



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.10.2012 Bulletin 2012/41

(51) Int Cl.:
E02D 29/14^(2006.01)

(21) Application number: **11380030.4**

(22) Date of filing: **05.04.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME

(72) Inventor: **Carandell Pérez, Joaquim**
08500 Vic (Barcelona) (ES)

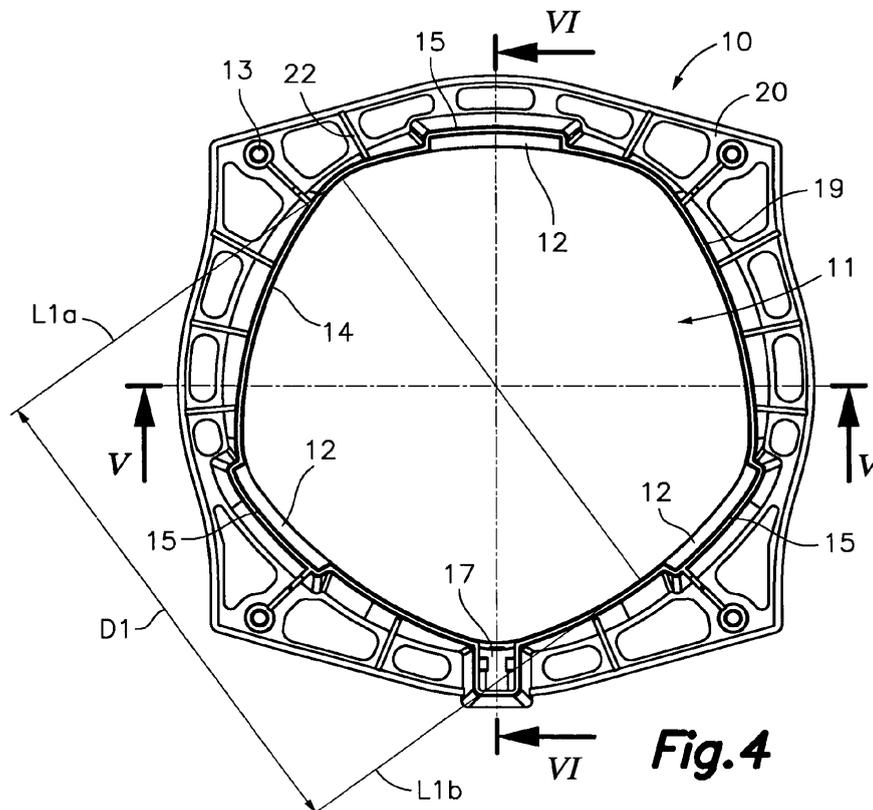
(74) Representative: **Torner Lasalle, Elisabet et al**
Torner, Juncosa I Associats, S.L.
C/Gran Via de les Corts Catalanes, 669 bis 1r 2a
08013 Barcelona (ES)

(71) Applicant: **BENITO ARTIS, SL**
08560 Manlleu Barcelona (ES)

(54) **Cover for an underground structure manhole**

(57) The cover comprises a frame (10) for being fixed to said manhole and a lid (50) for covering a passage opening (11) of the frame. An inner edge (14) of the passage opening (11) of the frame and an outer edge (51) of the lid have the form of respective first and second non-circular curves of constant width, geometrically sim-

ilar to one another. In the curves of constant width, a distance between two parallel geometric lines tangent to opposite points of said inner edge (14) of the passage opening (11) of the frame or outer edge (51) of the lid is constant no matter what the direction of said two parallel lines. The frame (10) and the lid (50) are lighter than a circular frame and a lid having an equivalent diameter.



Description

Field of the Art

[0001] The present invention relates to a manhole cover for an underground structure, such as a sewer for example, said cover comprising a frame fixed to the ground and a movable lid. The frame has a passage opening with a non-circular inner edge which however has a span in any direction equivalent to a pre-established diameter sufficient to allow the passage of a person. In many places, this equivalent diameter is established by regulations.

Background of the Invention

[0002] Manhole covers for underground structures, of the type comprising a frame and a lid, are well known in the state of the art. The frame is suitable for being fixed to the ground in relation to said manhole and comprises a passage opening to provide access therethrough, and the lid is configured to be coupled to the frame covering said passage opening.

[0003] Patent US-A-4840514 discloses a cover of the type described above in which the lid and the frame comprise respective hinge elements cooperating to allow rotating the lid with respect to the frame about a horizontal axis between a closed position, in which the lid is coupled to the frame covering the passage opening, and an open position, in which the lid is inclined backwards at a certain angle in relation to a vertical position thus leaving the passage opening clear. As a result of the aforementioned inclination the lid is stable in said open position. Furthermore, when the lid is in the aforementioned vertical position, the hinge elements allow the lid to be separated from the frame by moving it vertically upwards.

[0004] Generally, the frame and/or the lid include a notch in which an end of a crowbar is inserted when the lid is in the closed position to allow the start of opening the lid. Once the opening has started, the lid must be gripped with the hands to manually lift it up to the open position, which, due to the relatively heavy weight of the lid, requires a great effort and involves a serious risk of getting ones' fingers caught.

[0005] Patent US-A-4650232 describes an especially designed tool for being used as a crowbar to start opening the lid of a manhole cover for an underground structure and as a lever arm to lift the lid and drag it out of the passage opening, though in this case the lid is not hinged to the frame. A drawback of this tool is that it is considerably large sized and must be transported to the location of the cover to be opened.

[0006] Patent US-A-5911537 discloses a lid for a manhole cover for an underground structure having a thickness that progressively decreases from the center towards the periphery to provide the lid with sufficient resistance to withstand rolling transit when the cover is installed, for example, in a road. A drawback of this solution is that it considerably increases the weight of the lid.

[0007] Patent EP-A-1769125 describes a lid for a manhole cover of an underground structure comprising a relatively thin plate provided with a structure of ribs projecting from a lower surface of the plate. The structure of ribs comprises inner ribs connected at their ends forming a regular hexagon and radial ribs extending from the vertices of said hexagon to the periphery of the plate. The inner ribs have a determined height, and the height of the radial ribs progressively decreases from the inner ribs to the periphery.

[0008] The mentioned patent EP-A-1769125 also describes pressure closure members comprising a protrusion located at the free end of a spring arm connected to the lid and cooperating with a corresponding protrusion formed in the frame to retain the lid in the closed position with respect to the frame. A drawback of these pressure closure members is that they are located in a position that is diametrically opposed to the hinge device, and they are unable to retain the lid pressed against the frame in the area adjacent to the hinge. This can be the cause of noises produced by the play of the hinge elements when the lid is passed over by rolling transit.

[0009] Generally, both the frame and the lid for manhole covers of underground structures are made of ductile cast steel, which, in combination with the dimensions necessary to provide a passage opening sufficient to allow the passage of a person, means that the weight of the lid and of the frame is considerably high. The passage opening of the frame is generally circular and its magnitude is determined by a minimum diameter, generally established by regulations, sufficient to allow the passage of a person.

[0010] Therefore there is a need for a manhole cover for an underground structure which includes a frame and a lid that are lighter than those of the prior art for the same minimum passage area diameter.

Description of the Invention

[0011] The present invention contributes to mitigating the foregoing and other drawbacks by providing a manhole cover for an underground structure of the type comprising a frame and a lid, where said frame is configured to be fixed to said manhole and comprises a passage opening sized to allow the passage of a person therethrough, and one or more seats to bear said lid covering said passage opening.

[0012] The cover of the present invention is characterized in that the passage opening of the frame has an inner edge in the form of a first polygon having convex curved sides in which a first distance between two first parallel geometric lines tangent to opposite points of said inner edge is never less than a pre-established equivalent diameter sufficient to allow the passage of a person no matter what the direction of said two first parallel lines, and the lid has an outer edge in the form of a second polygon having convex curved sides geometrically similar to said first polygon having convex curved sides.

[0013] In one embodiment, the inner edge of the passage opening of the frame has the form of a first non-circular curve of constant width, in which said first distance between two first parallel geometric lines tangent to opposite points of said inner edge is constant no matter what the direction of said two first parallel lines, and the outer edge of the lid has the form of a second non-circular curve of constant width, in which a second distance between two second parallel geometric lines tangent to opposite points of said outer edge is constant no matter what the direction of said two second parallel lines, where said first and second curves of constant width are geometrically similar.

[0014] Therefore, the aforementioned first distance between said two first parallel geometric lines tangent to opposite points of the inner edge of the passage area of the frame is equivalent to the diameter of the passage area of the frame, and said second distance between the two second parallel geometric lines tangent to opposite points of the outer edge of the lid is equivalent to the diameter of the outer edge of the lid.

[0015] There are many curves of constant width different from the circumference, the most well-known version of which are the Reuleaux polygons, which are regular polygons having an odd number of sides, where each side is an arc of circumference having its center in the opposite vertex, with the particularity that all the diameters traced from any of the curved sides of the polygon have the same length. The polygon having curved sides forming the curve of constant width can further have vertices that are rounded by means of corresponding arcs of circumference, in which case the arc of circumference defining each curved side of the polygon has its center in the center of the arc of circumference rounding the opposite vertex, maintaining the particularity of constant diameter.

[0016] In the cover of the present invention, said first and second curves of constant width are respectively first and second regular polygons having geometrically similar convex curved sides, preferably with rounded vertices in a geometrically similar manner. Any curve of constant width defined by a regular polygon having curved sides, either with or without rounded vertices, has a perimeter and area that are less than the perimeter and area of a circumference of equivalent diameter.

[0017] Therefore, the frame of the cover of the present invention with the inner edge of the passage opening in the form of the first curve of constant width has a perimeter and area that are less than that of a circular frame of equivalent diameter. Accordingly, to manufacture the frame of the cover of the present invention a smaller amount of material will be necessary compared to a conventional circular frame of equivalent diameter, and its weight will be less. Similarly, the lid of the cover of the present invention with the outer edge in the form of the second curve of constant width has a perimeter and area that are less than that of a circular lid of equivalent diameter. Accordingly, to manufacture the lid of the cover of

the present invention a smaller amount of material will be necessary compared to a conventional circular lid of equivalent diameter, and its weight will be less.

[0018] The more sides the base polygon has the more similar the geometry of the curve of constant width will be to the circumference, and there will be less saving in material. Therefore, in the cover of the present invention it has been provided that the base polygons for the first and second curves of constant width are selected from first and second equilateral triangles, first and second regular pentagons and first and second regular heptagons. In a preferred embodiment, the first and second curves of constant width are pentagons having geometrically similar convex curved sides, and more preferably pentagons having geometrically similar convex curved sides and rounded vertices. The triangle is discarded as the base polygon because it provides an excessive reduction of the passage area and the heptagon and other polygons having a larger number of sides has been discarded because they provide insufficient weight reduction.

[0019] In one embodiment, said second distance or second equivalent diameter of the outer edge of the lid is greater than said first distance or first equivalent diameter of the inner edge of the passage opening of the frame, which assures that in no position will the lid be able to pass through the passage opening of the frame.

[0020] Optionally, the lid has an extendable handle installed on an inner face thereof which can be moved between a retracted position, in which said extendable handle does not project from the outer edge of the lid, and an extended position, in which the extendable handle projects from the outer edge of the lid. Therefore, when the extendable handle is in the retracted position, the lid with the extendable handle can be placed in the closed position with respect to the frame. Preferably, the lid is articulated to the frame by a hinge device and when the extendable handle is in said extended position, it provides a grip member and a lever arm on one side of the lid opposite said hinge device which allows lifting the lid, rotating it about a horizontal axis with respect to the frame applying less force than what would be necessary without the extendable handle.

[0021] In this embodiment, the frame preferably comprises lower pressure closure members and the lid comprises other corresponding upper pressure closure members. When the lid is in its closed position, the aforementioned upper pressure closure members of the lid lock with said lower pressure closure members of the frame retaining the lid in the closed position with respect to the frame. Furthermore, the lid can be placed in an ajar position, in which the upper pressure closure members of the lid are supported on the lower pressure closure members of the frame, whereby the lid stays in said ajar position with sufficient clearance with respect to the frame to allow the extendable handle to be gripped and moved between said retracted and extended positions without risk of getting ones' fingers caught. The lid and/or the

frame have a recess configured to receive an end of a conventional crowbar that can be used to move the lid from the closed position to the ajar position.

[0022] Advantageously, at least one of the lower pressure closure members of the frame and a corresponding one of the upper pressure closure members of the lid in the cover of the present invention are located adjacent to the hinge device. Thus, when the lid is in the closed position the mutually locked upper and lower pressure closure members keep the lid pressed against the frame also at the side corresponding to the hinge device and thereby prevent noises produced by the play of the elements of the hinge device when the lid is passed over by rolling transit.

[0023] In another embodiment, the second distance or second equivalent diameter of the outer edge of the lid is slightly less than said first distance or first equivalent diameter of the inner edge of the passage opening of the frame, and the lid comprises protrusions projecting radially from the outer edge thereof. The frame comprises box-shaped elements located adjacent to and above the inner edge of the passage opening, and the aforementioned protrusions of the lid fit in said box-shaped elements of the frame when the lid is in a closed position with respect to the frame.

[0024] Also in this embodiment, the lid is articulated to the frame by a hinge device, and one of the protrusions of the lid, which is located on one side of the lid opposite said hinge device, has a recess configured to receive an end of a conventional crowbar which can be used to start opening the lid when it is in the closed position.

[0025] Preferably, the lid has three of said protrusions distributed regularly around the outer edge thereof and peripheral ribs projecting from an inner face of said protrusions and extending therealong parallel to the outer edge of the lid. From an inner face of the lid there project inner ribs which are connected at their ends forming a polygon centered with respect to the outer edge of the lid, and three pairs of intermediate ribs. The two intermediate ribs of each pair are connected at one of their ends to said inner ribs and at their other end to opposite ends of one of said peripheral ribs of a corresponding protrusion. The height of the inner ribs is greater than the height of the peripheral ribs, and the height of the intermediate ribs progressively decreases from the inner ribs to the peripheral ribs.

[0026] When the lid is in the closed position, the peripheral ribs are supported on the seats formed in the box-shaped elements of the frame, and the intermediate ribs transmit the loads applied on the lid, for example by the rolling transit, to the peripheral ribs and to the frame. This arrangement of reinforcement ribs has been proven to provide the lid with greater strength against forces perpendicular to the upper surface thereof compared to lids with ribs arranged in radial directions distributed at equal angular intervals around it. In a particular variant of this embodiment, the polygon formed by the inner ribs is a regular hexagon and the two intermediate ribs of each

pair are mutually parallel.

[0027] Preferably, both the frame and the lid of the cover of the present invention are one-piece bodies obtained by molding ductile cast steel.

Brief Description of the Drawings

[0028] The foregoing and other features and advantages will be more fully understood from the following detailed description of embodiments with reference to the attached drawings, in which:

Fig. 1 is a top plan view of a manhole cover for an underground structure according to a first embodiment of the present invention, comprising a frame and a lid, in a closed position;

Fig. 2 is a cross-section view taken through the plane II-II of Fig. 1;

Fig. 3 is a perspective view of the frame of the cover of the first embodiment;

Fig. 4 is a top plan view of the frame of Fig. 3;

Fig. 5 is a cross-section view taken through the plane V-V of Fig. 4;

Fig. 6 is a cross-section view taken through the plane VI-VI of Fig. 4;

Fig. 7 is a perspective view of the lid of the cover of the first embodiment;

Fig. 8 is a top plan view of the lid of Fig. 7;

Fig. 9 is a cross-section view taken through the plane IX-IX of Fig. 8;

Fig. 11 is a bottom plan view of the lid of the first embodiment;

Fig. 11 is a cross-section view taken through the broken plane XI-XI of Fig. 10;

Fig. 12 is a top plan view of a manhole cover for an underground structure according to a second embodiment of the present invention, comprising a frame, a lid and an extendable handle, in a closed position;

Fig. 13 is a cross-section view taken through the plane XIII-XIII of Fig. 12;

Fig. 14 is a cross-section view taken through the broken plane XIV-XIV of Fig. 12, with two enlarged details;

Fig. 15 is a bottom plan view of the cover of the second embodiment, showing the frame, the lid, and the extendable handle in a retracted position;

Fig. 16 is a perspective view of the frame of the cover of the second embodiment;

Fig. 17 is a top plan view of the frame of Fig. 16;

Fig. 18 is a cross-section view taken through the broken plane XVIII-XVIII of Fig. 17, with two enlarged details;

Fig. 19 is a perspective view of the lid of the cover of the second embodiment;

Fig. 20 is a top plan view of the lid of Fig. 19;

Fig. 21 a cross-section view taken through the plane XXI-XXI of Fig. 20;

Fig. 22 a cross-section view taken through the plane XXII-XXII of Fig. 20;

Fig. 23 is a bottom plan view of the lid of Fig. 19;

Fig. 24 is an enlarged partial cross-section view taken through the plane XXIV-XXIV of Fig. 23;

Fig. 25 is an enlarged partial cross-section view taken through the plane XXV-XXV of Fig. 23;

Fig. 26 is a top plan view of the cover of the second embodiment, with the lid in an ajar position with respect to the frame and the extendable handle in an extended position; and

Fig. 27 is a cross-section view taken through the plane XXVII-XXVII of Fig. 26, including a force and lever arms diagram.

Detailed Description of Exemplary Embodiments

[0029] First in reference to Figs. 1 to 11, reference numeral 100 generally designates a cover (shown as a whole in Figs. 1 and 2) according to a first embodiment of the present invention, which comprises a frame 10 (shown individually in Figs. 3 to 6) and a lid 50 (shown individually in Figs. 7 to 11). The cover 100 is provided for covering a manhole of an underground structure, such as a sewer network (not shown).

[0030] The aforementioned frame 10 is configured to be fixed to said manhole of the underground structure. To that end the frame 10 comprises a perimetral tubular wall 19 defining a passage opening 11 and a perimetral fixing flange 20 extending outwards from a lower end of said perimetral tubular wall 19. The perimetral fixing flange 20 has openings for reducing weight and fixing holes 13 for installing screws or the like by means of which the frame 10 is fixed to the underground structure in relation to said manhole. When the frame 10 is fixed in the operating position, the perimetral fixing flange 20 is underground and an upper edge of the perimetral tubular wall 19 is substantially flush with the surface of the ground.

[0031] As is shown in Fig. 4, the passage opening 11 of the frame 10, which is sized to allow the passage of a person therethrough, has an inner edge 14 in the form of a first non-circular curve of constant width, in which a first distance D1 between two first parallel geometric lines L1a, L1b tangent to opposite points of said inner edge 14 is constant no matter what the direction of said two first parallel lines L1a, L1b. This first distance D1 is equivalent to a diameter of the inner edge 14 of the passage opening 11 of the frame 10.

[0032] In the embodiment shown, the aforementioned first curve of constant width defined by the inner edge 14 of the passage opening 11 of the frame 10 is a first regular pentagon having convex curved sides and rounded vertices, though alternatively other curves of constant width are within the scope of the present invention.

[0033] The perimetral tubular wall 19 of the frame 10 has a substantially vertical upper portion that follows the outline of the first curve of constant width, and a down-

wardly and outwardly inclined lower portion defining a transition between the outline of the first curve of constant width at the upper end and a substantially circular outline at the lower end, where it connects with the perimetral fixing flange 20. Between the perimetral tubular wall 19 and the perimetral fixing flange 20 are arranged reinforcement gussets 22.

[0034] The perimetral tubular wall 19 of the frame 10 defines three box-shaped elements 15 located adjacent to and above the inner edge 14 of the passage opening 11, and distributed at equal angular intervals around the frame. These box-shaped elements 15 are open in the upper portion and have bottom walls forming seats 12 bearing the lid 50 when it is in a closed position covering the passage opening 11, as will be explained below. The bottom walls of the box-shaped elements are reinforced in the lower portion by gussets 21

[0035] The frame likewise defines a conventional type hinge element 17 configured to cooperate with another hinge element 60 formed in the lid 50. The aforementioned hinge element 17 of the frame 10 is located in a position diametrically opposed to one of the box-shaped elements 15.

[0036] As shown in Fig. 8, the lid 50 comprises a cover plate 61 having an outer edge 51 in the form of a second non-circular curve of constant width, in which a second distance D2 between two second parallel geometric lines L2a, L2b tangent to opposite points of said outer edge 51 is constant no matter what the direction of said two second parallel lines L2a, L2b. This second distance D2 is equivalent to a diameter of the outer edge 51 of the lid 50. The second curve of constant width of the lid 50 is geometrically similar to the first curve of constant width of the frame 10, therefore in the embodiment shown the second curve of constant width of the lid 50 is a pentagon having convex curved sides and rounded vertices.

[0037] The second distance D2 equivalent to the outer diameter 51 of the lid 50 is slightly less than the first distance D1 equivalent to the diameter of the inner edge 14 of the passage opening 11 of the frame 10, such that the cover plate 61 of the lid fits inside the upper portion of the perimetral tubular wall 19 of the frame 10. The cover plate 61 has an upper surface that is substantially flush with an upper edge of the perimetral tubular wall 19 of the frame 10 when the lid 50 is in a closed position. The aforementioned upper surface of the cover plate 61 has a pattern of non-slip projections 62 and optionally one or more embossed inscriptions (not shown) in clearings of said pattern of non-slip projections 62.

[0038] The lid 50 comprises protrusions 55 projecting radially from the outer edge 51 thereof and a conventional hinge element 60 which also projects from the outer edge 51 in a position diametrically opposed to one of said protrusions 15. The protrusions 55 of the lid 50 fit in said box-shaped elements 15 of the frame 10 when the lid 50 is in a closed position with respect to the frame 10 (Fig. 2) and the hinge element 60 is inserted in the aforementioned hinge element 17 of the frame 10. The cooperation

of the hinge elements 17, 60 forms a hinge device which allows rotating the lid 10 about a horizontal axis with respect to the frame 10 between a closed position (Figs. 1 and 2) and a stable open position (not shown) in which the lid is inclined backwards at a certain angle in relation to a vertical position. When the lid is in the aforementioned vertical position, the hinge elements 17, 60 allow the lid 50 to be separated from the frame 10 by moving it vertically upwards.

[0039] The lid 50 of this first embodiment has three of said protrusions 55 distributed regularly around the outer edge 51 at angular intervals of 120°. The protrusion 55 of the lid 50 which is in a position diametrically opposed to the hinge element 17 has a recess 56 configured to receive an end of a crowbar when the lid 50 is in the closed position. This crowbar is used to start opening the lid 50 as is conventional.

[0040] As best shown in Fig. 10, the lid 50 includes an arrangement of reinforcement ribs projecting from a lower surface of the cover plate 61. These reinforcement ribs include peripheral ribs 57 projecting from an inner face of said protrusions 55 and extending therealong parallel to the outer edge 51, inner ribs 58 which are connected to one another at their ends forming a hexagon centered with respect to the outer edge 51, and three pairs of intermediate ribs 59. The two intermediate ribs 59 of each pair are mutually parallel and have respective inner ends connected to two adjacent vertexes of the hexagon formed by said inner ribs 58 and respective outer ends connected to opposite ends of one of said peripheral ribs 57 of one of the protrusions 55.

[0041] The inner ribs 58 have a determined height (Fig. 11), the peripheral ribs 57 have a height less than the height of the inner ribs 58, and the intermediate ribs 59 have at their inner ends a height substantially equal to the height of the inner ribs 58 and at their outer ends a height substantially equal to the height of the peripheral ribs 57. The height of the intermediate ribs 59 progressively decreases from their inner ends to their outer ends.

[0042] When the lid 50 is in the closed position, the peripheral ribs 57 are supported on the seats 12 formed in the box-shaped elements 15 of the frame 10, and the intermediate ribs 59 efficiently transmit the loads applied on the cover plate 61 of the lid 50 to the peripheral ribs 57 and to the frame 10.

[0043] Now in reference to Figs. 12 to 27, reference number 200 generally designates a cover (shown as a whole in Figs. 12 to 15, 26 and 27) according to a second embodiment of the present invention, which comprises a frame 10 (shown individually in Figs. 16 to 18), a lid 50 (shown individually in Figs. 19 to 25), and an extendable handle 70 (shown in Figs. 15, 26 and 27). The cover 100 is provided for covering a manhole of an underground structure, such as a sewer network (not shown).

[0044] In this second embodiment, in a manner similar to the first embodiment, the frame 10 comprises a perimetral tubular wall 19 formed around a passage opening 11 and a perimetral fixing flange 20 extending outwards

from a lower end of said perimetral tubular wall 19. The perimetral fixing flange 20 has fixing holes 13. A seat 12 (Figs. 17 and 18) extending along the entire perimeter of the frame 10 is formed between the perimetral tubular wall 19 and an inner edge 14 of the passage opening. The aforementioned seat 12 is configured to house an annular rubber seal 75 (Figs. 13 and 14).

[0045] As shown in Fig. 17, the aforementioned inner edge 14 of the passage opening 11 of the frame 10 has the form of a first non-circular curve of constant width, in which a first distance D1 between two first parallel geometric lines L1a, L1b tangent to opposite points of said inner edge 14 is constant no matter what the direction of said two first parallel lines L1a, L1b. This first distance D1 is equivalent to a diameter of the inner edge 14 of the passage opening 11 of the frame 10.

[0046] In the embodiment shown, the aforementioned first curve of constant width defined by the inner edge 14 of the passage opening 11 of the frame 10 is a first regular pentagon having convex curved sides and rounded vertexes, though alternatively other curves of constant width are within the scope of the present invention.

[0047] The perimetral tubular wall 19 of the frame 10 has a substantially vertical upper portion that follows the outline of the first curve of constant width, and a downwardly and outwardly inclined lower portion defining a transition between the outline of the first curve of constant width at the upper end and a substantially circular outline at the lower end, where it connects with the perimetral fixing flange 20. Reinforcement gussets 22 are arranged between the perimetral tubular wall 19 and the perimetral fixing flange 20.

[0048] The frame further comprises a conventional type hinge element 17 and a recess 18 configured to receive an end of a crowbar when the lid is in a closed position. Said hinge element 17 and said recess 18 are located in diametrically opposed positions of the frame. The frame further includes lower pressure closure members 16 projecting slightly from the inner edge 14 and into the passage area 11. One of said lower pressure closure members 16 is located adjacent to the hinge element 17 (Fig. 17).

[0049] As shown in Fig. 20, the lid 50 comprises a cover plate 61 having an outer edge 51 in the form of a second non-circular curve of constant width, in which a second distance D2 between two second parallel geometric lines L2a, L2b tangent to opposite points of said outer edge 51 is constant no matter what the direction of said two second parallel lines L2a, L2b. This second distance D2 is equivalent to a diameter of the outer edge 51 of the lid 50. The second curve of constant width of the lid 50 is geometrically similar to the first curve of constant width of the frame 10, therefore in the embodiment shown the second curve of constant width of the lid 50 is a pentagon having convex curved sides and rounded vertexes.

[0050] The second distance D2 equivalent to the outer diameter 51 of the lid 50 is greater than the first distance D1 equivalent to the diameter of the inner edge 14 of the

passage opening 11 of the frame 10 and slightly less than the inner outline of the upper portion of the perimetral tubular wall 19 of the frame 10, such that the cover plate 61 of the lid fits inside the upper portion of the perimetral tubular wall 19 of the frame 10 but it is impossible for it to pass through the passage opening 11. The cover plate has a lower ridge 63 along its perimeter, and this lower ridge 63 of the lid 50 is supported on the rubber seal 75 arranged in the seat 12 of the frame (Figs. 13 and 14).

[0051] The cover plate 61 has an upper surface which is substantially flush with an upper edge of the perimetral tubular wall 19 of the frame 10 when the lid 50 is in a closed position. The aforementioned upper surface of the cover plate 61 has a pattern of non-slip projections 62 and optionally one or more embossed inscriptions (not shown) in clearings of said pattern of non-slip projections 62.

[0052] The lid 50 comprises a conventional hinge element 60 projecting from the outer edge 51 and a projection 65 also projecting from the outer edge 51 in a position diametrically opposed to the hinge element 60. The hinge element 60 is inserted in the aforementioned hinge element 17 of the frame 10 and said projection 65 is partially housed in the recess 18 of the frame 10 when the lid is in a closed position. The projection 65 cooperates with the aforementioned crowbar for the start of opening the lid. The cooperation of the hinge elements 17, 60 forms a hinge device which allows rotating the lid 10 about a horizontal axis with respect to the frame 10 between a closed position (Figs. 12 to 15) and a stable open position (not shown) in which the lid is inclined backwards at a certain angle in relation to a vertical position. When the lid is in the aforementioned vertical position, the hinge elements 17, 60 allow the lid 50 to be separated from the frame 10 by moving it vertically upwards.

[0053] As best shown in Figs. 15 and 19, the lid 50 includes an arrangement of reinforcement ribs projecting from a lower surface of the cover plate 61. These reinforcement ribs include inner ribs 58 which are connected to one another at their ends forming a hexagon centered with respect to the outer edge 51, and six radial ribs 64 distributed regularly at angular intervals of 60° and connected at their inner ends to vertexes of the hexagon formed by said inner ribs 58. The inner ribs 58 have a determined height (Figs. 20 and 21), and the height of the radial ribs 64 progressively decreases from their inner ends, where they have a height substantially equal to the height of the inner ribs 58, towards the periphery.

[0054] The lid 50 further comprises three elastic arms 66 connected at one of their ends to the inner face of the cover plate 61 and having at their free ends corresponding upper pressure closure members 54 locking with the aforementioned lower pressure closure members 16 of the frame 10 when the lid 50 is in the closed position. Thus, the locking of the lower and upper pressure closure members 16, 54 retains the lid 50 in said closed position pressed against the rubber seal 75 installed in the frame 10 even in a region corresponding to the hinge device

17, 60, thus preventing possible noises when being passed over due to the inevitable play in the hinge device 17, 60.

[0055] Furthermore, the lid 50 can be placed in an ajar position, in which the upper pressure closure members 54 of the lid 50 are supported on the lower pressure closure members 16 of the frame 10 to stably keep the lid 50 in said ajar position. To that end, the upper pressure closure members 54 of the lid 50 have support surfaces 68 located at different heights, the lower they are the further the upper pressure closure members 54 are from the hinge device 17, 60 (Figs. 14, 23 and 24).

[0056] The lid 50 has an extendable handle 70 installed on an inner face thereof comprising a grip member 71 connected to a pair of sliding arms 72, which are inserted such that they can slide in corresponding holes 53 formed in protrusions of said inner face of the lid 50, such as the radial ribs 64 for example. Each sliding arm 72 has a stop 73 at a free end thereof which prevents said free end from passing through the corresponding hole 53. Therefore, the extendable handle 70 can be moved between a retracted position (Fig. 15), in which said extendable handle 70 does not project from the outer edge 51 of the lid 50, and an extended position (Figs. 26 and 27), in which the extendable handle 70 projects from the outer edge 51 of the lid 50. One of the radial ribs 64 has a notch 67 in which the grip member 71 is housed and retained when the extendable handle 70 is in the retracted position (Figs. 13 and 22).

[0057] The extendable handle 70 extends in a direction opposite to the hinge device 17, 60. When the lid is arranged in the ajar position (Figs. 26 and 27), there is sufficient clearance between the lid 50 and the frame 10 to allow the extendable handle 70 to be gripped and moved between said retracted and extended positions with complete safety. When the extendable handle 70 is in the extended position, it provides a lever arm on one side of the lid 50 opposite said hinge device 17, 60.

[0058] Given that the lid 50 has a center of mass M and the hinge device 17, 60 has a horizontal axis of rotation E, the extendable handle 70 is sized such that when it is in the extended position (Fig. 27), a distance X2 from the grip member 71 of the extendable handle 70 to said axis of rotation E is more than two times greater than a distance X1 from said center of mass M to the axis of rotation E. This means that the force F which must be applied to the grip member 71 of the extendable handle 70 to lift the lid 50, rotating it about the axis of rotation E, is more than two times less than the weight P of the lid 50. The extendable handle can also be used for handling the lid 50 when it is separated from the frame 10.

Claims

1. A manhole cover for an underground structure, of the type comprising a frame (10) and a lid (50), wherein said frame (10) is configured to be fixed to

- said manhole and comprises a passage opening (11) to provide access therethrough, and at least one seat (12) to bear said lid (50) covering said passage opening (11), **characterized in that** the passage opening (11) of the frame (10) has an inner edge (14) in the form of a first polygon having convex curved sides in which a first distance (D1) between two first parallel geometric lines (L1a, L1b) tangent to opposite points of said inner edge (14) is never less than a pre-established equivalent diameter sufficient to allow the passage of a person no matter what the direction of said two first parallel lines (L1a, L1b), and the lid (50) has an outer edge (51) in the form of a second polygon having convex curved sides geometrically similar to said first polygon having convex curved sides.
2. The manhole cover according to claim 1, **characterized in that** said first polygon having convex curved sides is a first non-circular curve of constant width, in which said first distance (D1) is constant no matter what the direction of said two first parallel lines (L1a, L1b), and said second polygon having convex curved sides has the form of a second non-circular curve of constant width, in which a second distance (D2) between two second parallel geometric lines (L2a, L2b) tangent to opposite points of said outer edge (51) is constant no matter what the direction of said two second parallel lines (L2a, L2b).
 3. The manhole cover according to claim 1 or 2, **characterized in that** said first and second polygons having convex curved sides are regular pentagons having convex curved sides.
 4. The manhole cover according to claim 3, **characterized in that** said regular pentagons having convex curved sides have rounded vertexes.
 5. The manhole cover according to any one of the preceding claims, **characterized in that** said second distance (D2) is greater than said first distance (D1) and said seat (12) of the frame (10) on which a perimetral region of the lid (50) is supported extends along a perimetral region outside the inner edge (14) of the passage opening (11).
 6. The manhole cover according to claim 5, **characterized in that** the lid (50) has an extendable handle (70) installed on an inner face thereof which can be moved between a retracted position in which said extendable handle (70) does not project from the outer edge (51) of the lid (50), and an extended position in which the extendable handle (70) projects from the outer edge (51) of the lid (50).
 7. The manhole cover according to claim 6, **characterized in that** the lid (50) is articulated to the frame (10) by a hinge device (17, 60) and when the extendable handle (70) is in said extended position, it provides a lever arm on one side of the lid (50) opposite said hinge device (17, 60).
 8. The manhole cover according to claim 7, **characterized in that** the lid (50) has a center of mass (M), the hinge device (17, 60) has an axis of rotation (E) and the extendable handle (70) comprises a grip member (71), and when the extendable handle (70) is in the extended position, a distance (P2) from said grip member (71) to said axis of rotation (E) is more than two times greater than a distance (P1) from said center of mass (M) to the axis of rotation (E).
 9. The manhole cover according to claim 8, **characterized in that** the grip member (71) of the extendable handle (70) is connected to a sliding arm (72) inserted such that it can slide in a corresponding hole (53) formed in a protrusion of said inner face of the lid (50), and a stop (73) in a free end of said sliding arm (72) prevents said free end from passing through said hole (53).
 10. The manhole cover according to claim 7, **characterized in that** the frame (10) comprises lower pressure closure members (16) and the lid (50) comprises corresponding upper pressure closure members (54), and the lid (50) can be placed in a closed position, in which said upper pressure closure members (54) of the lid (50) lock with said lower pressure closure members (16) of the frame (10) retaining the lid (50) in said closed position with respect to the frame (10), and in an ajar position, in which the upper pressure closure members (54) of the lid (50) are supported on the lower pressure closure members (16) of the frame (10) to keep the lid (50) in said ajar position with sufficient clearance with respect to the frame (10) to allow the extendable handle (70) to be gripped and moved between said retracted and extended positions.
 11. The manhole cover according to claim 7, **characterized in that** the frame (10) comprises lower pressure closure members (16) and the lid (50) comprises corresponding upper pressure closure members (54) locking with said lower pressure closure members (16) of the frame (10) retaining the lid (50) in a closed position with respect to the frame (10), where at least one of the lower pressure closure members (16) of the frame (10) and a corresponding one of said upper pressure closure members (54) of the lid (50) are adjacent to said hinge device (17, 60).
 12. The manhole cover according to any one of claims 1 to 4, **characterized in that** the frame (10) comprises box-shaped elements (15) located adjacent to and above the inner edge (14) of the passage

opening (11), and the lid (50) comprises protrusions (55) projecting radially from the outer edge (51) thereof, where said protrusions (55) of the lid (50) fit in said box-shaped elements (15) of the frame (10) when the lid (50) is in a closed position with respect to the frame (10). 5

13. The manhole cover according to any one of the preceding claims, **characterized in that** the frame (10) or the lid (50) has a recess (18, 56) configured to receive an end of a crowbar when the lid is in a closed position. 10

14. The manhole cover according to claim 13, **characterized in that** the lid (50) is articulated to the frame (10) by a hinge device (17, 60), and said recess (18, 56) is located on one side of the lid (50) opposite said hinge device (17, 60). 15

15. The manhole cover according to claim 12, **characterized in that** the lid (50) has three of said protrusions (55) distributed regularly around the outer edge (51), peripheral ribs (57) projecting from an inner face of said protrusions (55) and extending therealong parallel to the outer edge (51), inner ribs (58) projecting from an inner face of the lid (50) and connected at their ends forming a polygon centered with respect to the outer edge (51), and three pairs of intermediate ribs (59) projecting from said inner face of the lid (50), where the two intermediate ribs (59) of each pair are connected at one of their ends to said inner ribs (58) and at the other end to opposite ends of one of said peripheral ribs (57) of a corresponding protrusion (55). 20
25
30
35

40

45

50

55

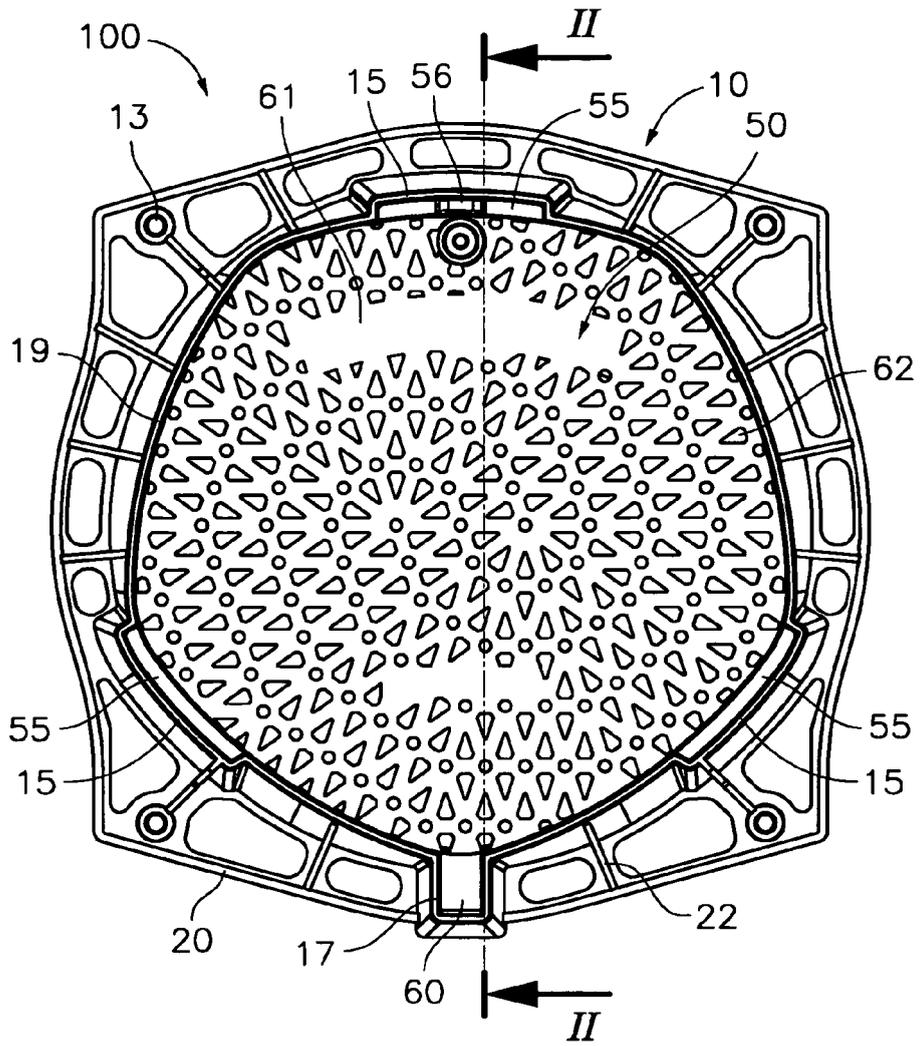


Fig. 1

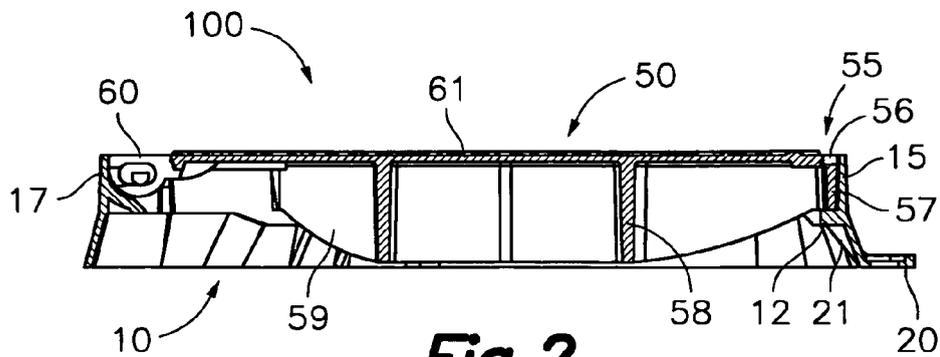


Fig. 2

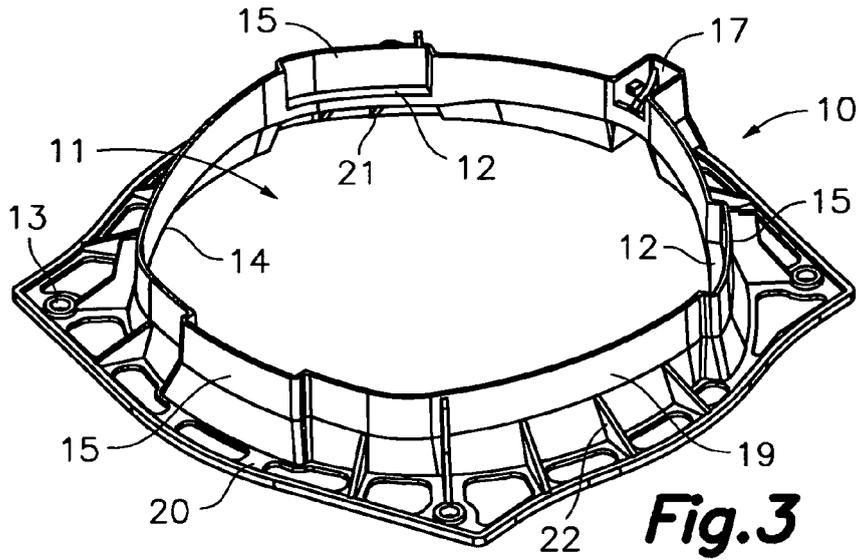


Fig. 3

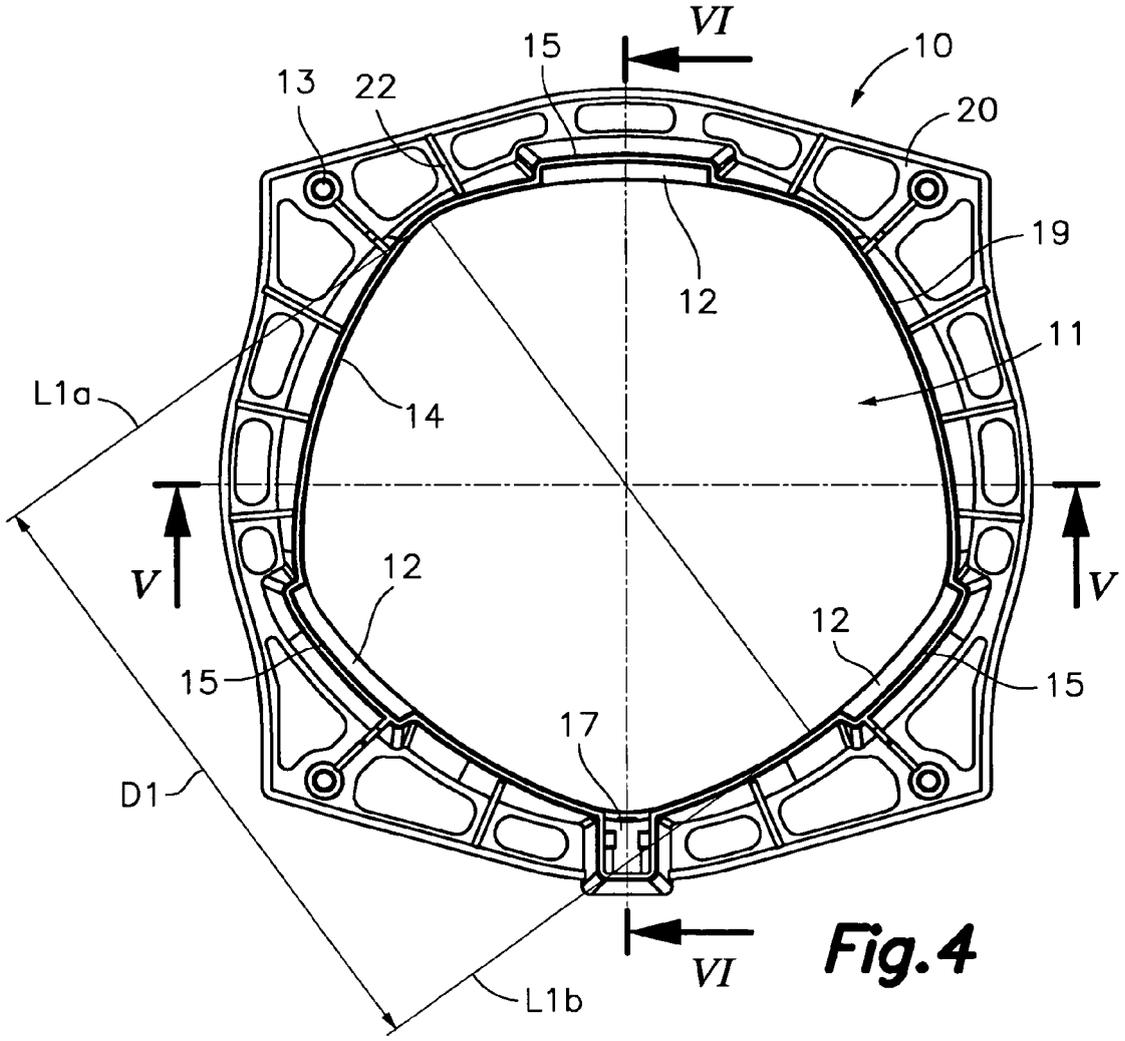


Fig. 4

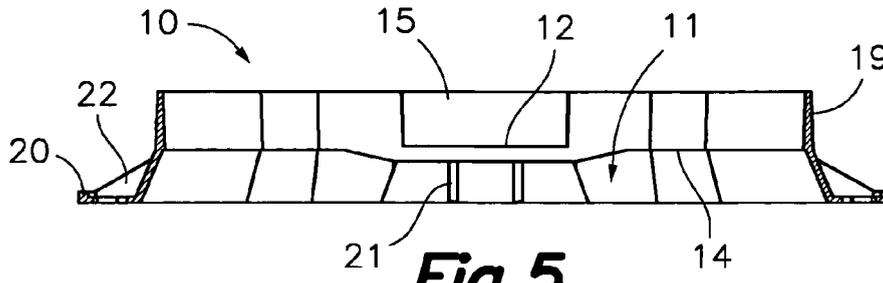


Fig. 5

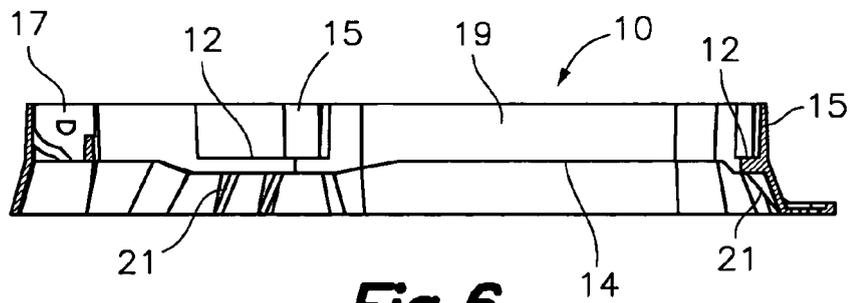


Fig. 6

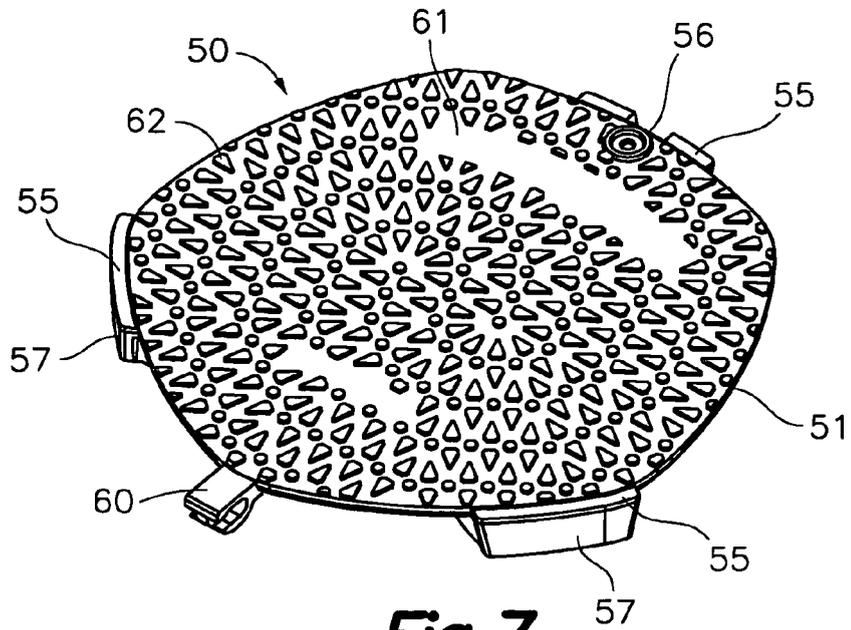
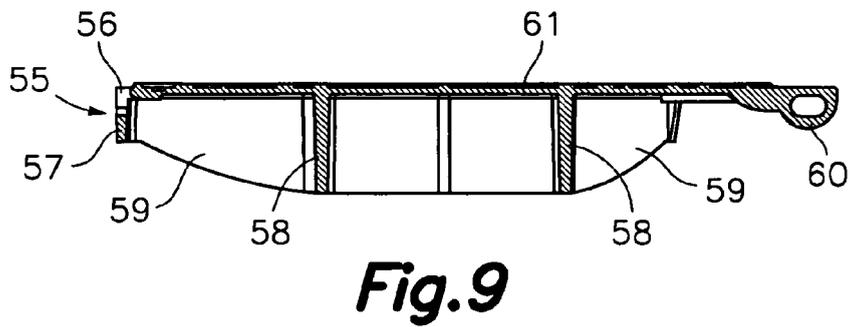
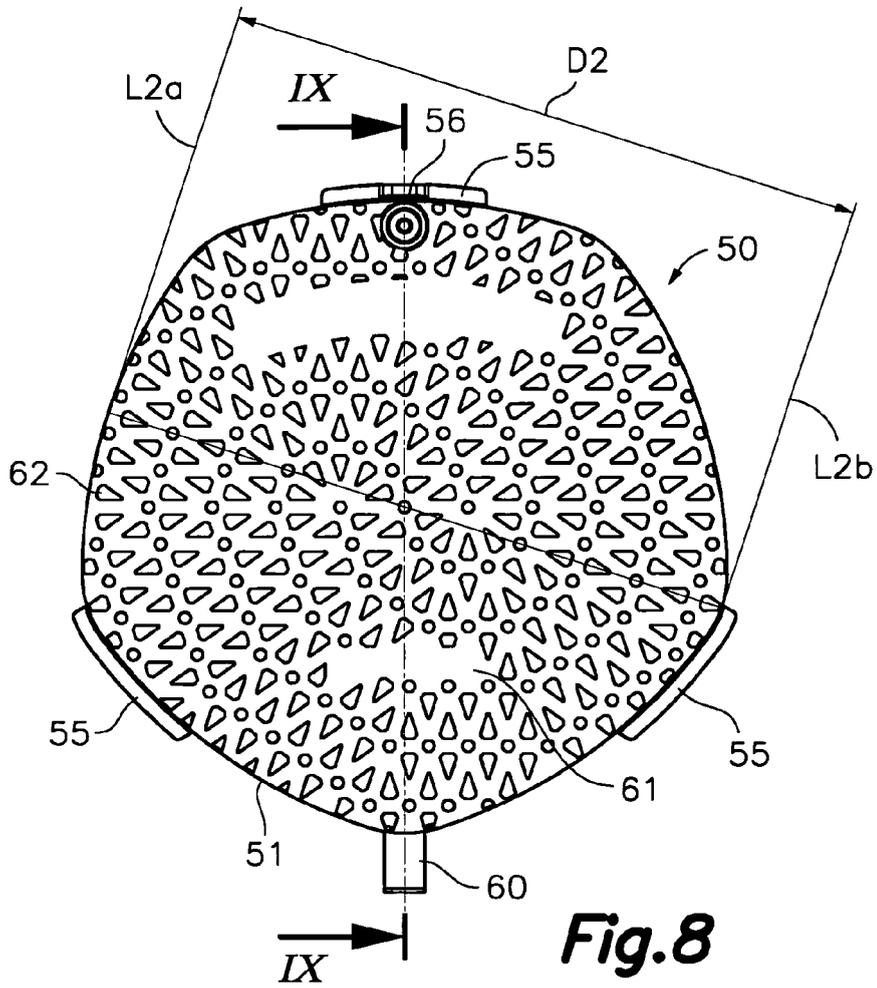


Fig. 7



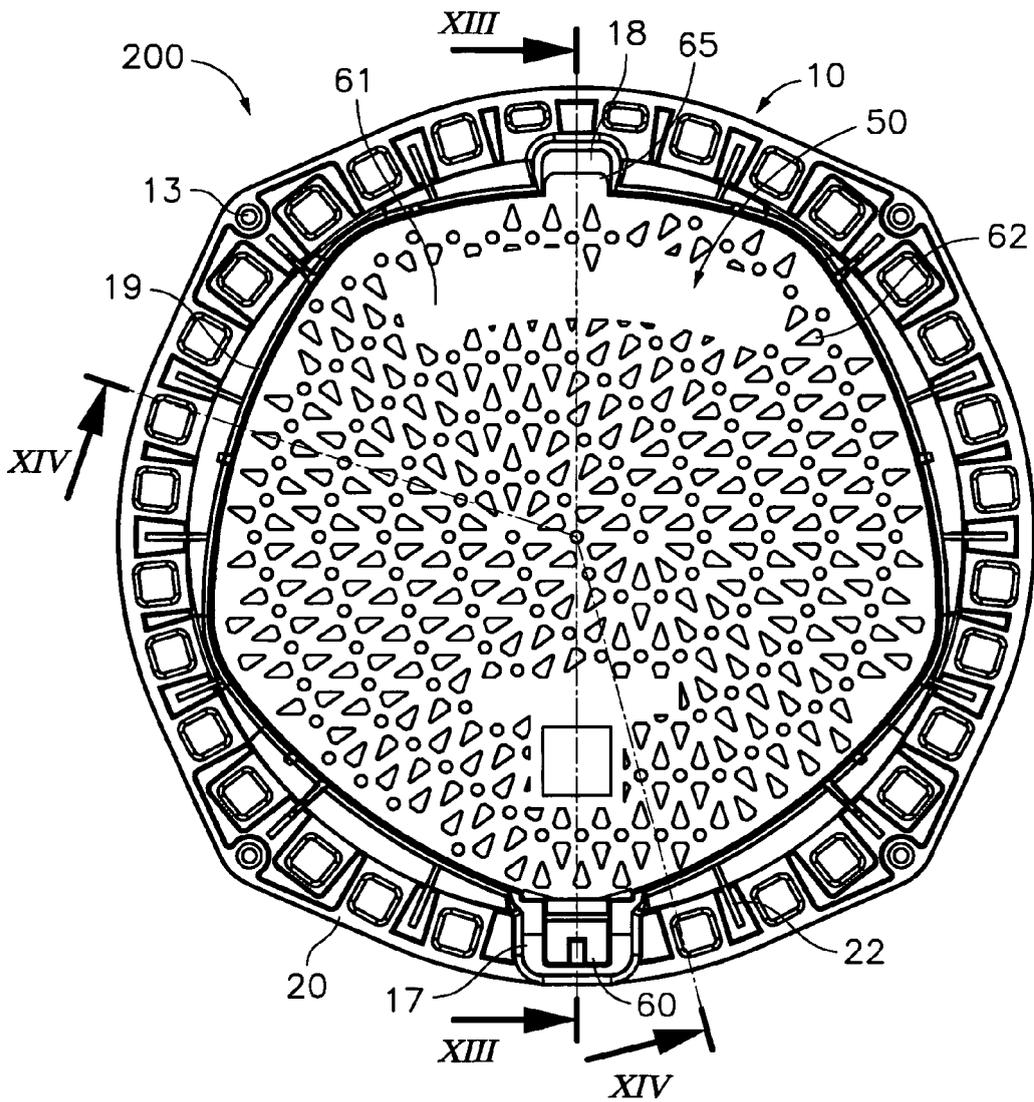


Fig. 12

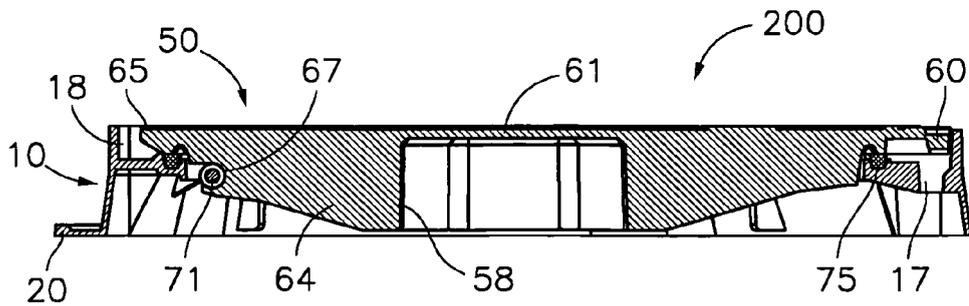
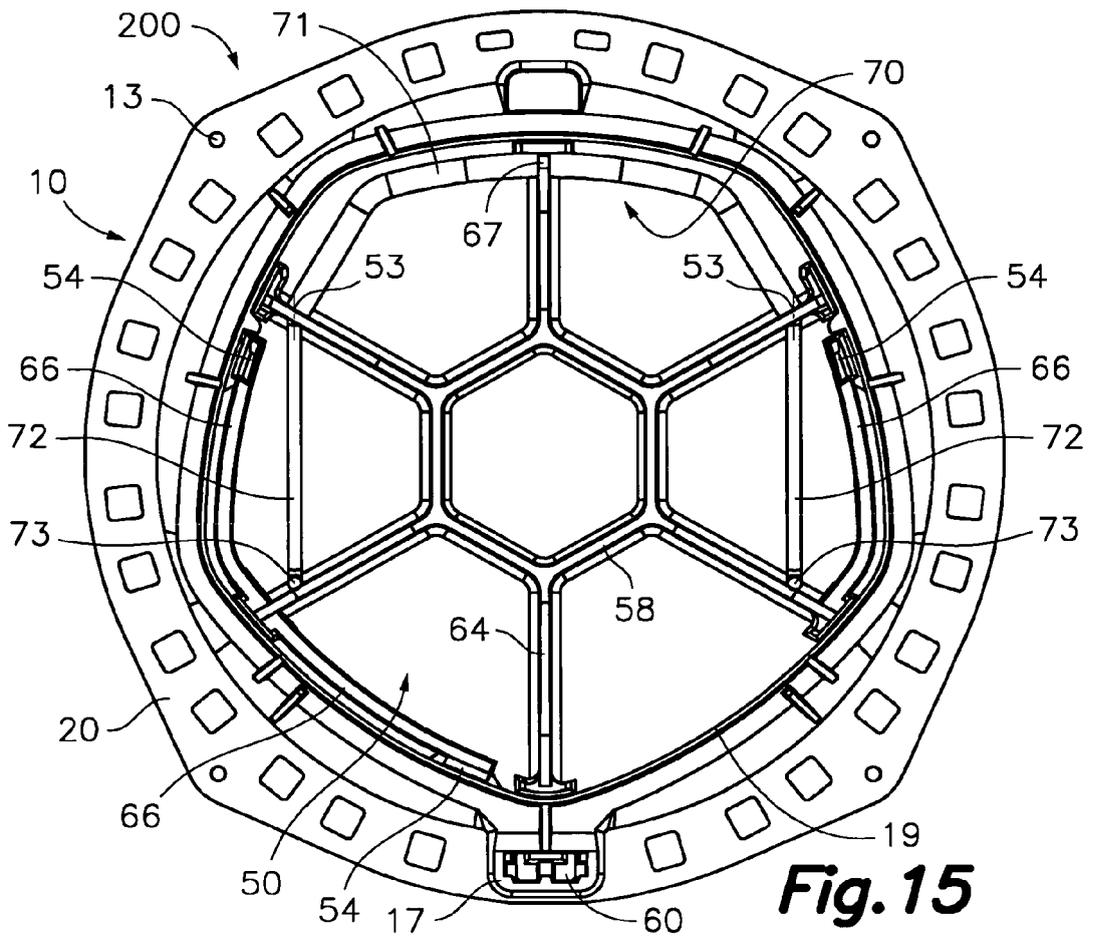
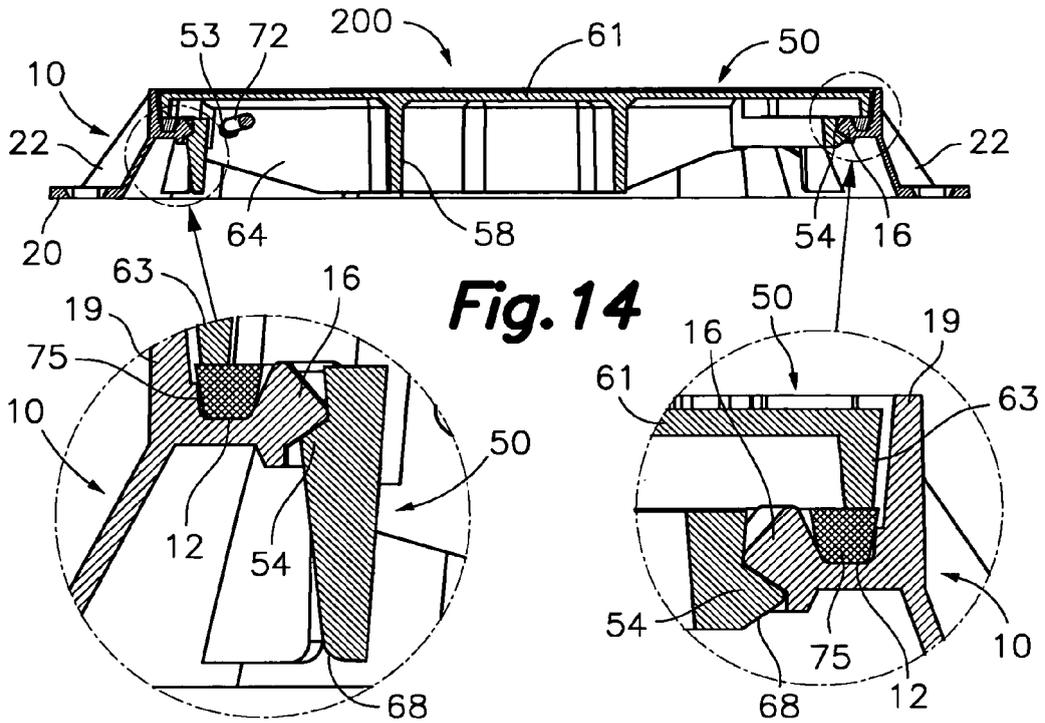


Fig. 13



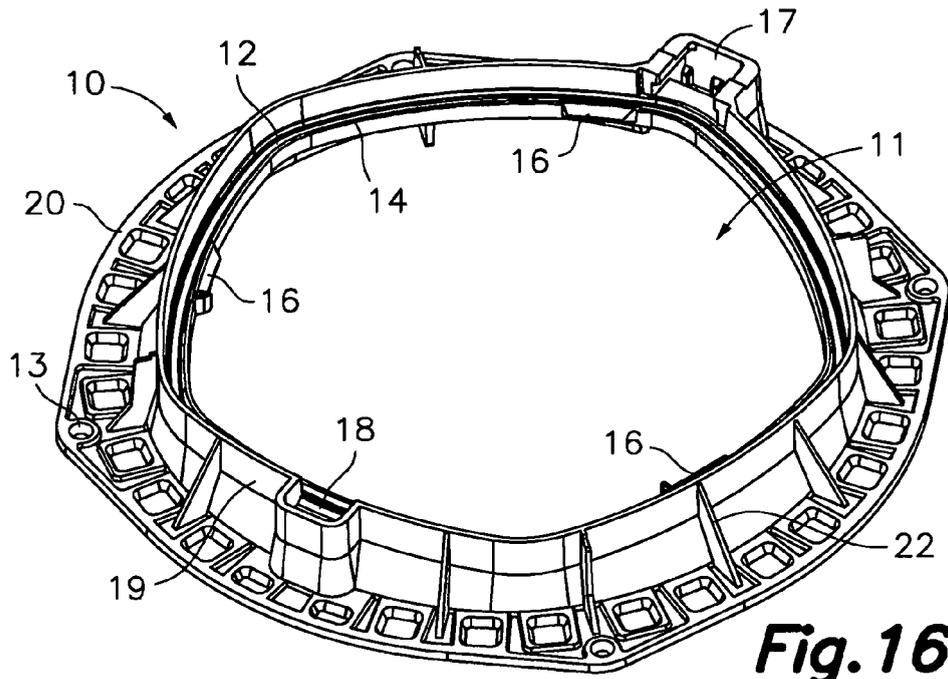


Fig. 16

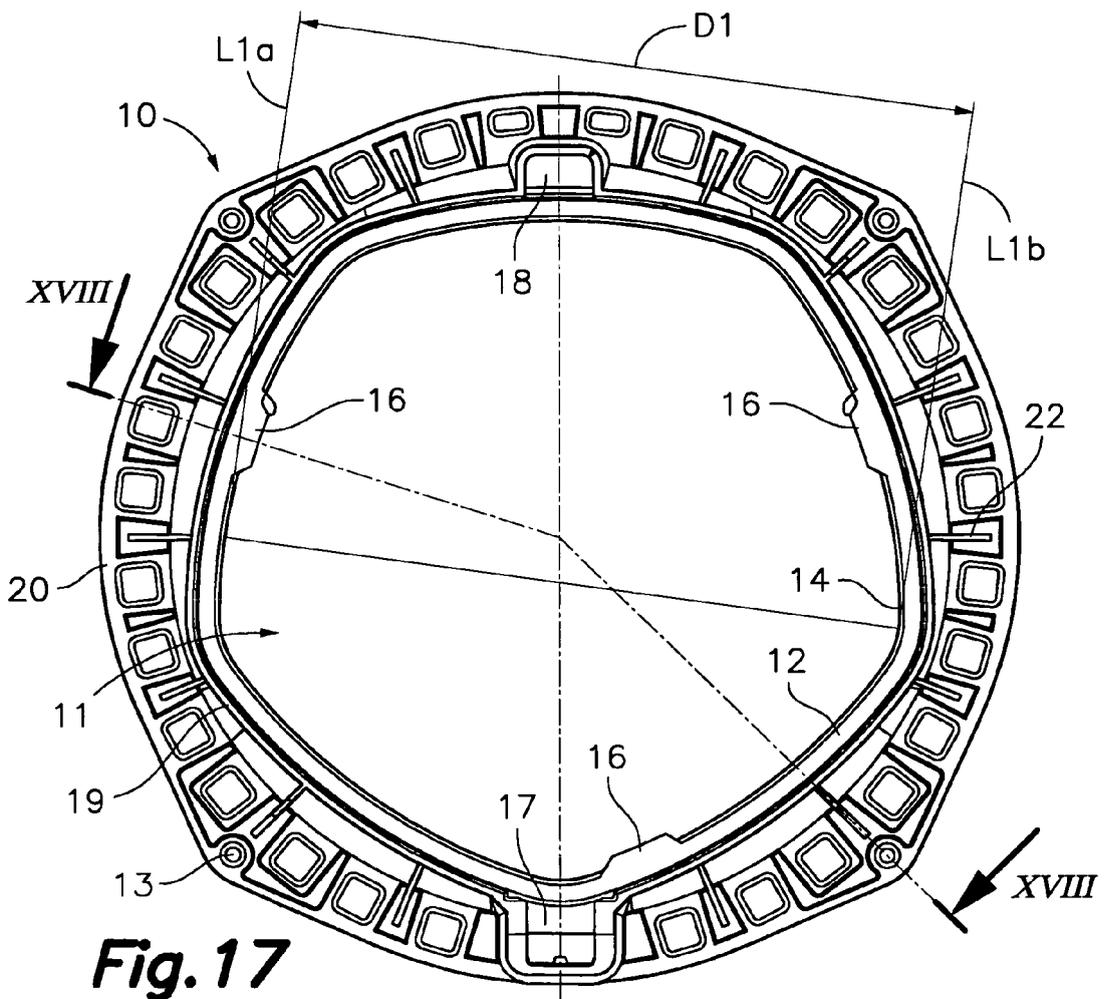


Fig. 17

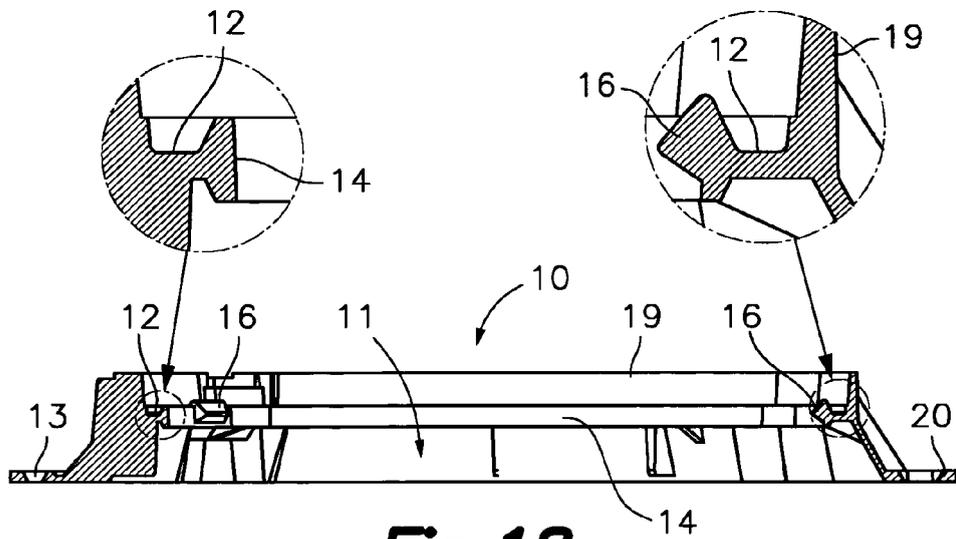


Fig. 18

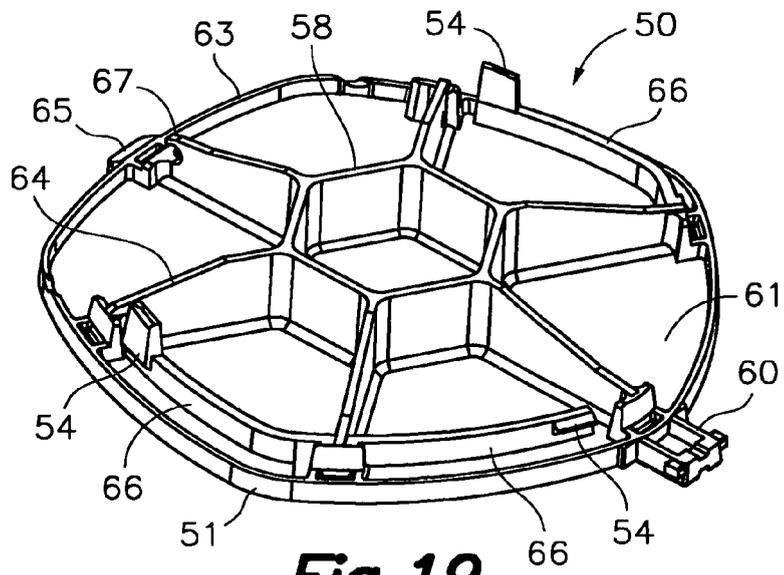


Fig. 19

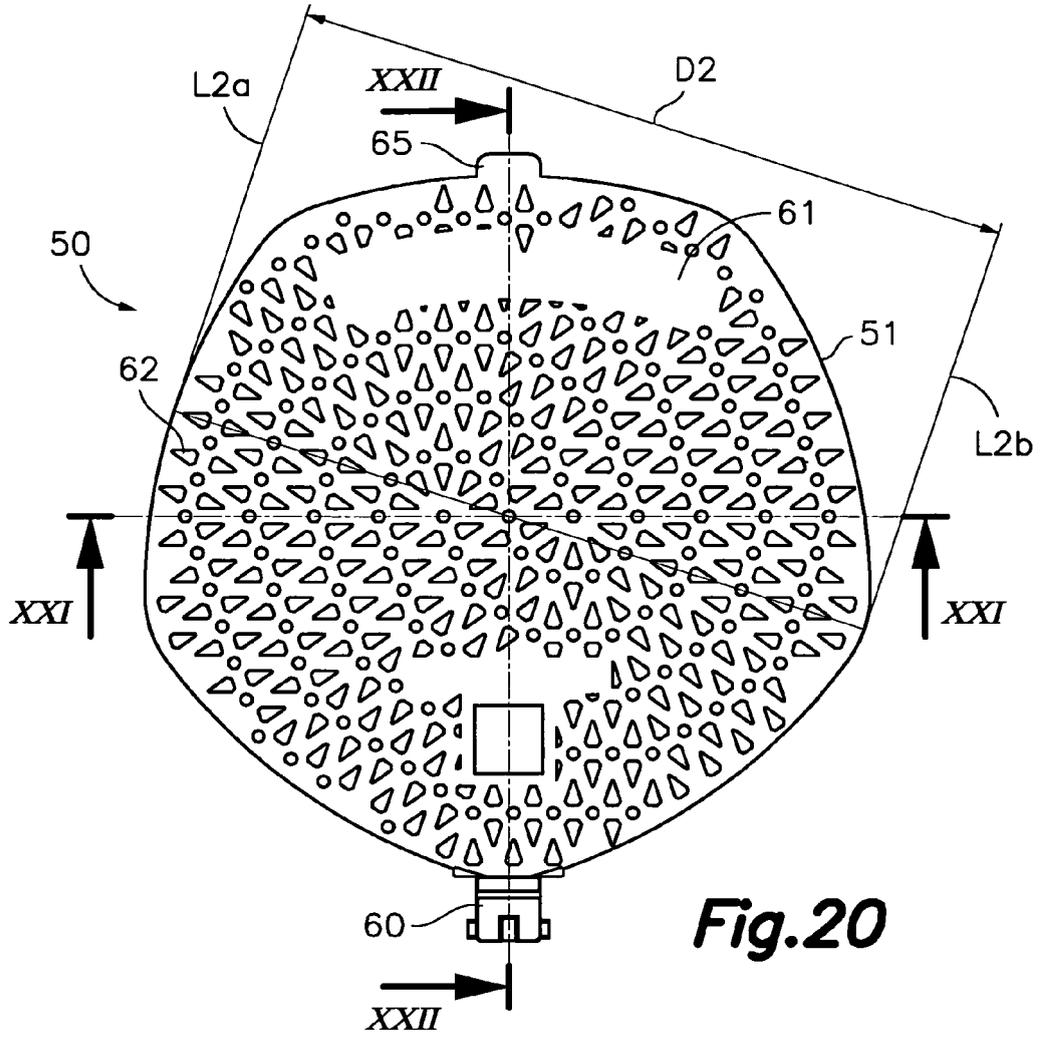


Fig.20

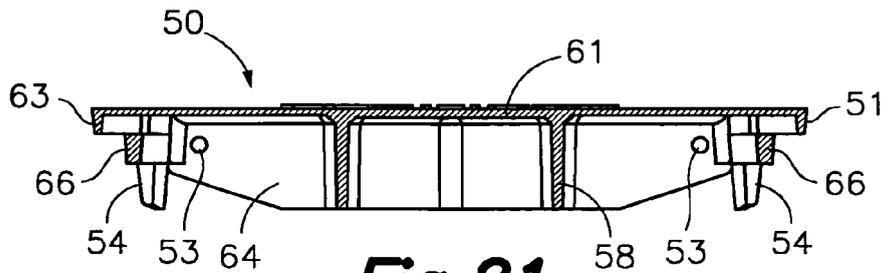


Fig.21

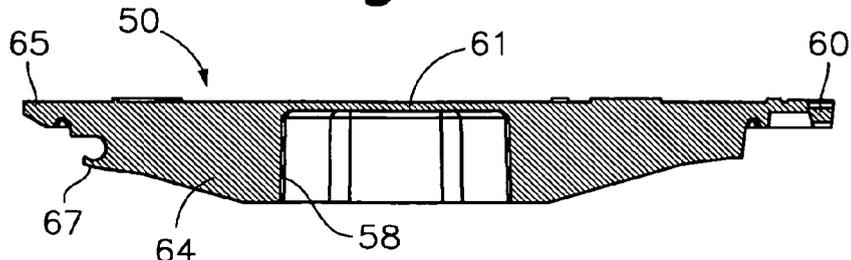


Fig.22

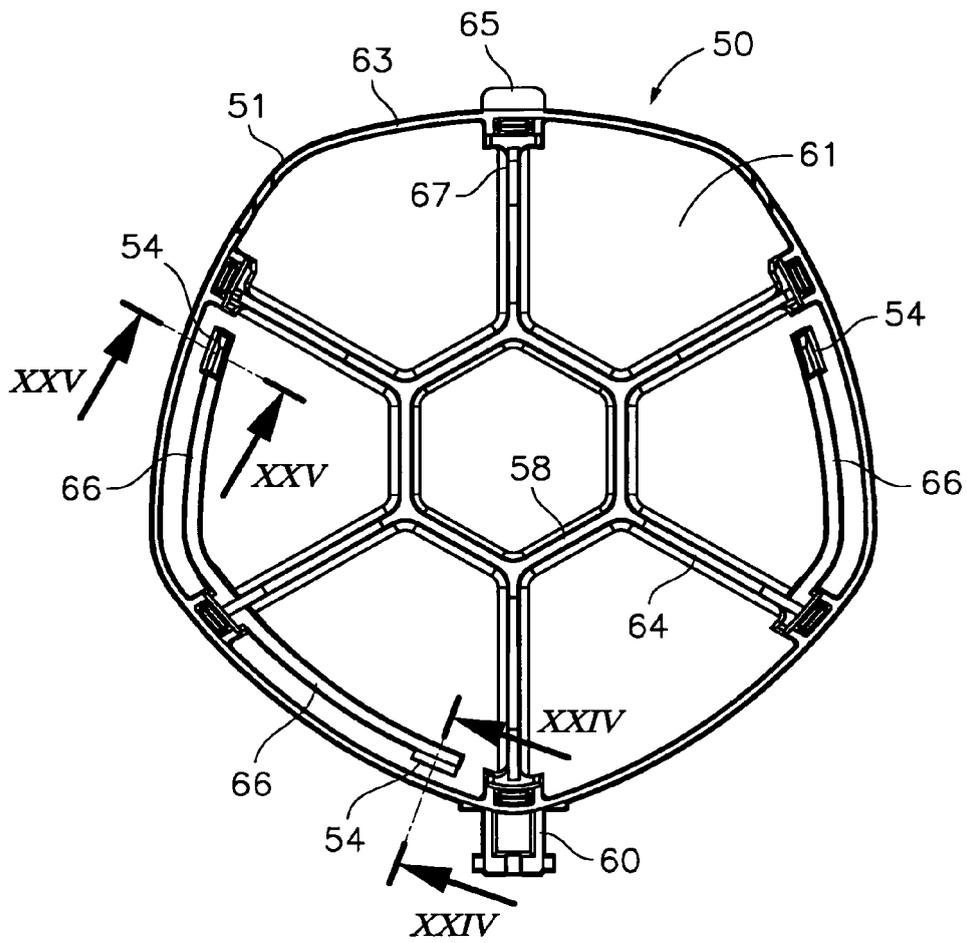


Fig.23

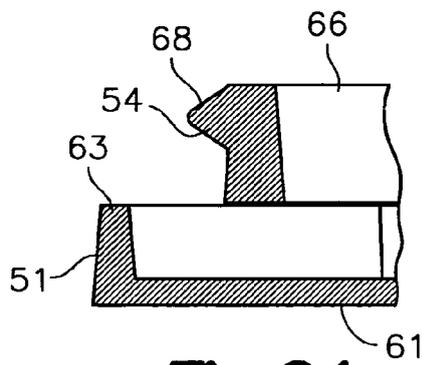


Fig.24

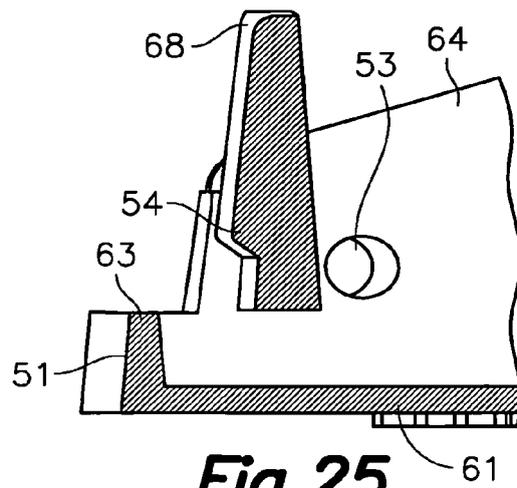


Fig.25



EUROPEAN SEARCH REPORT

Application Number
EP 11 38 0030

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 298 21 453 U1 (HEINRICH MEIER EISENGIESEREI G [DE]) 4 March 1999 (1999-03-04) * the whole document * -----	1-15	INV. E02D29/14
A	FR 2 844 296 A1 (LEFEUVRE SA [FR]) 12 March 2004 (2004-03-12) * the whole document * -----	1-15	
A	NL 7 114 782 A (EISENGIESSEREI MEIER) 2 May 1973 (1973-05-02) * the whole document * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 October 2011	Examiner Geiger, Harald
CATEGORY OF CITED DOCUMENTS		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	
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			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 38 0030

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-10-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 29821453	U1	04-03-1999	NONE
FR 2844296	A1	12-03-2004	NONE
NL 7114782	A	02-05-1973	NONE

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 4840514 A [0003]
- US 4650232 A [0005]
- US 5911537 A [0006]
- EP 1769125 A [0007] [0008]