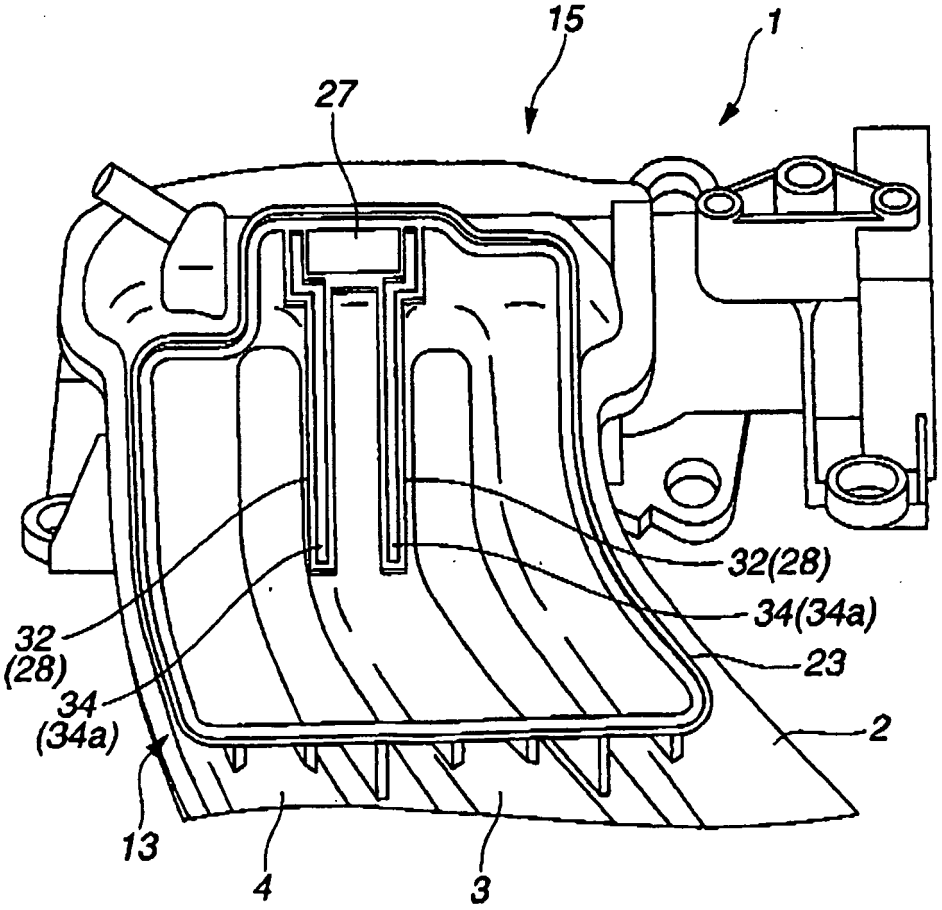


FIG.5

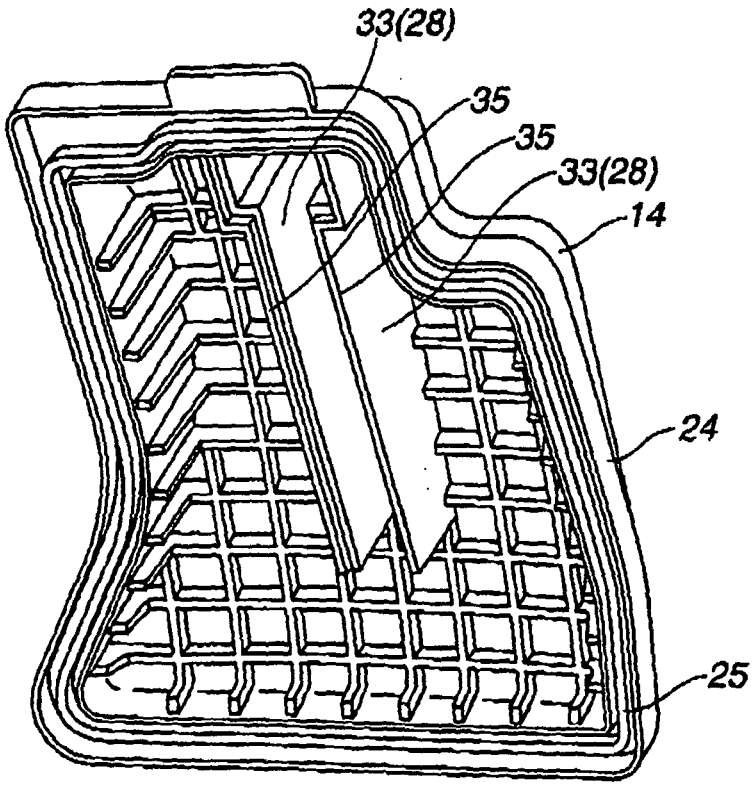


FIG.6

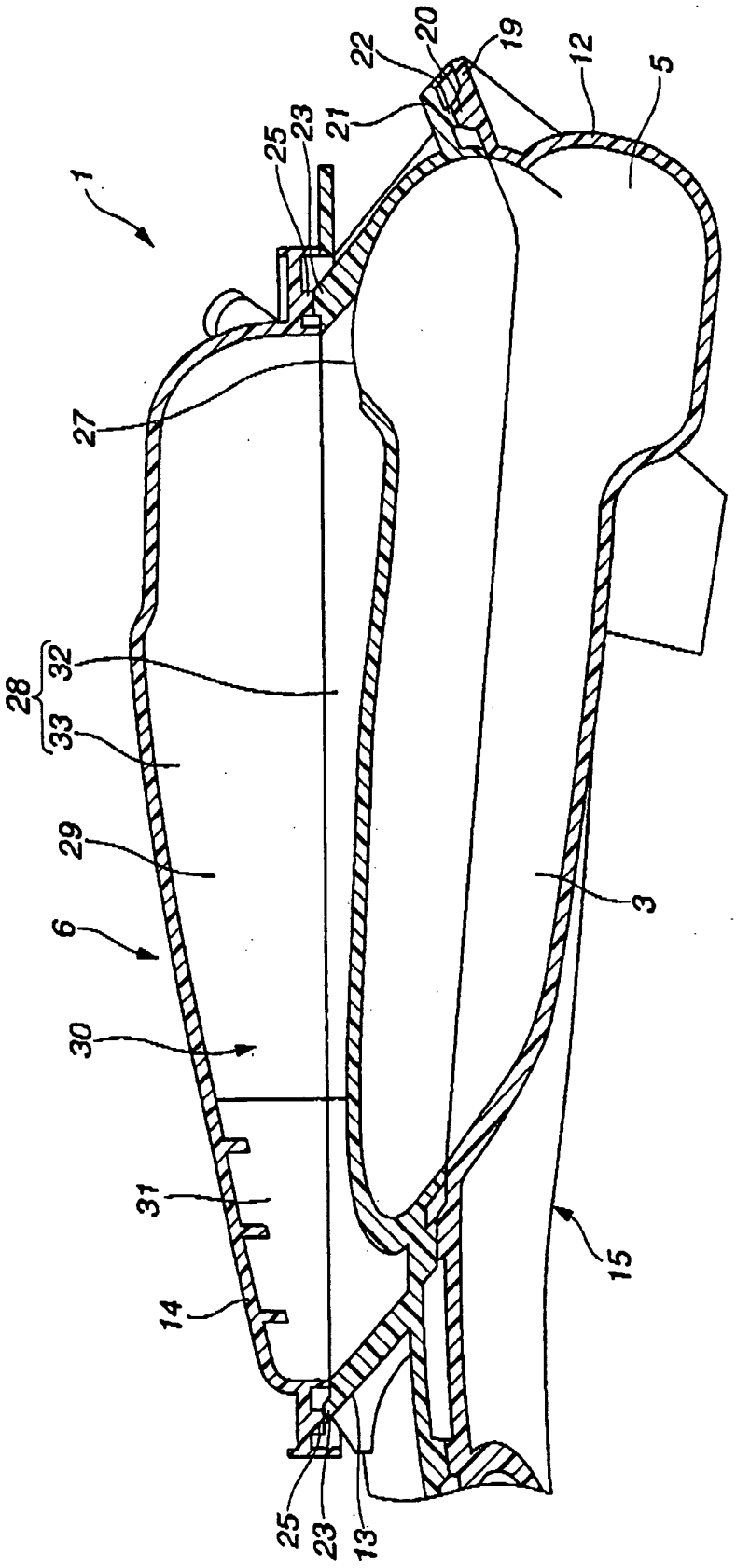


FIG.7

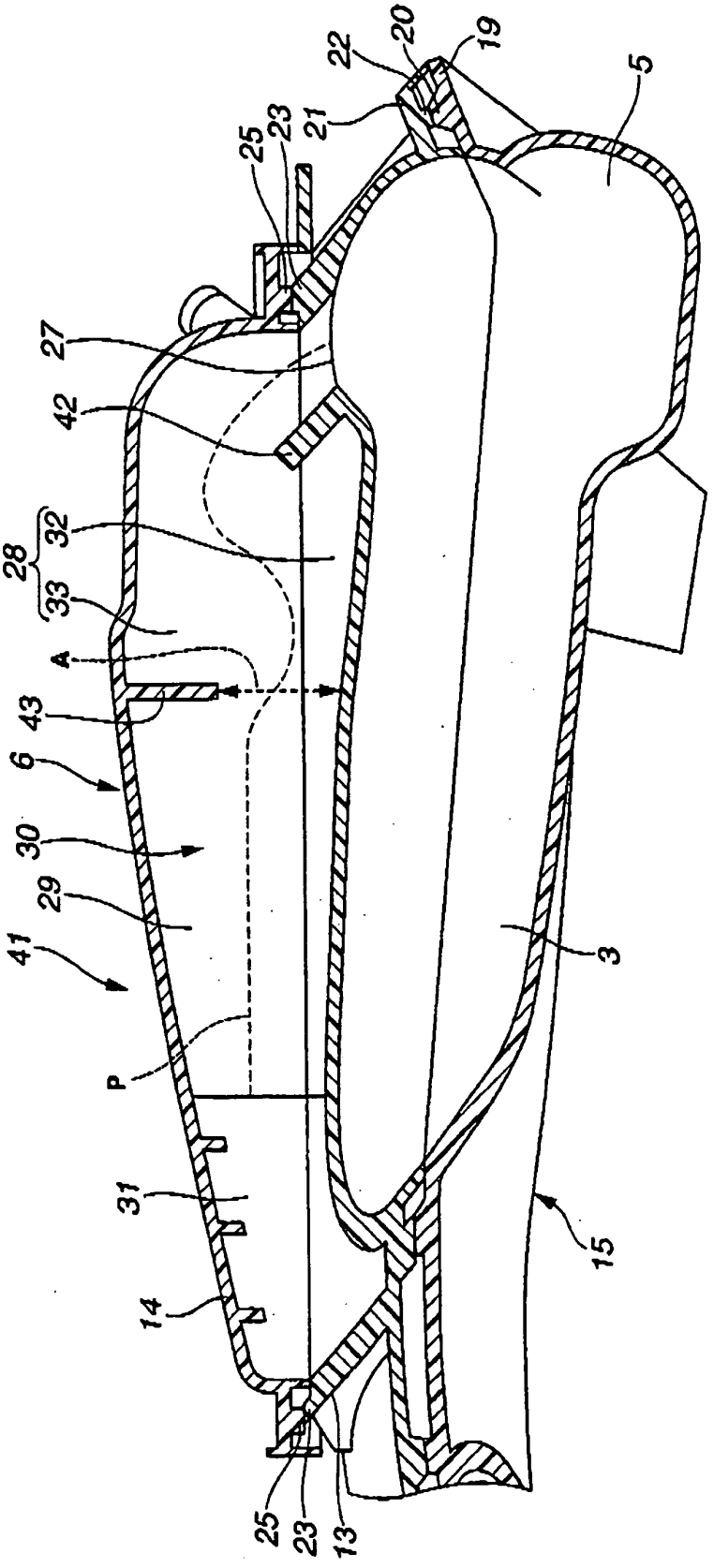


FIG.8

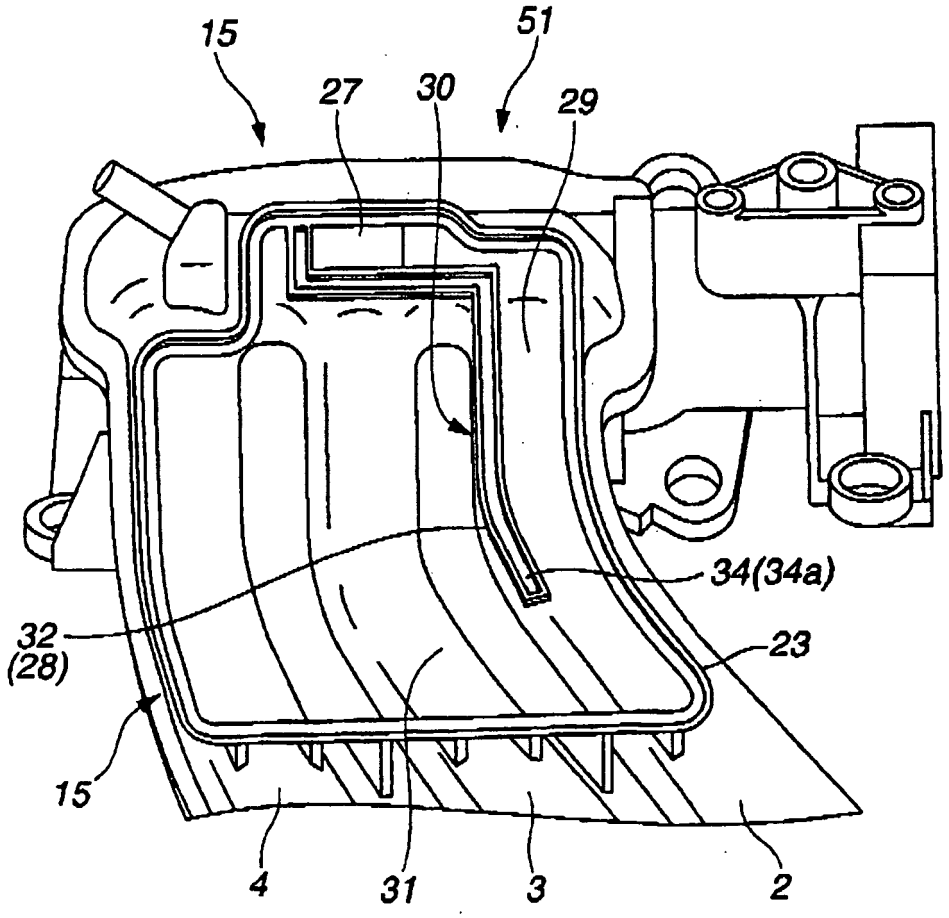
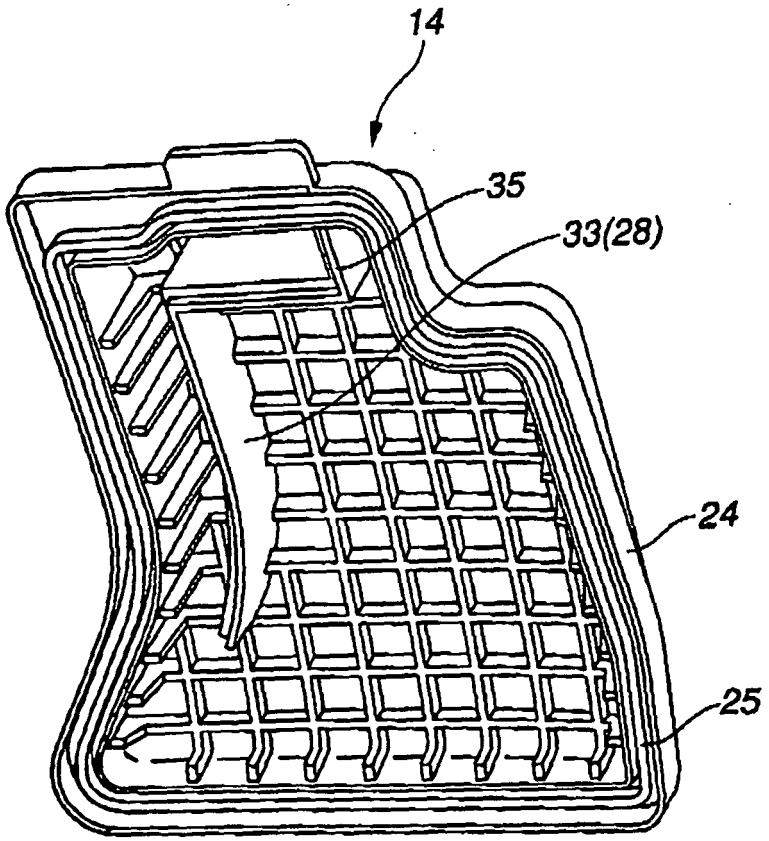


FIG.9



REFERENCES CITED IN THE DESCRIPTION

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