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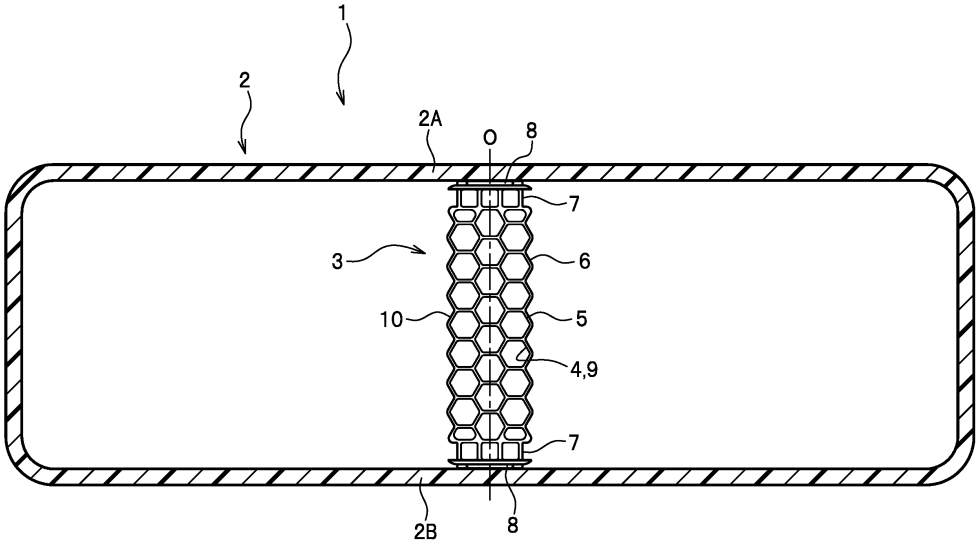
(54) **FUEL TANK**

(57) A fuel tank (1) made of a resin includes: a tank body (2) having walls facing each other therein; and an internal strut (3) including both ends fixed to the facing walls respectively. The internal strut has a grid shape such that through holes (4) are arranged as viewed from a side. The through holes (4) are, for example, hexagonal holes (9). The internal strut (3) has circular welding faces welded to the walls on both the ends of the internal strut respectively, having a substantially cylindrical shape. The internal strut (3) is two or more internal struts, and a coupling part (13) is provided and couples neighboring internal struts (3) to each other.

FIG. 1



EP 4 155 600 A1

Description

TRCHNICAL FIELD

[0001] The present invention relates to a resinous fuel tank.

BACKGROUND OF THE INVENTION

[0002] As a resinous fuel tank, a technique for supporting walls that face each other in a tank body with an internal strut is known. In a fuel tank, walls of the tank body can deform toward outside or inside the fuel tank due to internal pressure variation. At this time, if the internal strut has no elasticity, stress tends to concentrate on welded parts between the tank body and the internal strut. In some cases, there is a risk that the welded parts crack or a risk that the internal strut buckles.

[0003] To solve this problem, Patent Document 1 describes a technique for providing an internal strut with a lobe that elastically deforms easily. According to this technique, when walls of a tank body deform toward outside or inside a fuel tank, the lobe flexes to absorb the amount of deformation of the tank body. This reduces concentration of stress on the welded parts.

PRIOR ART REFERENCE

PATENT DOCUMMENT

[0004] Patent Document 1: U.S. Patent No. 6338420B1

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED

[0005] Meanwhile, in a case where a portion that elastically deforms easily is provided in some part, there is a problem that the strut tends to lack rigidity. Therefore, an internal strut that has high-level elasticity and rigidity at the same time in a balanced manner is demanded.

MEANS TO SOLVE PROBLEM

[0006] According to a first aspect of the present invention, a fuel tank made of a resin includes: a tank body that has walls facing each other therein; and an internal strut including both ends fixed to the facing walls respectively. The internal strut has a grid shape such that through holes are arranged as viewed from a side.

[0007] According to the first aspect of the present invention, an internal strut has a grid shape such that through holes are arranged as viewed from the side. Therefore, as compared to an internal strut partially including a portion that elastically deforms easily, the internal strut enhances in the rigidity. When walls of a tank body are deformed outward or inward due to internal pressure variation of the tank body and a tensile or compressive force is applied to the internal strut in the axis direction, the grid structure has a portion around each of the through holes flexed in the axis direction. This construction of the internal strut of the present invention ensures the elasticity and the rigidity in a balanced manner and reduces stress concentration on welded parts between the tank body and the internal strut.

[0008] According to a second aspect, the through holes are hexagonal holes.

[0009] According to the second aspect, the grid shape is a honeycomb shape and thus both high rigidity and excellent elasticity of the internal strut are achieved.

[0010] According to a third aspect, the internal strut has circular welding faces welded to the walls on both ends of the internal strut respectively having a substantially cylindrical shape.

[0011] According to the third aspect, when the internal strut is formed in a substantially cylindrical shape having circular welding face parts on both ends thereof, respectively, the load applied to the welded parts or the internal strut is transmitted uniformly around the axis. This construction reduces excessive stress concentration on the internal strut.

[0012] According to a fourth aspect, the internal strut is two or more internal struts and the fuel tank further includes a coupling part coupling neighboring internal struts to each other.

[0013] According to the fourth aspect, the coupling part that couples the internal struts to each other is provided, and if an excessive force is applied to one of the internal struts, the coupling part transmits the excessive force to the other internal strut through the coupling part.

[0014] According to a fifth aspect, the coupling part is located away from both ends of the internal struts.

[0015] According to the fifth aspect, the coupling part is provided at a region highly elastic due to the grid shape, and thus stress concentration on the coupling part is reduced.

[0016] According to a sixth aspect, the coupling part has coupling through holes extending therethrough in the same direction as the through holes extend, and the coupling through holes are arranged side by side in axial directions of the internal struts.

[0017] According to the sixth aspect, the elasticity of the coupling part itself is ensured and the coupling part is expanded and contracted according to expanding and contracting motions of the internal struts. This construction further reduces the stress concentration on the coupling part.

ADVANTAGEOUS EFFECTS OF THE INVENTION

[0018] According to the present invention, when the stress concentration on the welded parts between the tank body and the internal strut is reduced during deformation of the tank body, the elasticity and the rigidity of the internal strut is ensured in a balanced manner.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0019]

FIG. 1 is a side sectional view of a fuel tank according to the present invention;
FIG. 2 is a side view of an internal strut according to a first embodiment;
FIG. 3 is an external perspective view of the internal strut according to the first embodiment;
FIG. 4 is a side view of internal struts according to a second embodiment;
FIG. 5 is an external perspective view of the internal struts according to the second embodiment;
FIG. 6 is a side view of an internal strut having circular holes as through holes; and
FIG. 7 is a side view of an internal strut having triangular holes as through holes.

DESCRIPTION OF THE EMBODIMENTS

[0020] As illustrated in FIG. 1, a fuel tank 1 includes an internal strut 3 that has both ends respectively fixed to walls 2A and 2B facing each other inside a resinous tank body 2. The tank body 2 has a layer structure which includes, for example, a multilayer sectional structure including a barrier layer made of a material highly impermeable to a fuel interposed between an inside thermoplastic resin layer forming the inner surface of the tank and an outside thermoplastic resin layer forming the outer surface of the tank. The inside thermoplastic resin layer and the outside thermoplastic resin layer are made of materials, for example, PE (high-density polyethylene) having high thermofusibility and high moldability. The both ends of the internal strut 3 are thermally welded to the inside thermoplastic resin layer of the walls 2A and 2B.

[0021] With reference also to FIGS. 2 and 3, the internal strut 3 has a grid shape in which through holes 4 are arranged adjacent to each other as viewed from the side (in a direction P orthogonal to the direction of an axis O of the internal strut 3). The through holes 4 are also arranged adjacent to each other in the vertical section of the internal strut 3 (section orthogonal to the directions of axis O and axis P). The internal strut 3 in the grid shape increases the rigidity of the internal strut 3 as compared to the conventional structure including an elastic portion provided in some part. For example, if an internal pressure variation in the tank body 2 causes a tensile or compressive stress to be applied to the internal strut 3 from the walls 2A and 2B in the direction of the axis O, a grid wall 5 around each of the through holes 4 flexes in the direction of the axis O. This elastically deforms the internal strut 3 in the direction of the axis O without occurrence of excessive stress concentration on it. That is, the internal strut 3 according to the present invention ensures both the elasticity and the rigidity in a balanced manner and reduces the stress concentration on welded parts between the tank body 2 and the internal strut 3. Further, flexing of the internal strut 3 also reduces the risk of the buckling of the internal strut 3.

[0022] Preferred embodiments of the internal strut 3 are described below.

First embodiment

[0023] In FIGS. 1 to 3, the internal strut 3 includes a strut central part 6 having the through holes 4 provided thereon, and welding face parts 8 formed on both the ends of the strut central part 6 with strut end parts 7 interposed therebetween, respectively, and has a substantially cylindrical shape as a whole. The internal strut 3 is made of a resin and the strut central part 6, the strut end parts 7, and the welding face parts 8 are molded integrally.

[0024] The through holes 4 are hexagonal holes 9. That is, the strut central part 6 of the internal strut 3 has a honeycomb structure. The hexagonal holes 9 are arranged in three lines extending in the direction of the axis O. The hexagonal holes 9 are arranged in a grid such that lines connecting the centers of the adjacent three hexagonal holes 9 define a triangular grid. When the hexagonal holes 9 each are a regular hexagon, lines connecting the centers of the adjacent three hexagonal holes 9 define a regular triangular grid. The grid wall 5 near the circumferential surface of the strut central part 6 is formed as accordion-like planes 10. Meanwhile, a part of each of the hexagonal holes 9 around an opening end is formed like an arc in a circumferential direction around the axis O as can be seen from FIG. 3. Accordingly, the strut central part 6 has a substantially cylindrical shape as a whole.

[0025] The welding face parts 8 are formed as a circular plate. The welding face parts 8 have arc ribs 12 formed thereon concentrically on the axis O. The arc ribs 12 each located on the same circumferential line are formed with cuts. Provision of these arc ribs 12 enables resin of the tank body 2 to come around the arc ribs 12 during thermal welding and therefore improves the weldability between the tank body 2 and the internal strut 3.

[0026] According to the present embodiment, the through holes 4 are the hexagonal holes 9 and accordingly the internal strut 3 has a honeycomb structure. Therefore, both high rigidity and excellent elasticity of the internal strut 3 are provided. The internal strut 3 in a substantially cylindrical shape, having the circular welding face parts 8 on the both ends, respectively, enables the load applied to the welded parts or the internal strut 3 to be transmitted uniformly around the axis O. This construction reduces excessive stress concentration on the internal strut 3.

Second embodiment

[0027] In a second embodiment, two internal struts 3

are coupled with a coupling part 13 as illustrated in FIGS. 4 and 5. Each of the internal struts 3 has the same construction as that in the first embodiment, and descriptions thereof are omitted. The coupling part 13 is provided at a midpoint of the internal struts 3 away from the both ends of the internal struts 3, specifically, on the strut central parts 6. The coupling part 13 is formed of rectangular plate-like parts as viewed in the direction of the axis O, which couples the planes 10 of the respective internal struts 3 to each other. The plate-like parts are placed to be spaced in the direction of the axis O. Accordingly, the coupling part 13 has hexagonal coupling through holes 14 extending therethrough in the same direction as the hexagonal holes 9 extend, that is, in the direction P and being arranged side by side in the directions of the axes O of the internal struts 3.

[0028] If an excessive force is applied on one of the internal struts 3, the coupling part 13 coupling the internal struts 3 to each other makes the excessive force transmitted to the other internal strut 3 through the coupling part 13. With the coupling part 13 provided at a midpoint of the internal struts 3 away from the both ends of the internal struts 3, the coupling part 13 is placed at a region being highly elastic due to the grid shape and stress concentration on the coupling part 13 is reduced. Further, because the coupling part 13 includes the coupling through holes 14 extending therethrough in the same direction as the hexagonal holes 9 and being arranged side by side in the directions of the axes O of the internal struts 3, the elasticity of the coupling part 13 itself is ensured and the coupling part 13 is expanded and contracted according to expanding and contracting motions of the internal struts 3. This construction further reduces the stress concentration around the coupling part 13.

[0029] Preferred embodiments of the present invention have been described above. The through holes 4 are not limited to the hexagonal holes 9 and may be circular holes 15 illustrated in FIG. 6, triangular holes 16 illustrated in FIG. 7, or the like as long as these holes are arranged in a grid. Namely, in the present embodiment illustrated in FIG. 6, the circular holes 15 are arranged in a grid such that lines connecting the centers of the adjacent three circular holes 15 define a regular triangular grid. In the present embodiment illustrated in FIG. 7, the triangular holes 16 are arranged in a grid such that lines connecting the centers of the adjacent six triangular holes 16 define a hexagonal grid. When the triangular holes 16 each are a regular triangle, the lines connecting the centers of the adjacent six triangular holes 16 define regular hexagonal grid.

[0030] In the second embodiment, it is permissible to provide three or more internal struts 3.

LIST OF REFERENCE SIGNS

[0031]

1 fuel tank
2 tank body
3 internal strut
4 through hole
5 grid wall
6 strut central part
7 strut end part
8 welding face part
9 hexagonal hole
13 coupling part
14 coupling through hole

Claims

1. A fuel tank made of a resin comprising:

a tank body having walls facing each other therein;
an internal strut including both ends fixed to the facing walls respectively;
wherein the internal strut has a grid shape such that through holes are arranged as viewed from a side.

2. The fuel tank according to Claim 1,
wherein the through holes are hexagonal holes.

3. The fuel tank according to Claim 1,
wherein the internal strut has circular welding faces welded to the walls on the both ends of the internal strut respectively, having a substantially cylindrical shape.

4. The fuel tank according to Claim 1,

wherein the internal strut is two or more internal struts,
the fuel tank further comprising a coupling part coupling neighboring internal struts to each other.

5. The fuel tank according to Claim 4,
wherein coupling part is located away from both ends of the internal struts.

6. The fuel tank according to Claim 5,

wherein the coupling part has coupling through holes extending therethrough in the same direc-

tion as the through holes extend, and

wherein the coupling through holes are arranged side by side in axial directions of the internal struts.

FIG. 1

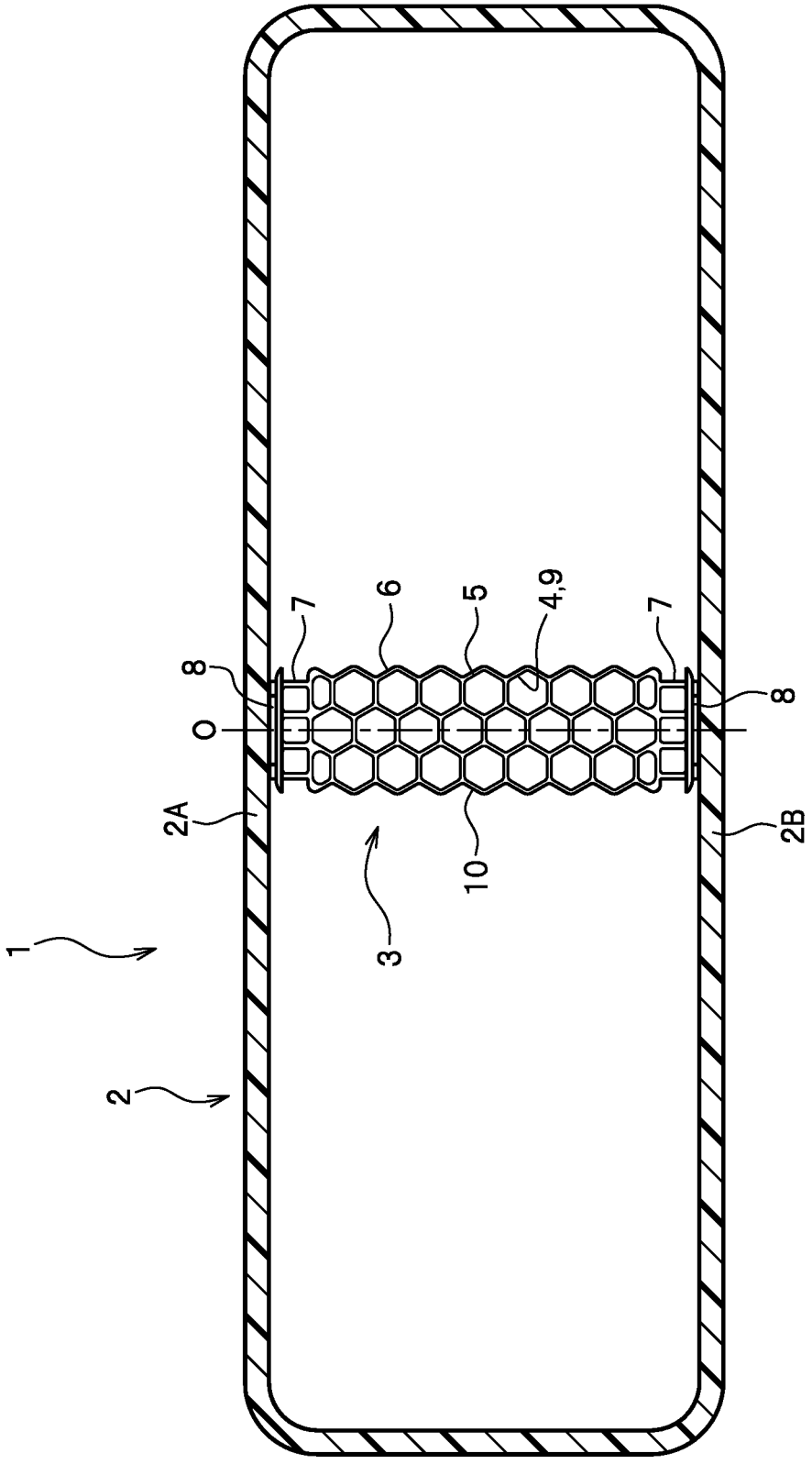


FIG. 2

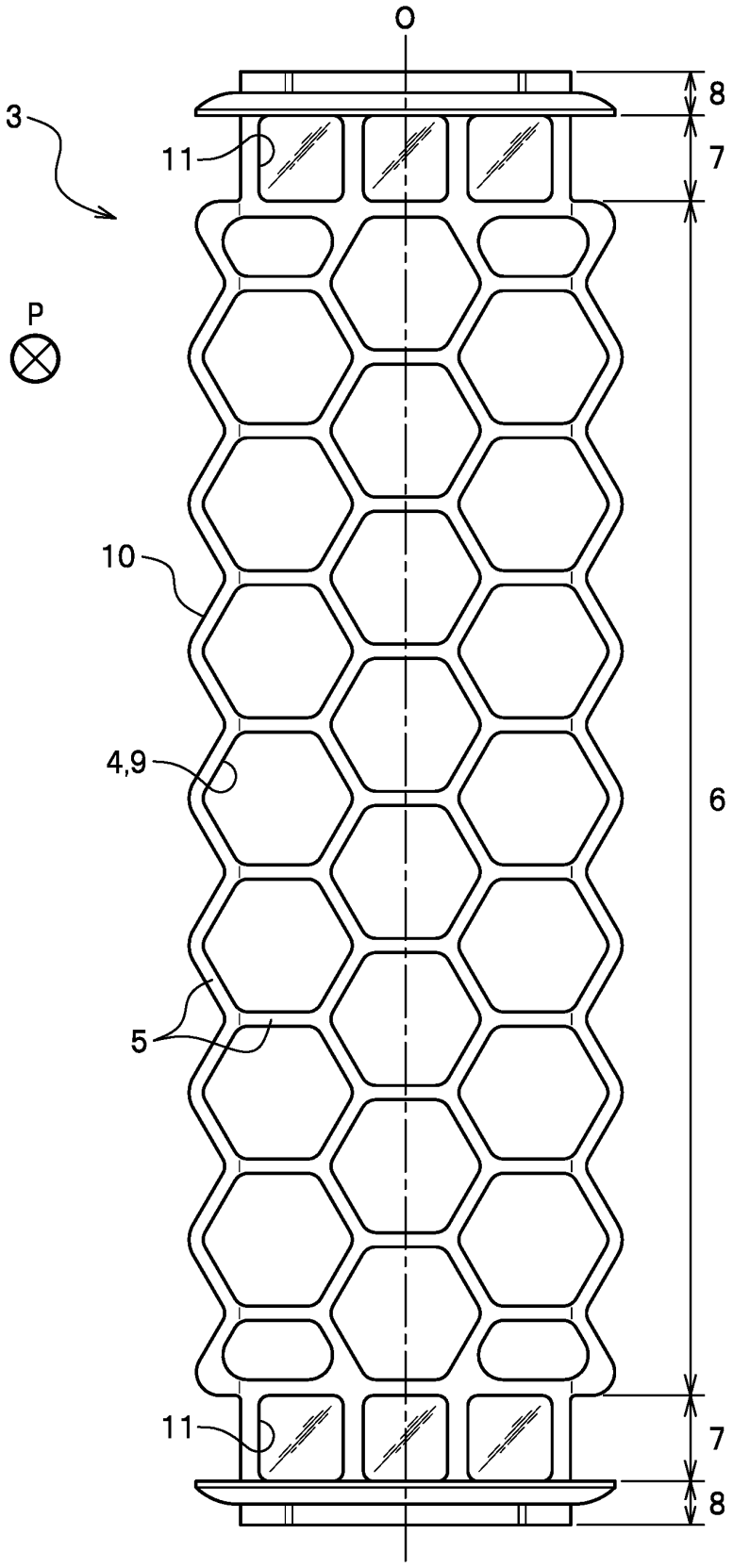


FIG. 3

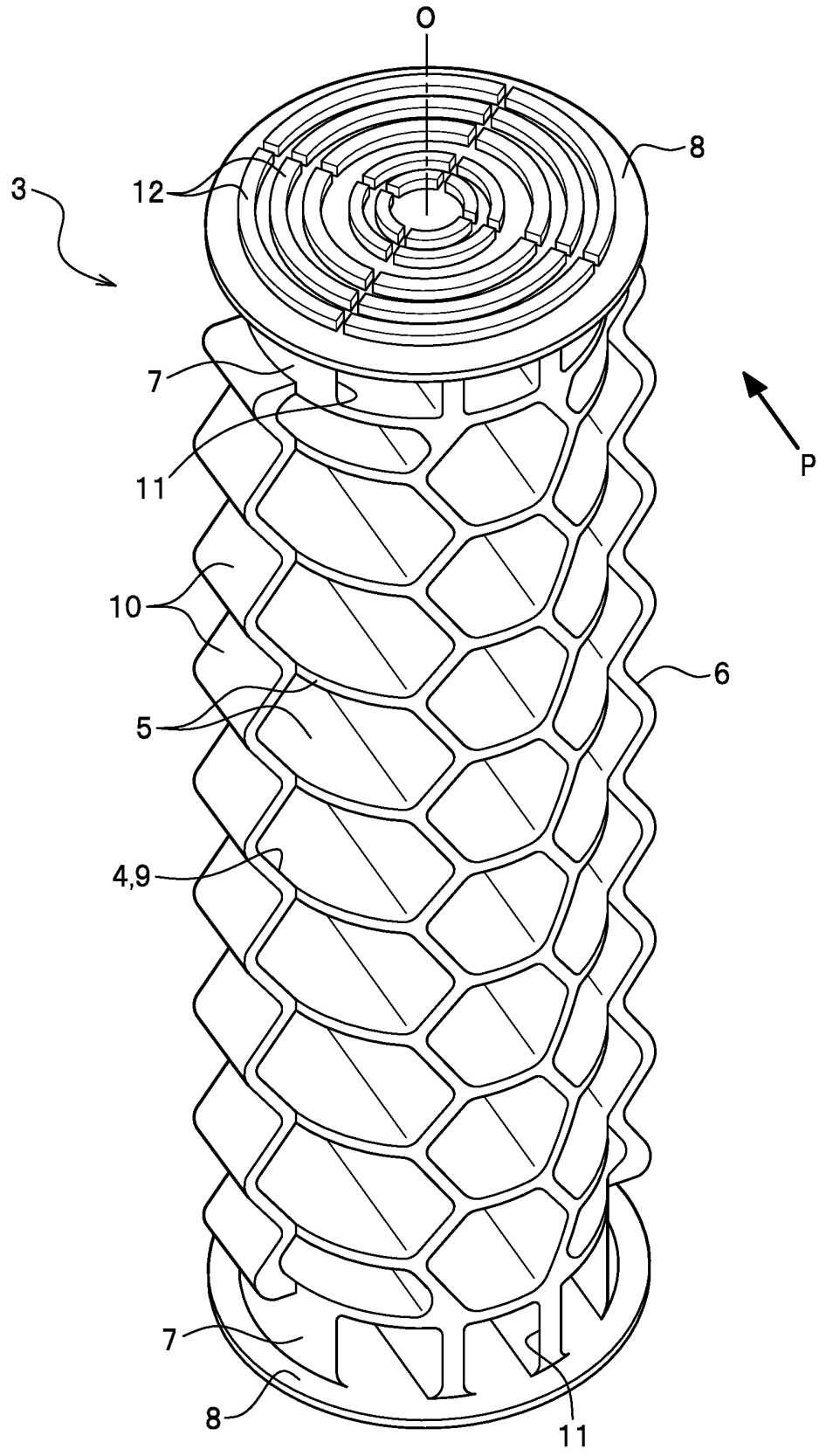


FIG. 4

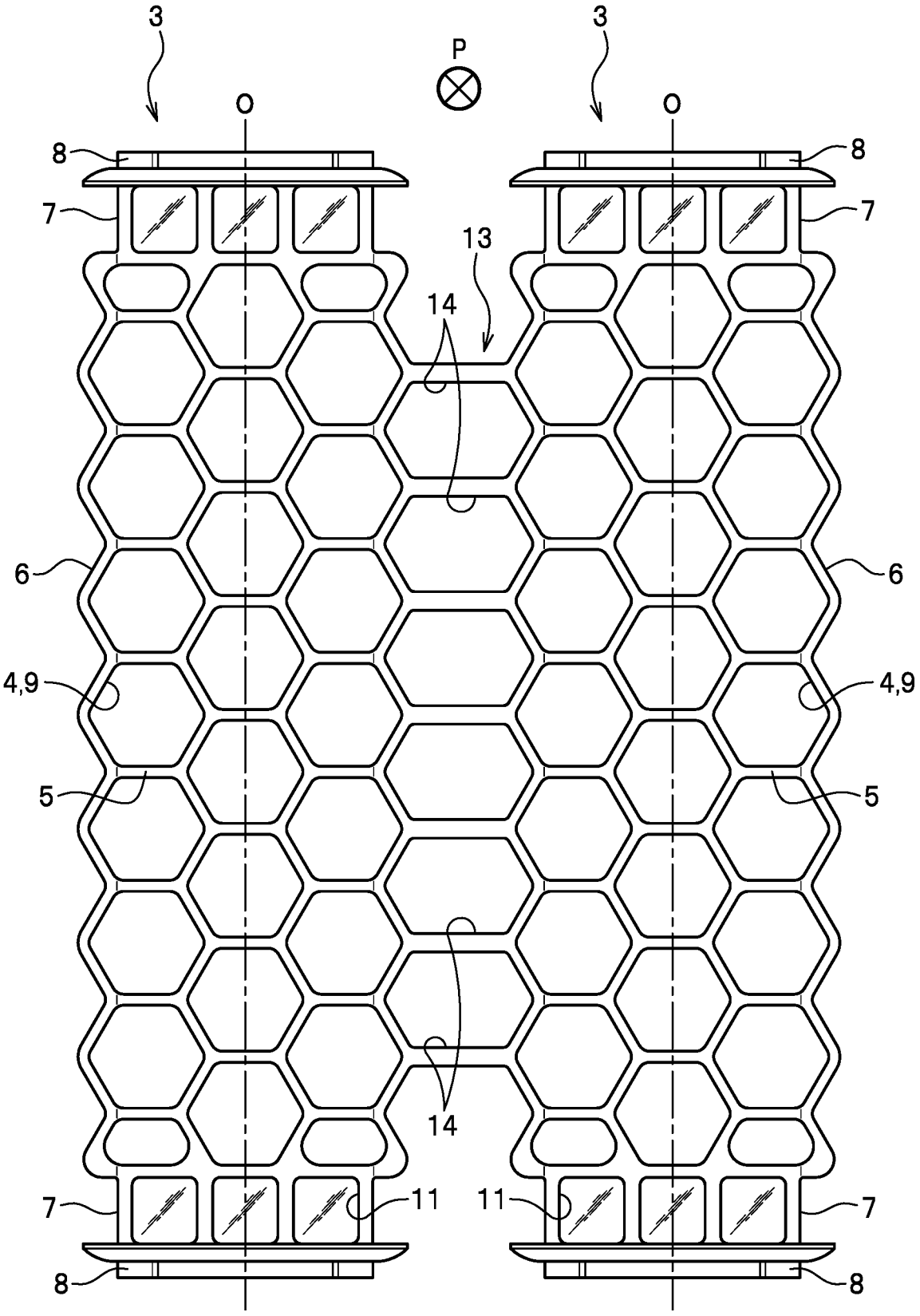


FIG. 5

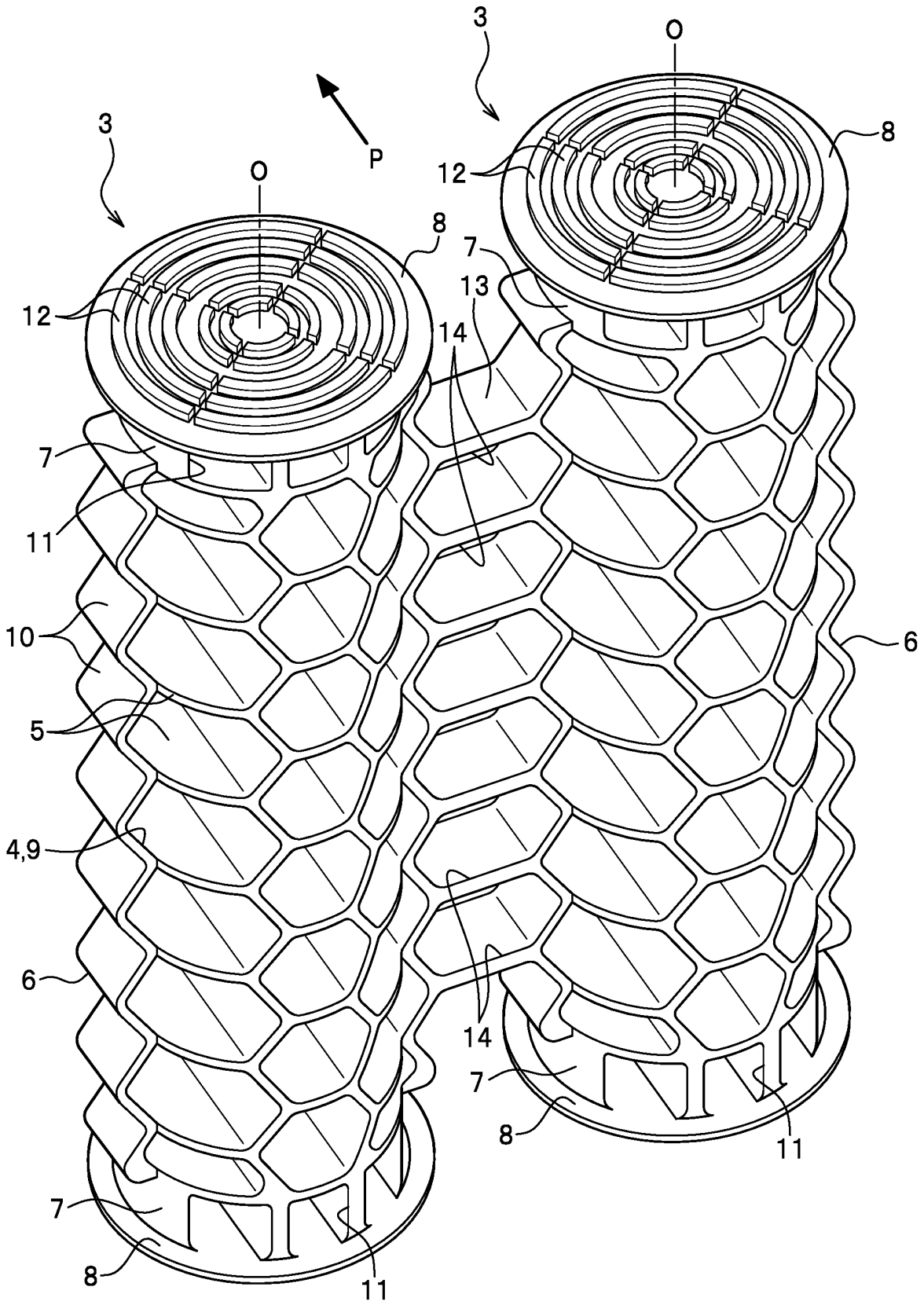


FIG. 6

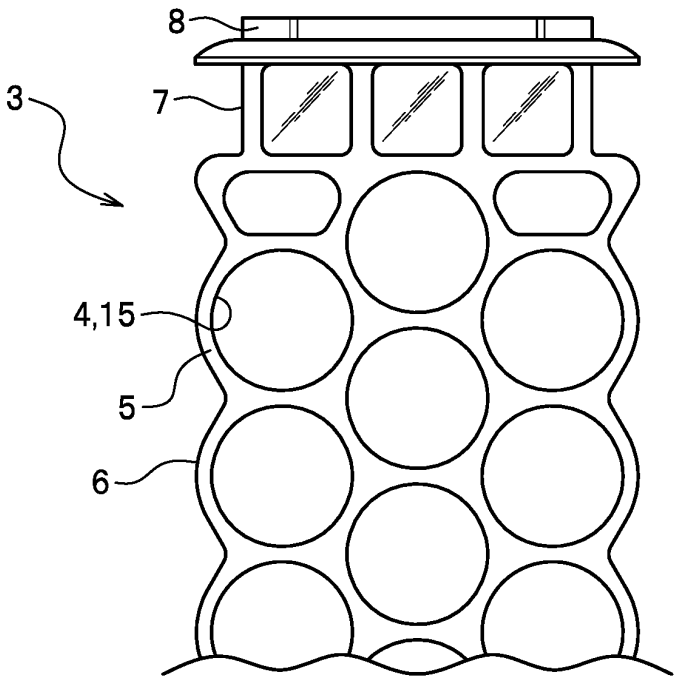
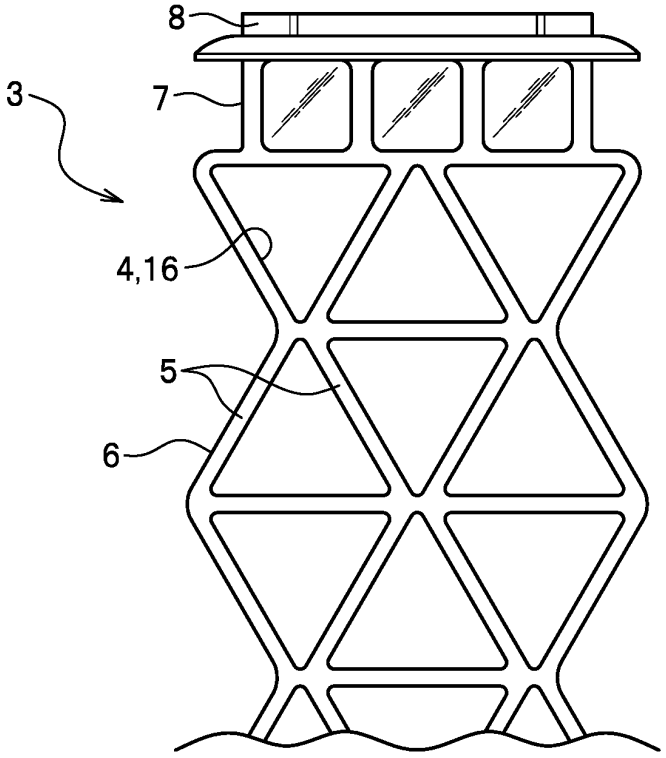


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/020166

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F17C1/16(2006.01)i
FI: F17C1/16

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F17C1/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2020
Registered utility model specifications of Japan 1996-2020
Published registered utility model applications of Japan 1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2018-127123 A (FTS KK) 16 August 2018, paragraphs [0029]-[0062], fig. 1-11, paragraphs [0029]-[0062], fig. 1-11	1-3 4-6
A	JP 2018-39413 A (TOYOTA MOTOR CORP.) 15 March 2018, paragraphs [0020]-[0049], fig. 1-9	1-6
A	JP 2019-14292 A (FTS KK) 31 January 2019, paragraphs [0031]-[0054], fig. 1-12	1-6
A	US 2002/0066737 A1 (STACK, Gary Francis) 06 June 2002, paragraphs [0011]-[0015], fig. 1	1-6

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
11.06.2020	23.06.2020
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/020166

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2018-127123 A	16.08.2018	(Family: none)	
JP 2018-39413 A	15.03.2018	US 2018/0065475 A1 paragraphs [0030]-[0062], fig. 1-9 CN 107804158 A	
JP 2019-14292 A	31.01.2019	(Family: none)	
US 2002/0066737 A1	06.06.2002	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6338420 B1 **[0004]**