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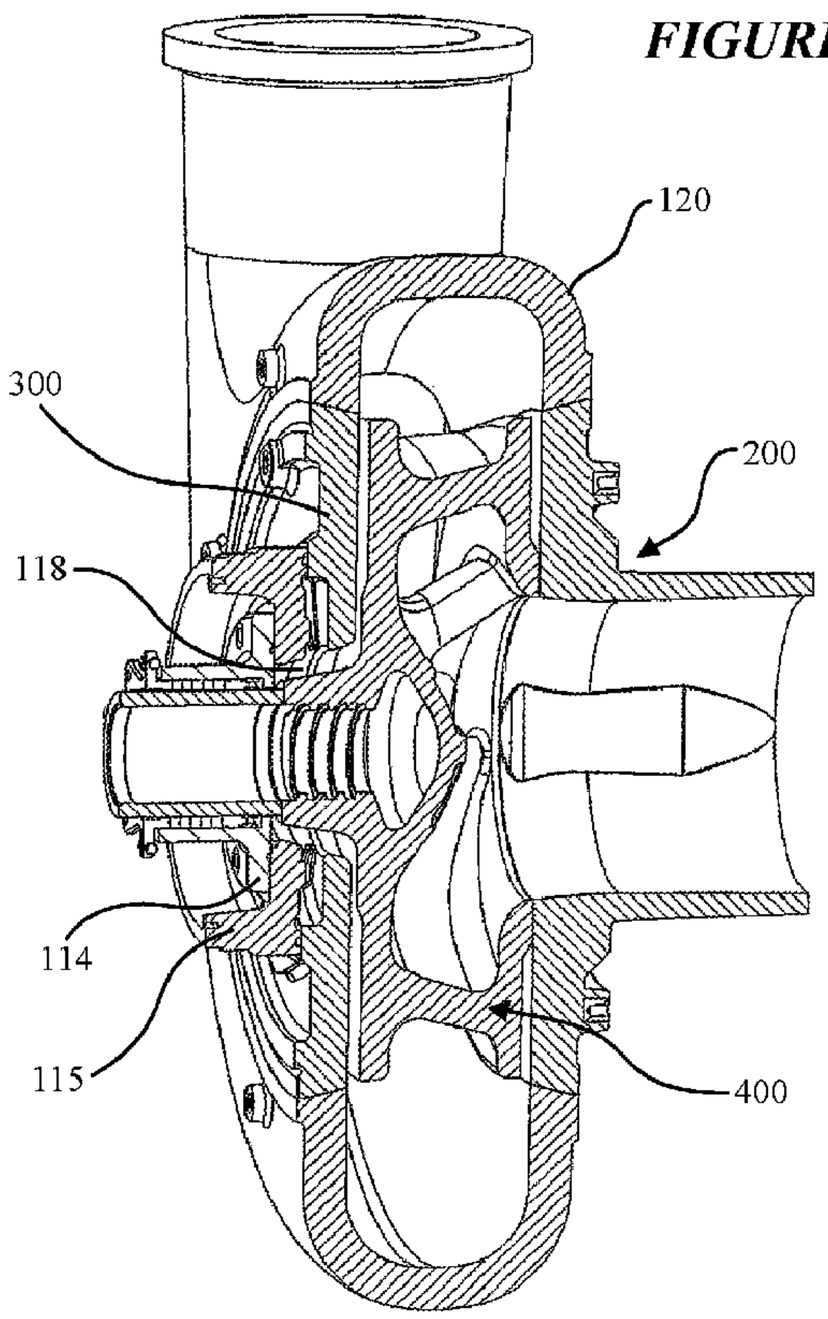

FIGURE 31

(57) Abrégé/Abstract:
A slurry pump comprising components which include a main pump liner (120), a front side liner, a back side liner and an impeller. The main pump liner comprises a continuous formation (156) projecting from an inner surface (152) of a discharge passageway

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(57) Abrégé(suite)/Abstract(continued):
(151) and a peripheral surface portion (145) of a pumping chamber (142) the formation (156) having a first end (157) within the discharge passageway (151) and spaced from an outlet port (154) and a second end (158) in the pumping chamber (142). The front side liner (200) includes a guide formation (220) on an inner surface (218) of an intake passageway (212), the guide formation (220) extending from an entry end (214) of the intake passageway (212) to an exit end (216) and including a leading end portion (222) at the entry end (214) of the passageway (212) and a trailing end portion (224) at the exit end (216), the guide formation (220) further including a guide surface (226) extending between the leading end portion (222) and the trailing end portion (224). The back liner comprises a plurality of vanes (330) on a rear face (308), the vanes (330) extending in a generally radial fashion and including an inner edge (313) and an outer edge (315), the inner edge (313) being adjacent the peripheral wall (312) of a passageway (310). The impeller has two raised formations or ribs (435, 436) on a nose or eye portion (430), one formation or rib (435) extending from the leading edge (420) of a pumping vane (410) in the region where the leading edge is adjacent a back shroud (402) over the nose or eye portion and through the apex (440) to a leading edge (422) of an oppositely disposed pumping vane (412) in the region where the edge is adjacent the back shroud (402).

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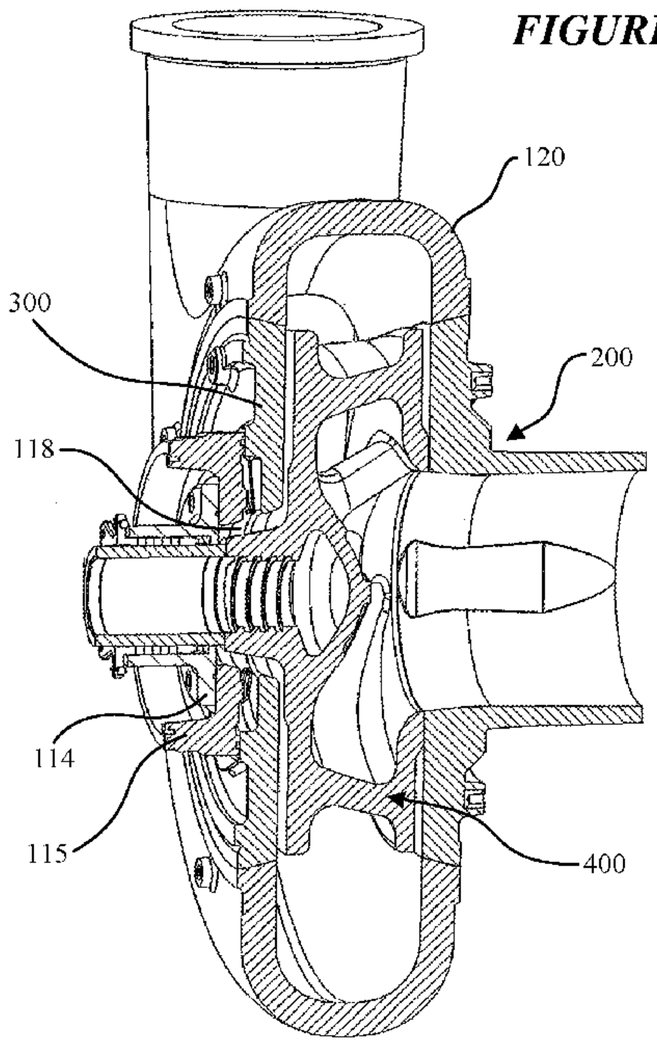

FIGURE 31

(57) Abstract: A slurry pump comprising components which include a main pump liner (120), a front side liner, a back side liner and an impeller. The main pump liner comprises a continuous formation (156) projecting from an inner surface (152) of a discharge passageway (151) and a peripheral surface portion (145) of a pumping chamber (142) the formation (156) having a first end (157) within the discharge passageway (151) and spaced from an outlet port (154) and a second end (158) in the pumping chamber (142). The front side liner (200) includes a guide formation (220) on an inner surface (218) of an intake passageway (212), the guide formation (220) extending from an entry end (214) of the intake passageway (212) to an exit end (216) and including a leading end portion (222) at the entry end (214) of the passageway (212) and a trailing end portion (224) at the exit end (216), the guide formation (220) further including a guide surface (226) extending between the leading end portion (222) and the trailing end portion (224). The back liner comprises a plurality of vanes (330) on a rear face (308), the vanes (330) extending in a generally radial fashion and including an inner edge (313) and an outer edge (315), the inner edge (313) being adjacent the peripheral wall (312) of a passageway (310). The impeller has two raised formations or ribs (435, 436) on a nose or eye portion (430), one formation or rib (435) extending from the leading edge (420) of a pumping vane (410) in the region where the leading edge is adjacent a back shroud (402) over the nose or eye portion and through the apex (440) to a leading edge (422) of an oppositely disposed pumping vane (412) in the region where the edge is adjacent the back shroud (402).

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SLURRY PUMP AND COMPONENTS THEREFOR

Technical Field

[0001] This disclosure relates generally to centrifugal slurry pumps and components or parts for use in such pumps. The components or parts of particular interest are pump impellers, and pump liners including main liners as well as side liners. Slurries are usually a mixture of liquid and particulate solids, and are commonly found in minerals processing, sand and gravel and/or dredging industry.

Background Art

[0002] In one typical form centrifugal slurry pumps generally comprise an outer housing which encases an inner liner. The liner may include a main liner (sometimes referred to as a volute) and two side liners. The liners are generally formed from hard metals or elastomers. The liner is configured with a pumping chamber therein. The main liner has openings on opposite sides thereof one of which provides an inlet to the pumping chamber. A discharge outlet is provided at the periphery of the main liner and may for example extend generally in a tangential direction. An impeller is mounted within the pumping chamber for rotation about an axis of rotation. A drive shaft is operatively connected to the impeller for causing rotation thereof. The drive shaft is disposed to one side of the outer housing and main liner. This is often referred to as the rear or back side of the pump. An inlet is disposed to the other side of the outer housing and liner. This is often referred to as the front side of the pump. The inlet is typically coaxial with the impeller rotation axis. The pump further includes a discharge outlet typically located at the periphery of the main liner and outer housing.

[0003] One of the side liners is at the front side of the pump and is often referred to as the front liner, front liner suction plate or throatbrush. The front liner provides for the pump inlet and may typically comprise a sidewall which extends laterally with respect to

the impeller rotation axis and an inlet conduit which extends from the side wall the inlet conduit being arranged generally co-axially with the impeller rotation axis. In particular applications where the pump is of the type referred to as a horizontal slurry pump the inlet conduit is disposed generally horizontally when in use.

[0004] The other of the side liners is at the rear or back side of the pump and is often referred to as the back side liner or frame plate liner insert. The back side liner comprises a generally circular disc-like body arranged such that when in use one side of thereof faces the impeller and the other side faces a seal assembly which may comprise a seal housing and seal chamber. The seal assembly may include a main seal which may be in the form of a stuffing box. The back side liner has a central passageway through which the drive shaft can pass.

[0005] The impeller typically includes a hub to which a drive shaft is operatively connected and at least one shroud. Pumping vanes are provided on one side of the shroud with discharge passageways between adjacent pumping vanes. In one form of impeller, two shrouds are provided with pumping vanes being disposed therebetween. The pumping vanes include a leading edge portion in the region of the inlet and a trailing edge portion in the region of the outer peripheral edge of the or each shroud. The impeller further includes an eye portion or nose which extends from one side of a shroud and is adjacent the pumping vanes leading edges and generally in the region of the impeller rotation axis. In one form, when assembled the hub is at least partially disposed within the central passageway of the back side liner.

[0006] Because of the abrasive nature of slurries the pump, and in particular the pump components such as the pump impeller and pump liner are subjected to extreme wear which leads to a significant reduction in the operational life of these components.

[0007] In operation slurry enters the impeller in the region of the centre or eye, and is then flung out to the periphery of the impeller and into the main pump liner. Because there is a pressure difference between the liner and the eye, there is a tendency for the

slurry to try and migrate into gaps which are between the side-liners and the impeller, resulting in high wear on the side-liners.

[0008] In order to reduce the driving pressure on the slurry in the gaps, as well as create a centrifugal field to expel particles, slurry pumps often have auxiliary or expelling vanes on the front shroud of the impeller. Auxiliary or expelling vanes may also be provided on the back shroud. The expelling vanes rotate the slurry in the gaps creating a centrifugal field and thus reducing the driving pressure for the returning flow, reducing the flow velocity and thus the wear on the side-liner. The purpose of these auxiliary vanes is to reduce flow re-circulation through the gap. These auxiliary vanes also reduce the influx of relatively large solid particles in these gaps. Much of the wear on the side-liners is a result of the flow generated by the rotating auxiliary vanes. In particular, there is wear from the tip or outer edge of the auxiliary vanes due to the creation of fluid vortices and entrained particles.

[0009] The rotating impeller causes slurry in the gaps between the impeller shroud and the side liners to rotate thereby creating vortices. The slurry in these gaps tend to rotate more slowly then the impeller. At the rear or back side of the pump the rotating slurry is rotating as it enters the seal chamber. This can cause wear on the seal which as mentioned earlier may be in the form of a stuffing box. Furthermore, the pressure in the seal chamber can become unstable.

[0010] The main liner is subjected to wear as a result of the turbulence in the pumping chamber which causes a rough flow pattern as the slurry passes through the main liner.

[0011] In horizontal slurry pumps larger and denser particulates or solids entering the inlet conduit of the front side liner tend to gravitate towards a lower region of the conduit. This can cause problems for the impeller as a result of greater concentration of solids or particulates because of the velocity and flow patterns generated.

Summary of the Disclosure

[0012] In a first aspect embodiments are disclosed of a centrifugal pump impeller for use in a slurry pump which comprises a front shroud and a back shroud, the front and back shrouds each having an inner face and respectively the inner faces facing one another, the front and back shrouds and also having respective back faces and, the front shroud has an inlet opening through which slurry is delivered to an interior region of the impeller, the impeller is mounted for rotation about rotation axis, the impeller further comprises a plurality of pumping vanes within the interior region the pumping vanes extending between the inner faces and of the front and back shrouds and, each of the pumping vanes having a leading edge in the region of the rotation axis, the vanes also have trailing edges which are disposed outwardly from the leading edges, the pumping vanes being spaced apart from another so as to provide passageways between adjacent pumping vanes, the impeller further including a hub extending from the outer face of the back shroud, the hub being coaxial with axis and adapted to be connected to a drive shaft, and a nose or eye portion having a generally dome shaped profile with an apex in the region of the axis, characterised in that the impeller further includes two raised formations or ribs on the nose or eye portion, one formation or rib extending from the leading edge of pumping vane in the region where the leading edge is adjacent the back shroud over the nose or eye portion and through the apex to the leading edge of oppositely disposed pumping vane in the region where the edge is adjacent the back shroud, and the other formation or rib extending from the leading edge of pumping vane in the region where the leading edge is adjacent the back shroud over the nose or eye portion and through the apex to the leading edge of pumping vane in the region where the leading edge is adjacent the back shroud.

[0013] In certain embodiments the formations or ribs and cross in the region of the apex at approximately right angles with respect to one another. So as to provide for four auxiliary passageways or zones each passageway or zone being disposed between respective adjacent formations or ribs.

[0014] In a second aspect embodiments are disclosed of a main pump liner for use

in a slurry pump comprising: a main body which includes a pump chamber section having opposed sides each having an opening therein with a major axis extending between the sides; the pump chamber section having a pumping chamber therein, the pumping chamber having an inner surface which includes a curved peripheral surface portion and side surface portions one on either side of the peripheral surface portion and extending from the peripheral surface portion to a respective one of the openings; the main body further including a discharge outlet section having a discharge passageway therein with an inner surface which is in fluid communication with the pumping chamber, the discharge passageway being of a generally linear configuration with a linear axis which extends generally tangentially from the pumping chamber and terminates at a discharge outlet port characterised in that the pump liner comprises a continuous formation projecting from the inner surface of the discharge passageway and the peripheral surface portion of the pumping chamber the formation having a first end within the discharge passageway and spaced from the outlet port and a second end in the pumping chamber which terminates before a lateral axis so as to be spaced therefrom, the lateral axis extending through the major axis and being parallel to the linear axis.

[0015] In certain embodiments the formation when viewed in cross-section comprises a segment of the curved peripheral surface of the pumping chamber and the inner surface of the discharge passageway.

[0016] In certain embodiments that the cross-sectional area of the segment is up to 10% of the cross-sectional area of the discharge passageway.

[0017] In certain embodiments the cross-sectional area of the segment is about 1.5% of the cross-sectional area of the discharge passageway.

[0018] In certain embodiments the formation is cast with the side liner.

[0019] In certain embodiments the formation is disposed in a plane which is at right angles to the major axis and centrally positioned with respect to the inner surface of the pumping chamber and discharge passageway.

[0020] In a third aspect embodiments are disclosed of a front side liner for use in a slurry pump comprising a main body having an inner side and an outer side, the side liner further comprising an intake section which extends outwardly away from outer side of the main body, the intake section including an intake passageway extending through the intake section having an entry end and an exit end, the intake passageway having an inner surface which is generally circular in cross-section, characterised in that the side liner further includes a guide formation on the inner surface of the intake passageway, the guide formation extending from the entry end of the intake passageway to the exit end and including a leading end portion at the entry end of passageway and a trailing end portion at the exit end, the guide formation further including a guide surface extending between the leading end portion and the trailing end portion.

[0021] In certain embodiments when the side liner is in use the central axis (P-P) is generally horizontally disposed and the guide formation is on a lowermost region of the inner surface of the intake passageway.

[0022] In certain embodiments the side liner further includes one or more first guides on a first portion of the inner surface of the passageway for directing fluid passing through the intake passageway so that in use said fluid leaves the exit end at the first portion with a first exit angle which is inclined relative to the central axis (P-P), and a second portion of the inner surface of the intake passageway which includes one or more second guides thereon for directing fluid passing through the intake passageway so that in use said fluid leaves the exit end at the second portion with a second exit angle which is inclined relative to the central axis, the second exit angle being greater than the first exit angle the formation being disposed between adjacent guides in the second portion. In use, when the central axis (P-P) is horizontally disposed, the second guides are below the central axis (P-P) with the formation being in a lowermost region between adjacent second guides.

[0023] In certain embodiments the guide formation, when viewed in cross-section

comprises a segment of the curved inner surface of the intake passageway, the guide surface when viewed in cross-section comprises the chord of the segment, the plane of the guide surface being substantially parallel with a central axis of the passageway which extends between the ends thereof.

[0024] In certain embodiments the leading end portion of the guide formation has an inclined or ramped surface which extends from the inner surface of the passageway to the guide surface of the guide formation and the trailing end portion has an inclined or ramped surface which extends from the guide surface to the inner surface of the passageway, the angle of inclination of inclined surface is less than the angle of inclination of inclined surface.

[0025] In a fourth aspect embodiments are disclosed of a back side liner for use in a slurry pump which comprises a main body which includes a generally annular disc shaped wall having a front face and a rear face with a passageway extending through the main body from the front face to the rear face of the wall in the direction of primary axis the passageway having a peripheral wall characterised in that the side liner further comprises a plurality of vanes on the rear face, the vanes extending in a generally radial fashion with respect to the primary axis and including an inner edge and an outer edge, the inner edge being adjacent the peripheral wall of the passageway.

[0026] In certain embodiments the rear face has a recess therein, the recess being stepped inwardly towards the front face, the recess having a recessed surface which is disposed around passageway and includes an outer peripheral wall, the plurality of vanes been disposed within the recess, and extending in a radial fashion from the outer peripheral wall towards the passageway. In certain embodiments the recess wherein an outer peripheral wall which is of a wave like configuration comprising alternating crests and valleys, a plurality of vanes being disposed within the recess, the vanes extending in a radial fashion from the outer peripheral wall towards the passageway terminating at the periphery of the passageway, the vanes being arranged in spaced apart fashion around the passageway.

[0027] In certain embodiments the vanes comprise a first group and a second group, the first group being longer than the second group, the first group extending from the crests and second group extending from the valleys. In certain embodiments the vanes include an upper surface which tapers inwardly towards the inner edge thereof.

[0028] In a fifth aspect embodiments are disclosed of a combination of a pump impeller and front side liner both of which are in the form of the embodiments described above in the summary of the disclosure.

[0029] In a sixth aspect embodiments are disclosed of an assembly for a slurry pump assembly comprising a main liner, a front liner, a back liner and an impeller each of which is in the form of the embodiments described above in the summary of the disclosure.

[0030] Other aspects, features, and advantages will become apparent from the following detailed description when taken in conjunction with the accompanying drawings, which are a part of this disclosure and which illustrate, by way of example, principles of inventions disclosed.

Brief Description of the Drawings

[0031] Notwithstanding any other forms which may fall within the scope of the method and apparatus as set forth in the Summary, specific embodiments of the method and apparatus will now be described, by way of example, and with reference to the accompanying drawings in which:

[0032] Figures 1 and 2 are schematic partial cross-sectional side elevations of typical pumps;

[0033] Figures 3 and 4 are isometric views of a main liner;

[0034] Figures 5 and 6 are sectional views of a main liner, according to one

embodiment of the present disclosure with one view showing a part thereof in dashed line;

[0035] Figure 7 is a sectional view of the main liner shown in figure 5 taken along the line A-A;

[0036] Figure 8 is a further sectional view of the main liner shown in figures 5 and 6;

[0037] Figure 9 is an isometric view of a front side liner according to one embodiment;

[0038] Figure 10 is a sectional view of the front side liner shown in figure 9;

[0039] Figures 11 and 12 are end elevations of the side liners shown in figures 9 and 10 viewed from opposite sides;

[0040] Figures 13 and 14 are isometric views of the side liners shown in figures 9 to 12 viewed from opposite sides;

[0041] Figure 15 is an enlarged view of part of front side liner;

[0042] Figures 16 to 20 are various views of a front side liner according to another embodiment;

[0043] Figure 21 is an isometric view of a rear side liner according to one embodiment;

[0044] Figure 22 is an end elevation of the rear side liner shown in figure 21;

[0045] Figure 23 is a sectional view of the rear side liner shown in figures 21 and 22;

[0046] Figure 24 is an isometric view of an impeller according to one embodiment;

[0047] Figure 25 is an end elevation of the impeller shown in figure 24;

[0048] Figure 26 is a sectional view of the impeller shown in figures 24 and 25;

[0049] Figure 27 is an exploded partial sectional isometric view of the impeller shown in figures 24 to 26 and the front side liner shown in figures 9 to 14;

[0050] Figure 28 is an end elevation of an assembly comprising the liners shown in figures 6 to 23 and the impeller shown in figures 24 to 26;

[0051] Figures 29 and 30 are views partially in section of an assembly; and

[0052] Figures 31 and 32 are sectional side views of the assembly shown in figures 28 to 31 together with a typical seal.

Detailed Description of Specific Embodiments

[0053] Referring to Figures 1 and 2 of the drawings, there is generally illustrated slurry pump apparatus 100 comprising a pump 10 and pump housing support in the form of a pedestal or base 112 (only partially shown) to which the pump 10 is mounted. Pedestals are also referred to in the pump industry as frames. The pump 10 generally comprises an outer casing 22 that is formed from two side casing parts or sections 23, 24 (sometimes also known as the frame plate and the cover plate) which are joined together about the periphery of the two side casings sections 23, 24. The pump 10 is formed with side openings one of which is an inlet hole 28 there further being a discharge outlet hole 29. The arrangement is such that when in use in a process plant, the pump is connected by piping to the inlet hole 28 and to the outlet hole 29, to facilitate for example pumping of a mineral slurry.

[0054] The pump 10 further comprises a pump inner liner 11 arranged within the outer casing 22 and which includes a main liner 12 and two side liners 14, 30. The side liner (or back liner) 14 is located nearer the rear side of the pump 10 (that is, nearest to the pedestal or base 112), and the other side liner (or front liner) 30 is located nearer the front side of the pump.

[0055] As shown in Figures 1 and 2 the two side casing parts 23, 24 of the outer casing 22 are joined together by bolts 27 located about the periphery of the casing parts 23, 24 when the pump is assembled for use. In some embodiments the main liner 12 can also be comprised of two separate parts which are disposed within the side casing parts 23, 24 and brought together to form a single main liner, although in the example shown in figure 1 the main liner 12 is made in one-piece, shaped similar to a car tyre. The liner 11 may be made of materials such as rubber, elastomer or of metal.

[0056] When the pump is assembled, the side openings in the main liner 12 are filled by or receive the two side liners 14, 30 to form a continuously-lined pumping chamber 42 disposed within the pump outer casing 22. A seal comprising a seal chamber housing 114 and cover plate 115 encloses the side liner (or back liner) 14 and is arranged to seal the space or seal chamber 118 between drive shaft 116 and the pedestal or base 112 to prevent leakage from the back area of the outer casing 22. The seal chamber housing takes the form of a circular disc section and an annular section with a central bore, and is known in one arrangement as a stuffing box 117. The stuffing box 117 is arranged adjacent to the side liner 14 and extends between the pedestal 112 and a shaft sleeve and packing that surrounds the shaft 116.

[0057] As shown in figures 1 and 2 an impeller 40 is positioned within the main liner 12 and is mounted or operatively connected to the drive shaft 116 which is adapted to rotate about a rotation axis X-X. A motor drive (not shown) is normally attached by pulleys to an exposed end of the shaft 116, in the region behind the pedestal or base 112. The rotation of the impeller 40 causes the fluid (or solid-liquid mixture) being pumped to pass from a pipe which is connected to the inlet hole through the pumping chamber 42 which is within the main liner 12 and the side liners 14, 30 and then out of the pump via the discharge outlet hole.

[0058] As shown, the front liner 30 (or throatbrush) includes a cylindrically-shaped delivery section 32 through which slurry enters the pumping chamber 42 when the pump is

in use. The delivery section 32 has a passage 33 therein with a first, outermost end 34 operatively connectable to a feed pipe (not shown) and a second, innermost end 35 adjacent the chamber 42. The front liner 30 further includes a side wall section 15 which mates in use with main liner 12 to form and enclose the chamber 42, the side wall section 15 having an inner face. In the embodiment of figure 1 the second end 35 of the front liner 30 has a raised lip 38 thereat, which is arranged in a close facing relationship with the impeller 40 when in an assembled position. The back liner 14 comprises a disc-like body having an outer edge which mates with the main liner and an inner face.

[0059] The impeller 40 includes a hub 41 from which a plurality of circumferentially spaced pumping vanes 43 extend. An eye portion 47 extends forwardly from the hub 41 towards the passage 33 in the front liner 30. The impeller 40 further includes a front shroud 50 and a back shroud 51, the vanes being disposed and extending therebetween and an impeller inlet 48. The hub 41 extends from the back liner 14. In figure 2 the shrouds are arranged in planes which are generally at right angles to the rotation axis. In figure 1 the front shroud is inclined with respect to the axis.

[0060] The front and back shrouds include an inner face, an outer face and a peripheral edge portion. The front shroud includes an inlet, and the vanes 43 extend between the inner faces of the shrouds. The shrouds are generally circular or disc-shaped when viewed in elevation; that is in the direction of rotation axis X-X (figure 1).

[0061] As illustrated in figure 2, each shroud has a plurality of auxiliary or expelling vanes on the outer faces thereof, there being a first group of auxiliary vanes 60 on the outer face of the front shroud and a second group of auxiliary vanes 61 on the outer face of the back shroud. In the embodiment of figure 1 there are auxiliary vanes on the front shroud only.

[0062] With reference to Figures 3 to 8 there is illustrated a main slurry pump liner 120 which comprises a main body 122 which includes a pump chamber section 124 having opposed sides 137, 138 (figure 8) each having an opening 139, 140 therein (figure 8) with

a major axis Q-Q extending between the sides (figures 5 and 6). The pump chamber section 124 has a pumping chamber 142 therein with an inner surface 144 which includes a peripheral surface portion 145 and side surface portions 146, 147 one on either side of the peripheral surface portion and extending from the peripheral surface portion to a respective one of the openings. The main body 122 further includes a discharge outlet section 150 having a discharge passageway 151 with an inner surface 152 which is in fluid communication with the pumping chamber. The discharge passageway is of a generally linear configuration with a linear axis Y-Y which extends generally tangentially from the pumping chamber 142 and terminates at a discharge outlet port 154.

[0063] The liner is provided with a continuous formation 156 on or projecting from the inner surface 152 of the discharge passageway 151 and the peripheral surface portion 145 of the pumping chamber 142. As best seen in figure 5 the formation 156 has a first or trailing end 157 within the discharge passageway 151 and spaced from the outlet port 154 and a second or leading end 158 in the pumping chamber 142 which terminates before a lateral axis Z-Z so as to be spaced therefrom. The lateral axis Z-Z extends through the major axis Q-Q and is parallel to the linear axis Y-Y.

[0064] As illustrated the formation 156 is disposed in the region of an outermost part of the peripheral surface portion 145 of pumping chamber inner surface 144 and inner surface 152 of the discharge passageway 151. As shown, that part of the formation 156 in the discharge passageway is generally straight or linear and that part in the pumping chamber is generally curved or arcuate.

[0065] As best shown in figure 8 the formation 156 when viewed in cross-section comprises a segment 160 of the inner surfaces 144 and 152 of pumping chamber and discharge passageway. The chord 162 of the segment 160 forms an outer surface 159 of the formation 156. The outer surface 159 is generally flat or planar. The first and second ends 157 and 158 of the formation 156 are inclined with respect to the outer surface 159 from the inner surfaces 144 and 152. In the embodiment illustrated the cross-sectional area of the segment 160 is about 1.5% of the cross-sectional area of the discharge opening. When the slurry pump is operating the formation within the main liner tends to split the

flow in the pumping chamber and discharge passageway. This leads to a significant reduction in turbulence effectively smoothing the flow pattern and increasing wear life.

[0066] Referring to Figures 9 to 15 there is illustrated a slurry pump side liner 200 which is a front liner for a pump the side liner 200 comprising a main body 202 having an inner side 204 and an outer side 206. In an assembled position in a pump the inner side 204 faces the pump impeller, as illustrated in figures 27 to 32. As clearly illustrated in figure 10 the side liner 200 further includes an intake section 210 which extends outwardly away from outer side 206 of the main body 202. The intake section 210 includes an intake passageway 212 extending through the intake section 210 having an entry end 214 and an exit end 216. The intake passageway 212 has an inner surface 218 which is generally circular in cross-section. In use the intake section 210 is generally horizontally disposed.

[0067] The side liner 200 further includes a guide formation 220 on the inner surface 218 of the intake passageway 212. The guide formation 220 extends from the entry end 214 of the intake passageway 212 to the exit end 216. The guide formation 220 includes a leading end portion 222 at the entry end 214 of passageway 212 and a trailing end portion 224 at the exit end 216. The guide formation 220 further includes a guide surface 226 extending between the leading end portion 222 and the trailing end portion 224.

[0068] As shown more clearly in figure 15 the guide formation, when viewed in cross-section comprises a segment 227 of the curved inner surface 218 of the lowermost portion of the intake passageway 218. The guide surface 226 when viewed in cross-section comprises the chord 228 of the segment 227. The plane of the guide surface 226 is substantially parallel with a central axis P-P of the passageway 212 which extends between the ends thereof. The leading end portion 222 of the guide formation 220 has an inclined or ramped surface 223 which extends from the inner surface 218 of the passageway 212 to the guide surface 226 of the guide formation 220. The trailing end portion 224 has an inclined or ramped surface 225 which extends from the guide surface 226 to the inner surface of the passageway. The angle of inclination of inclined surface 223 is less than the

angle of inclination of inclined surface 225.

[0069] Another embodiment of a side liner is illustrated in figures 16 to 20. The structure of this side liner is substantially the same as that described with reference to figures 8 to 15. This embodiment differs from the earlier embodiment in that the inner surface of the passageway also includes a first group of guides 230 on a first portion of the inner surface of the passageway and a second group of guides 232 on a second portion of the passageway inner surface. The formation 220 is disposed between adjacent guides 232 which, in use, is the lowermost section of the passageway. The arrangement is such that, in use, said fluid leaves an exit end of the first group of guides 230 with a first exit angle which is inclined relative to the central axis and fluid leaves an exit end of the second group of guides 232 with a second exit angle which is inclined relative to the central axis, the second exit angle being greater than the first exit angle. Full details of this structure is described in European Patent Application 11750076.9 the contents of which are incorporated herein by cross-reference. The cross-sectional area of the segment 227 is from about 0.5% to about 1.5% of the cross-sectional area of the intake passageway 212. In a preferred form, and in the embodiment illustrated, the cross-sectional area of the segment 227 is about 1.0% of the cross sectional area of the intake passageway 212.

[0070] Referring to figures 21 to 23 of the drawings there is shown a slurry pump side liner 300 (often referred to as a back side liner) which comprises a main body 302 which includes a generally annular disc shaped wall 304 having a front face 306 and a rear face 308 with a passageway 310 extending through the main body 302 from the front face 306 to the rear face 308 of the wall 304 in the direction of primary axis P-P. As shown the passageway 310 has an inner surface 311 which is slightly frusto-conical in shape. The wall 304 has an outer peripheral rim 314 with a peripheral surface 315. The front face 306 is generally planar.

[0071] The rear face 308 has a series of bosses 317 for receiving fasteners which secure the side liner 300 to the pump outer casing. The rear face 308 has a recess section 316, the recess section 316 being stepped inwardly towards the front face 306. The recess section 316 has a recess surface 318 which is disposed around passageway 310. The

recess 316 has an outer peripheral wall 320 which is of a wave like configuration comprising alternating crests 322 and valleys 324.

[0072] A plurality of vanes 330 are disposed within the recess, the vanes extending in a generally radial fashion from the outer peripheral wall towards the passageway 310. The recess 316 has an outer peripheral wall 320 which is of a wave like configuration comprising alternating crests 322 and valleys 324.

[0073] As shown the vanes 330 have an inner edge 336 which terminates at the periphery of the passageway 310 and an outer edge 337 which is at the wall 320. The vanes 330 are arranged in spaced apart fashion around the passageway 310. As shown there are groups of vanes identified as a first group 332 and a second group 334. The first group 332 are longer than the second group 334. The first group extend from the crests 322 and second group extend from the valleys 324. The vanes separate the recess into a series of zones. The vanes 330 have an upper or outer surface 331 which is tapered inwardly from the outer edge 337 towards the inner edge thereof. The outer edge of the vanes is at a height which approximates the depth of the recess at the wall 320.

[0074] Referring to figures 24 to 27 of the drawings there is shown a centrifugal pump impeller 400 which comprises a front shroud 401 and a back shroud 402. The front and back shrouds each have an inner face 403 and 404 (figure 27) respectively the inner faces facing one another. The front and back shrouds 401 and 402 also have respective back faces 405 and 406. The front shroud has an inlet opening 450 through which slurry is delivered to an interior region 455 of the impeller 400. The impeller 400 is mounted for rotation about rotation axis B-B (figures 24 and 29).

[0075] The impeller 400 further comprises a plurality of pumping vanes 410, 411, 412, 413 (figure 26) within the interior region 455 the pumping vanes extending between the inner faces 403 and 404 of the front and back shrouds 401 and 402. Each of the pumping vanes has a leading edge 420, 421, 422, 423 in the region of the rotation axis B-B. The vanes also have trailing edges (not shown) which are disposed outwardly from the leading edges. Each pumping vane 410, 411, 412, 413 is generally arcuate in cross-

section and includes an inner leading edge 420, 421, 422, 423 and an outer trailing edge 424, 425, 426, 427 and opposed faces 445 and 446, the side face 445 being a pumping or pressure side which is the leading face with respect to the direction of rotation of the impeller. The vanes are normally referred to as backward-curving vanes when viewed with the direction of rotation. The pumping vanes are spaced apart from another so as to provide passageways 414 between adjacent pumping vanes.

[0076] The impeller 400 further includes a hub 415 extending from the outer face of the back shroud. The hub is coaxial with axis B-B is adapted to be connected to a drive shaft. There is further provided a nose or eye portion 430 having a generally dome shaped profile with an apex 440 in the region of the axis B-B.

[0077] The impeller 400 further includes two raised formations or ribs 435, 436 on the nose or eye portion 430. Formation or rib 435 extends from the leading edge 420 of pumping vane 410 in the region where the leading edge is adjacent the back shroud 402 over the nose or eye portion and through the apex 440 to the leading edge 422 of oppositely disposed pumping vane 412 in the region where the edge is adjacent the back shroud 402. Similarly, formation or rib 436 extends from the leading edge 421 of pumping vane 411 in the region where the leading edge is adjacent the back shroud 402 over the nose or eye portion and through the apex 440 to the leading edge 423 of pumping vane 413 in the region where the leading edge is adjacent the back shroud 402. The formations or ribs 435, 436 follow the shape of the pumping vane side faces 445, 446 with which they are associated and precede smoothly into the eye portion 430 of the impeller.

[0078] As shown the formations or ribs 435 and 436 cross in the region of the apex 440 at approximately right angles with respect to one another. Furthermore, the formations or ribs 435 and 436 provides for four auxiliary zones 437 each zones being disposed between respective adjacent formations or ribs 435 and 436 and adjacent a respective passageway 414. This is clearly illustrated in figure 25. The height of the formations or ribs 435 and 436 (that is the distance the formations or ribs 435 and 436 project from the back shroud and nose or eye of the impeller) is generally consistent along the length of the formations or ribs 435 and 436. The height of the formations or ribs 435 and 436 may be

about 10% of the distance between the inner faces 403, 404 of the front and back shroud 401, 402. The width of the formations or ribs 435 and 436 may be about 50% of the width of the pumping vane 410, 411, 412 and 413.

[0079] Figures 28 to 32 illustrate an assembly which comprises main liner 120, front side liner 200, rear side liner 300 and impeller 400 and the way the various components work together when in use. The assembly is suitable for use in pumps such as for example those described with reference to figures 1 and 2.

[0080] The operation slurry enters the pumping chamber 124 via the intake section 210 of front side liner 200. The formation 220 tends to direct particulates or solids towards a central region of the passageway 212. Because of the orientation of the pump when in operation (that is its main axis is generally horizontally disposed) the solids and particulates gravitate towards a lower region of passageway 212. The formation facilitates a more even spread of the particulates in the flow stream as the slurry enters the impeller 400 thereby smoothing the flow pattern and reducing wear on both the front side liner and the impeller.

[0081] The raised formations or ribs 435 and 436 when used in conjunction with a pre-swirl guide vane side liner as shown in figures 16 to 20, the dual benefit is obtained that is preconditioning of the slurry flow prior to reaching the impeller is effected by the pre-swirl vanes and the "lifting" movement of the new formation serves to move particulates to a more central location, facilitating more even particle distribution in the impeller. The design of the formation is such that a lower angle of inclination is present on the inlet side of the front side liner, in order to effect a more gradual change in the cross-section and avoid problems of wear associated with rapid changes in cross-section. This is in contrast to the discharge side of the front side liner, where a steeper angle is present. The steeper angle effects a more pronounced lifting effect by encouraging particles to separate from the wall prior to entering the impeller on the eye portion 430 of the impeller 400 further improve the flow pattern tending to keep the solids in the slurry in the middle region of the flow stream. The formations of ribs 435 and 436 provide for a pre-rotation of the slurry in the region of the impeller eye portion 430 thereby reducing the relative

velocity on the leading edge of the impeller pumping vanes and further tending to keep solids or particulates away from the back shroud this being a major wear rear in slurry pumps.

[0082] The slurry enters the pumping chamber from the impeller with a substantial turbulent flow pattern. The formation tends to split the flow in the pumping chamber and discharge passageways. This leads to a significant reduction in turbulence effectively smoothing the flow pattern and increasing wear life. By directing the flow in this manner, particles entrained in the flow are less likely to cause the wear which is typical for slurries in turbulent flow. The location of the formation is optimised for pumping applications in the high flow regime, which typically causes the greatest turbulence and wear to be near to the discharge passageway.

[0083] Finally, the provision of the vanes 330 on the rear side liner 300 inhibits rotational flow into the seal chamber and thereby stabilizes slurry pressure in the seal chamber and reduces wear on the seal. Furthermore, such rotational flow leads to back liner wear in cases where expelling vanes are not present on the adjacent shroud of the impeller. Incorporation of inhibitor vanes on the back liner can significantly reduce this wear problem, which otherwise has been resolved by incorporating impeller back shroud expeller or auxiliary vanes.

[0084] In the foregoing description of preferred embodiments, specific terminology has been resorted to for the sake of clarity. However, the invention is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar technical purpose. Terms such as "top" and "bottom", "front" and "rear", "inner" and "outer", "above", "below", "upper" and "lower" and the like are used as words of convenience to provide reference points and are not to be construed as limiting terms.

[0085] The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as, an

acknowledgement or admission or any form of suggestion that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

[0086] In this specification, the word "comprising" is to be understood in its "open" sense, that is, in the sense of "including", and thus not limited to its "closed" sense, that is the sense of "consisting only of". A corresponding meaning is to be attributed to the corresponding words "comprise", "comprised" and "comprises" where they appear.

[0087] In addition, the foregoing describes only some embodiments of the invention(s), and alterations, modifications, additions and/or changes can be made thereto without departing from the scope and spirit of the disclosed embodiments, the embodiments being illustrative and not restrictive.

[0088] Furthermore, invention(s) have been described in connection with what are presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the invention(s). Also, the various embodiments described above may be implemented in conjunction with other embodiments, e.g., aspects of one embodiment may be combined with aspects of another embodiment to realize yet other embodiments. Further, each independent feature or component of any given assembly may constitute an additional embodiment.

[0089] The reference numerals in the following claims do not in any way limit the scope of the respective claims.

Table of Parts

	Pump apparatus	100
	Pump	10
5	Pedestal	112
	Outer casing	22
	Side casing sections	23, 24
	Inlet hole	28
	Discharge outlet hole	29
10	Inner liner	11
	Main liner	12
	Side liners (front and back)	14, 30
	Bolts	27
	Pumping chamber	42
15	Seal chamber housing	114
	Cover plate	115
	Drive shaft	116
	Stuffing box	117
	Impeller	40
20	Delivery section	32
	Passage	33
	Outer end	34
	Inner end	35
	Sidewall section	15
25	Inner face	16
	Lip	38
	Hub	41
	Pumping vanes	43
	Eye portion	47
30	Rotation axis	X-X
	Auxiliary vanes	60

Auxiliary vanes	61
Main liner	120
Main body	122
Pump chamber section	124
Opposed sides	137/138
Major axis	Q-Q
Openings	139-140
Pumping chamber	142
Inner surface	144
Peripheral surface portion	145
Side surface portions	146/147
Discharge outlet section	150
Discharge passageway	151
Inner surface	152
Linear axis	Y-Y
Discharge outlet port	154
Formation	156
First end	157
Second end	158
Lateral axis	Z-Z
Segment	160
Side liner	200
Main body	202
Inner side	204
Outer side	206
Intake section	210
Intake passageway	212
Entry end	214
Exit end	216
Inner surface	218
Guide formation	220

Leading end portion	222
Trailing end portion	224
Guide surface	226
Segment	227
Chord	228
First group of guides	230
Second group of guides	232
Central axis	P-P
Back side liner	300
Main body	302
Annular disc shaped wall	304
Front face	306
Rear face	308
Passageway	310
Inner surface	311
Outer peripheral edge	312
Bosses	317
Recess	316
Primary axis	P-P
Recess inner surface	318
Peripheral wall	320
Crests	322
Valleys	324
Vanes	330
Upper surface	331
Vanes first group	332
Vanes second group	334
Pump impeller	400
Front shroud	401
Back shroud	402
Inner face	403/404

Outer face	405/406
Main/rotation axis	B-B
Pumping vanes	410/411/412/413
Hub	415
Leading edge	420/421/422/423
Trailing edge	424/425/426/427
Eye portion	430
Raised formations	435/436
Pressure side face	445
Rear side face	446
Auxiliary passageway	447
Inlet opening	450
Interior region	455
Apex	440

Claims:

1. A centrifugal pump impeller (400) which comprises a front shroud (401) and a back shroud (402), the front and back shrouds each having an inner face (403) and (404) respectively the inner faces facing one another, the front and back shrouds (401) and (402) also having respective outer faces (405) and (406), the front shroud having an inlet opening (450) through which slurry is delivered to an interior region (455) of the impeller (400), the impeller (400) being mounted for rotation about rotation axis (B-B), the impeller (400) further comprising a plurality of pumping vanes (410, 411, 412, 413) within the interior region (455) the pumping vanes extending between the inner faces (403) and (404) of the front and back shrouds (401) and (402), each of the pumping vanes having a leading edge (420, 421, 422, 423) in the region of the rotation axis (B-B), the vanes further having trailing edges which are disposed outwardly from the leading edges, the pumping vanes being spaced apart from another so as to provide passageways (414) between adjacent pumping vanes, the impeller (400) further including a hub (415) extending from the outer face of the back shroud, the hub being coaxial with axis (B-B) and adapted to be connected to a drive shaft, and a nose or eye portion (430) having a generally dome shaped profile with an apex (440) in the region of the axis (B-B), characterised in that the impeller (400) further includes two raised formations or ribs (435, 436) on the nose or eye portion (430), one formation or rib (435) extending from the leading edge (420) of one pumping vane (410) in the region where the leading edge is adjacent the back shroud (402) over the nose or eye portion and through the apex (440) to the leading edge (422) of an oppositely disposed pumping vane (412) in the region where the edge is adjacent the back shroud (402), and the other formation or rib (436) extending from the leading edge (421) of another pumping vane (411) in the region where the leading edge is adjacent the back shroud (402) over the nose or eye portion (430) and through the apex (440) to the leading edge (423) of an oppositely disposed pumping vane (413) in the region where the leading edge is adjacent the back shroud (402).

2. A centrifugal pump impeller according to claim 1 characterised in that the formations or ribs (435 and 436) cross in the region of the apex (440) at approximately

right angles with respect to one another, so as to provide for four auxiliary zones (437) each zone being disposed between respective adjacent formations or ribs (435 and 436).

3. In combination a pump impeller according to claim 1 or claim 2 and a side liner, the side liner comprising a main body (202) having an inner side (204) and an outer side (206), wherein in an assembled position in a pump the inner side (204) faces the pump impeller (400), the side liner (200) further comprising an intake section (210) which extends outwardly away from outer side (206) of the main body (202), the intake section (210) including an intake passageway (212) extending through the intake section (210) having an entry end (214) and an exit end (216), the intake passageway (212) having an inner surface (218) which is generally circular in cross-section with a central axis (P-P), characterised in that the side liner (200) further includes a guide formation (220) on the inner surface (218) of the intake passageway (212), the guide formation (220) extending from the entry end (214) of the intake passageway (212) to the exit end (216) and including a leading end portion (222) at the entry end (214) of passageway (212) and a trailing end portion (224) at the exit end (216), the guide formation (220) further including a guide surface (226) extending between the leading end portion (222) and the trailing end portion (224).

4. The combination according to claim 3 wherein when the side liner (200) is in use the central axis is generally horizontally disposed and the guide formation (220) is on the lowermost region of the inner surface (218) of the intake passageway (212).

5. The combination according to claim 3 or claim 4 characterised in that it further includes one or more first guides (23) on a first portion of the inner surface (218) of the passageway (212) for directing fluid passing through the intake passageway (212) so that in use said fluid leaves the exit end (216) at the first portion with a first exit angle which is inclined relative to the central axis (P-P), and a second portion of the inner surface (218) of the intake passageway (212) which includes one or more second guides (232) thereon for directing fluid passing through the intake passageway (212) so that in use said fluid leaves the exit end at the second portion with a second exit angle which is inclined relative to the

central axis, the second exit angle being greater than the first exit angle the formation being disposed between adjacent guides (232) in the second portion.

6. The combination according to any one of claims 3 to 5 characterised in that the guide formation (220), when viewed in cross-section comprises a segment (227) of the curved inner surface (218) of the intake passageway (212), the guide surface (226) when viewed in cross-section comprises the chord (228) of the segment (227), the plane of the guide surface (226) being substantially parallel with the central axis of the passageway (P-P) which extends between the ends thereof.

7. The combination according to claim 6 characterised in that the leading end portion (222) of the guide formation (220) has an inclined or ramped surface (223) which extends from the inner surface (218) of the passageway (212) to the guide surface (226) of the guide formation (220) and the trailing end portion (224) has an inclined or ramped surface (225) which extends from the guide surface (226) to the inner surface of the passageway, the angle of inclination of inclined surface (223) is less than the angle of inclination of inclined surface (224).

8. A pump liner (120) comprising:

a main body (122) which includes a pump chamber section (124) having opposed sides (137, 138) each having an opening (139, 140) therein with a major axis (Q-Q) extending between the sides;

the pump chamber section (124) having a pumping chamber (142) therein, the pumping chamber (142) having an inner surface (144) which includes a curved peripheral surface portion (145) and side surface portions (146, 147) one on either side of the peripheral surface portion and extending from the peripheral surface portion to a respective one of the openings;

the main body (122) further including a discharge outlet section (150) having a discharge passageway (151) therein with an inner surface (152) which is in fluid communication with the pumping chamber, the discharge passageway being of a generally linear configuration with a linear axis (Y-Y) which extends generally tangentially from the

pumping chamber (142) and terminates at a discharge outlet port (154) characterised in that the pump liner comprises a continuous formation (156) projecting from the inner surface (152) of the discharge passageway (151) and the peripheral surface portion (145) of the pumping chamber (142) the formation (156) having a first end (157) within the discharge passageway (151) and spaced from the outlet port (154) and a second end (158) in the pumping chamber (142) which terminates before a lateral axis (Z-Z) so as to be spaced therefrom, the lateral axis (Z-Z) extending through the major axis (Q-Q) and being parallel to the linear axis (Y-Y).

9. A pump liner according to claim 8 characterised in that the formation (156) when viewed in cross-section comprises a segment (160) of the curved peripheral surface of the pumping chamber and the inner surface of the discharge passageway (151).

10. A pump liner according to claim 9 characterised in that the cross-sectional area of the segment (160) is up to 10% of the cross-sectional area of the discharge passageway (151).

11. A pump liner according to claim 10 characterised in that the cross-sectional area of the segment (160) is about 1.5% of the cross-sectional area of the discharge passageway (151).

12. A pump liner according to any one of claims 8 to 11 characterised in that the formation (156) is formed integral with the main body (122).

13. A pump liner according to any one of claims 8 to 12 characterised in that the formation (156) is disposed in a plane which is at right angles to the major axis (Q-Q) and centrally positioned with respect to the inner surfaces (144), (152) of the pumping chamber (142) and discharge passageway (151).

14. A liner assembly and impeller for a slurry pump the liner assembly comprising a pump liner (120) according to any one of claims 8 to 13, a side liner comprising a main body (202) having an inner side (204) and an outer side (206), the side liner (200) further

comprising an intake section (210) which extends outwardly away from outer side (206) of the main body (202), the intake section (210) including an intake passageway (212) extending through the intake section (210) having an entry end (214) and an exit end (216), the intake passageway (212) having an inner surface (218) which is generally circular in cross-section with a central axis (P-P), characterised in that the side liner (200) further includes a guide formation (220) on the inner surface (218) of the intake passageway (212), the guide formation (220) extending from the entry end (214) of the intake passageway (212) to the exit end (216) and including a leading end portion (222) at the entry end (214) of passageway (212) and a trailing end portion (224) at the exit end (216), the guide formation (220) further including a guide surface (226) extending between the leading end portion (222) and the trailing end portion (224), a back side liner (300) which comprises a main body (302) which includes a generally annular disc shaped wall (304) having a front face (306) and a rear face (308) with a passageway (310) extending through the main body (302) from the front face (306) to the rear face (308) of the wall (304) in the direction of primary axis (P-P) the passageway (310) having a peripheral wall (312) characterised in that the side liner further comprises a plurality of vanes (330) on the rear face, the vanes extending in a generally radial fashion with respect to the primary axis (P-P) and including an inner edge (313) and an outer edge (315), the inner edge (313) being adjacent the peripheral wall (312) of the passageway (310), the impeller comprising a front shroud (401) and a back shroud (402), the front and back shrouds each having an inner face (403) and (404) respectively the inner faces facing one another, the front and back shrouds (401) and (402) also having respective back faces (405) and (406), the front shroud has an inlet opening (450) through which slurry is delivered to an interior region (455) of the impeller (400), the impeller (400) is mounted for rotation about rotation axis (B-B), the impeller (400) further comprises a plurality of pumping vanes (410), (411, 412, 413) within the interior region (455) the pumping vanes extending between the inner faces (403) and (404) of the front and back shrouds (401) and (402), each of the pumping vanes having a leading edge (420, 421, 422, 423) in the region of the rotation axis (B-B), the vanes also have trailing edges which are disposed outwardly from the leading edges, the pumping vanes being spaced apart from another so as to provide passageways (414) between adjacent pumping vanes, the impeller (400) further including a hub (415)

extending from the outer face of the back shroud, the hub being coaxial with axis (B-B) and adapted to be connected to a drive shaft, and a nose or eye portion (430) having a generally dome shaped profile with an apex (440) in the region of the axis (B-B), characterised in that the impeller (400) further includes two raised formations or ribs (435, 436) on the nose or eye portion (430), one formation or rib (435) extending from the leading edge (420) of pumping vane (410) in the region where the leading edge is adjacent the back shroud (402) over the nose or eye portion and through the apex (440) to the leading edge (422) of oppositely disposed pumping vane (412) in the region where the edge is adjacent the back shroud (402), and the other formation or rib (436) extending from the leading edge (421) of pumping vane (411) in the region where the leading edge is adjacent the back shroud (402) over the nose or eye portion and through the apex (440) to the leading edge (423) of pumping vane (413) in the region where the leading edge is adjacent the back shroud (402).

15. A front side liner comprising a main body (202) having an inner side (204) and an outer side (206), the side liner (200) further comprising an intake section (210) which extends outwardly away from outer side (206) of the main body (202), the intake section (210) including an intake passageway (212) extending through the intake section (210) having an entry end (214) and an exit end (216), the intake passageway (212) having an inner surface (218) which is generally circular in cross-section with a central axis (P-P), characterised in that the side liner (200) further includes a guide formation (220) on the inner surface (218) of the intake passageway (212), the guide formation (220) extending from the entry end (214) of the intake passageway (212) to the exit end (216) and including a leading end portion (222) at the entry end (214) of the passageway (212) and a trailing end portion (224) at the exit end (216), the guide formation (220) further including a guide surface (226) extending between the leading end portion (222) and the trailing end portion (224).

16. A front side liner according to claim 15 characterised in that when the side liner is in use the central axis (P-P) is generally horizontally disposed and the guide formation (220) is on a lowermost region of the inner surface (218) of the intake passageway (212).

17. A front side liner according to claim 15 or claim 16 characterised in that it further includes one or more first guides (230) on a first portion of the inner surface (218) of the passageway (212) for directing fluid passing through the intake passageway (212) so that in use said fluid leaves the exit end (216) at the first portion with a first exit angle which is inclined relative to the central axis (P-P), and a second portion of the inner surface (218) of the intake passageway (212) which includes one or more second guides (232) thereon for directing fluid passing through the intake passageway (212) so that in use said fluid leaves the exit end at the second portion with a second exit angle which is inclined relative to the central axis, the second exit angle being greater than the first exit angle the formation being disposed between adjacent guides (232) in the second portion.

18. A front side liner according to any one of claim 15 to 17 characterised in that the guide formation, when viewed in cross-section comprises a segment (227) of the curved inner surface (218) of the intake passageway (212), the guide surface (226) when viewed in cross-section comprises the chord (228) of the segment (227), the plane of the guide surface (226) being substantially parallel with the central axis of the passageway (P-P) which extends between the ends thereof.

19. A front side liner according to claim 18 characterised in that the leading end portion (222) of the guide formation (220) has an inclined or ramped surface (223) which extends from the inner surface (218) of the passageway (212) to the guide surface (226) of the guide formation (220) and the trailing end portion (224) has an inclined or ramped surface (225) which extends from the guide surface (226) to the inner surface of the passageway, the angle of inclination of inclined surface (223) is less than the angle of inclination of inclined surface (224).

20. A back side liner which comprises a main body (302) which includes a generally annular disc shaped wall (304) having a front face (306) and a rear face (308) with a passageway (310) extending through the main body (302) from the front face (306) to the rear face (308) of the wall (304) in the direction of primary axis (P-P) the passageway

(310) having a peripheral wall (312) characterised in that the side liner further comprises a plurality of vanes (330) on the rear face (308), the vanes (330) extending in a generally radial fashion with respect to the primary axis (P-P) and including an inner edge (313) and an outer edge (315), the inner edge (313) being adjacent the peripheral wall (312) of the passageway (310).

21. A back side liner according to claim 20 characterised in that the rear face (308) includes a recess (316) therein, the recess (316) being stepped inwardly towards the front face (306), the recess (316) having a recessed surface (318) which is disposed around passageway (310) and includes an outer peripheral wall (320), the plurality of vanes (330) been disposed within the recess (316), and extending in a radial fashion from the outer peripheral wall (320) towards the passageway (310).

22. A back side liner according to claim 21 characterised in that the recess (316) the outer peripheral wall (320) is of a wave like configuration comprising alternating crests (322) and valleys (324), the plurality of vanes (330) being disposed within the recess (316), the vanes (330) extending in a radial fashion from the outer peripheral wall (320) towards the passageway (310) terminating at the periphery of the passageway (310), the vanes (330) being arranged in spaced apart fashion around the passageway (310).

23. A back side liner according to claim 21 characterised in that the vanes comprise a first group (332) and a second group (334), the first group (332) being longer than the second group (334), the first group extending from the crests (322) and second group extending from the valleys (324).

24. A back side liner according to any one of claims 20 to 23 wherein the vanes (330) include an upper surface which tapers inwardly towards the inner edge thereof.

25. A back side liner according to any one of claims 20 to 24 wherein the vanes (330) are arranged in spaced apart fashion around the rear face (308).

FIGURE 1

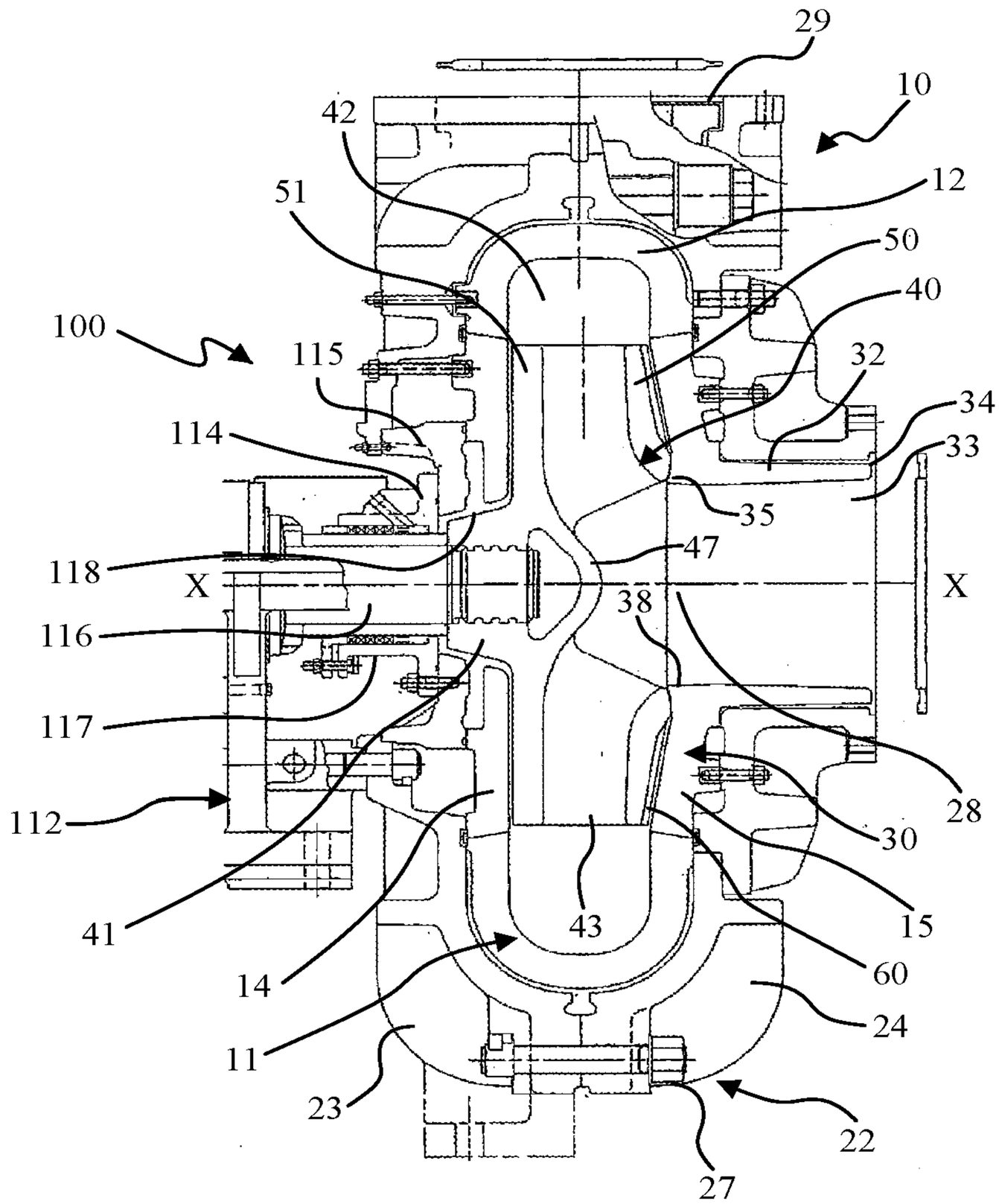
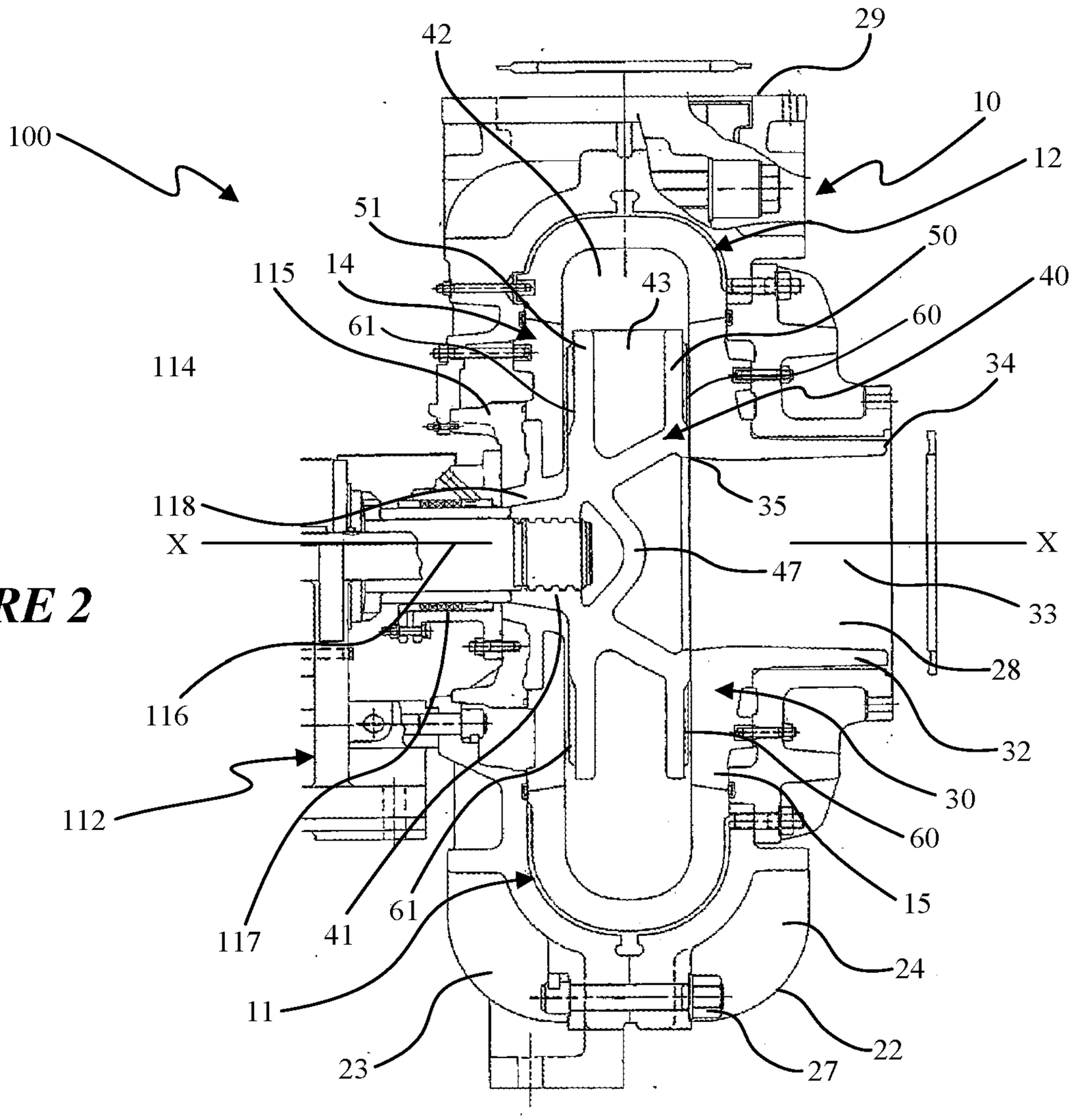
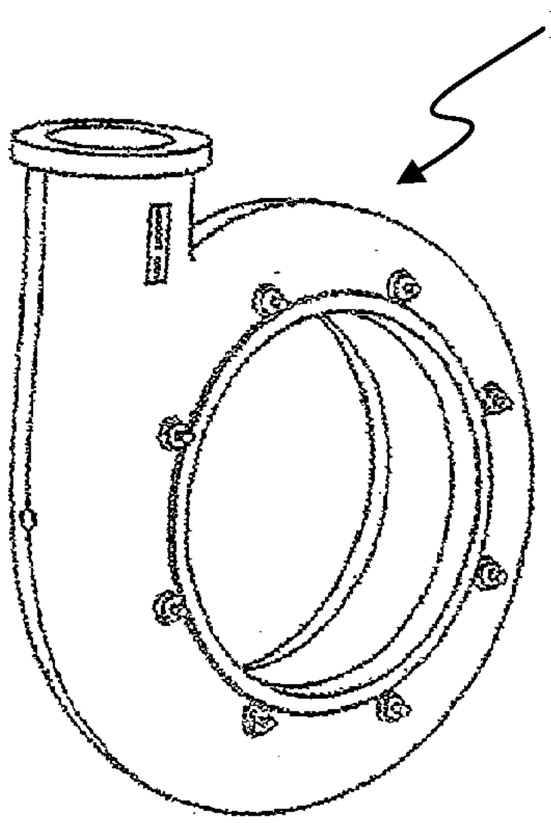


FIGURE 2





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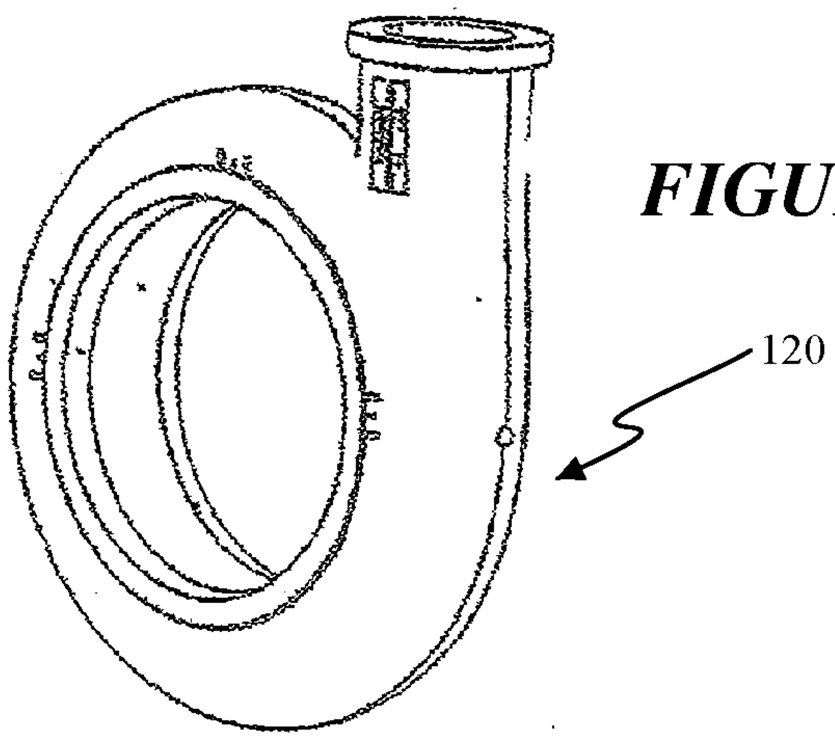

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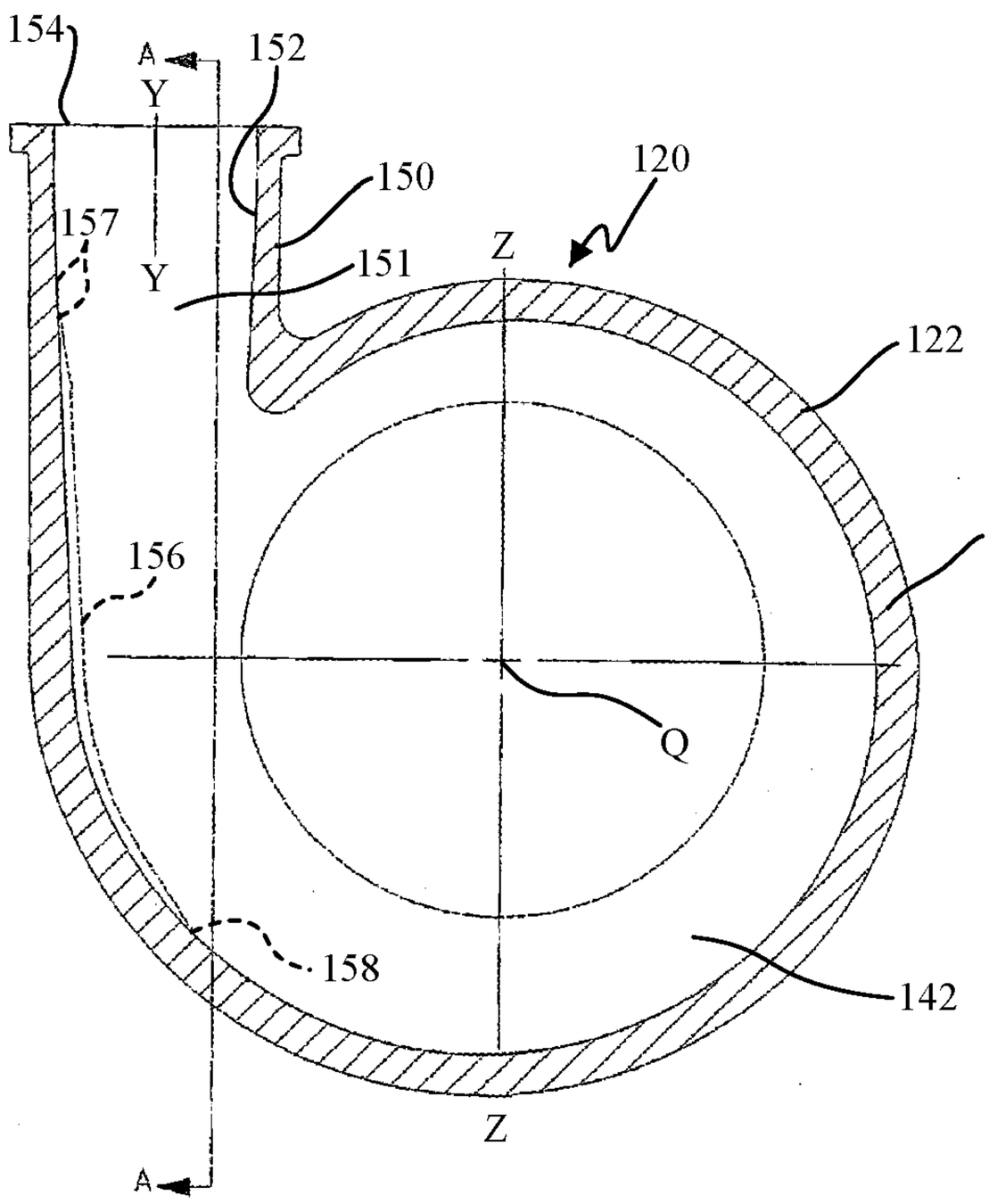
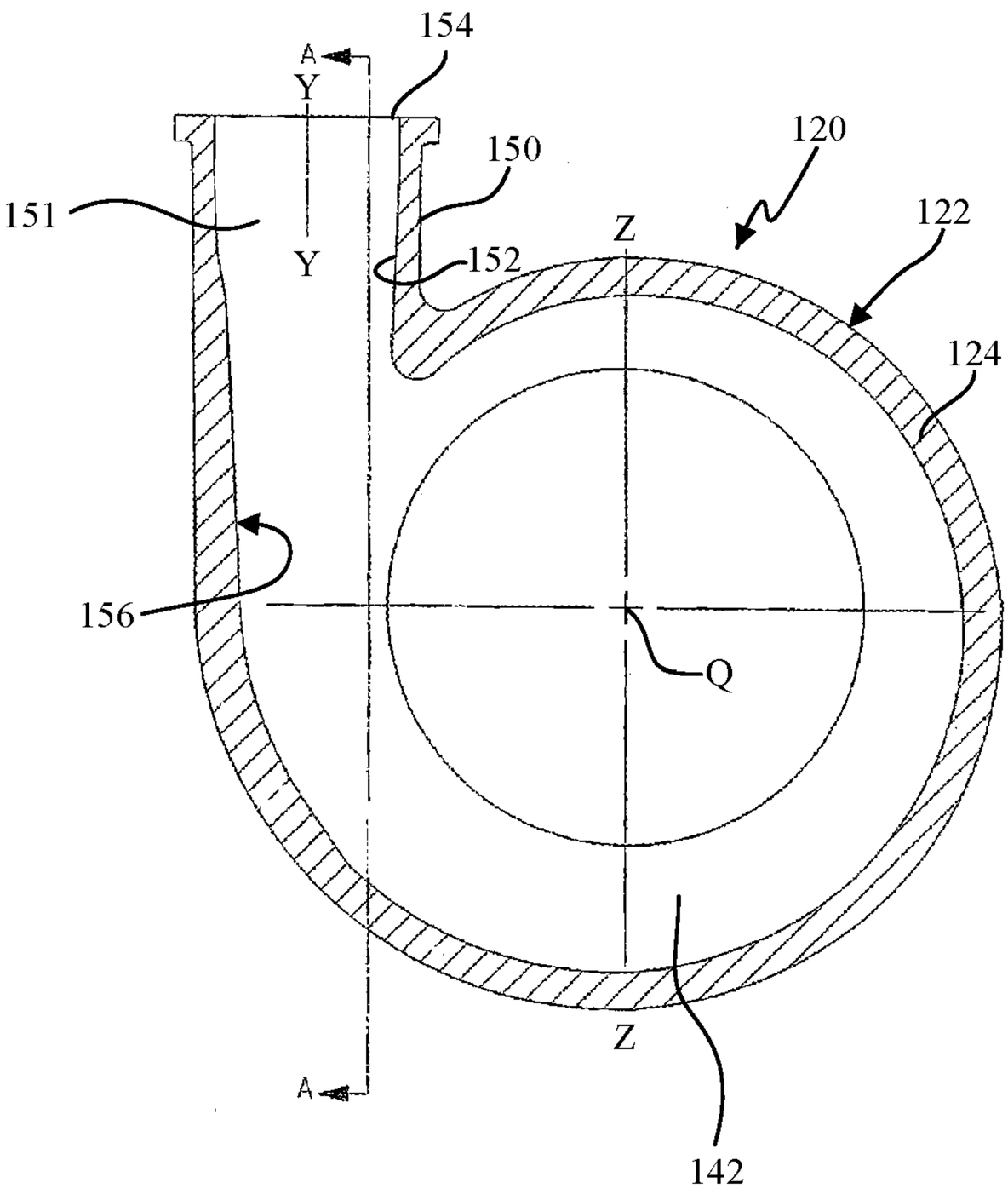


FIGURE 5



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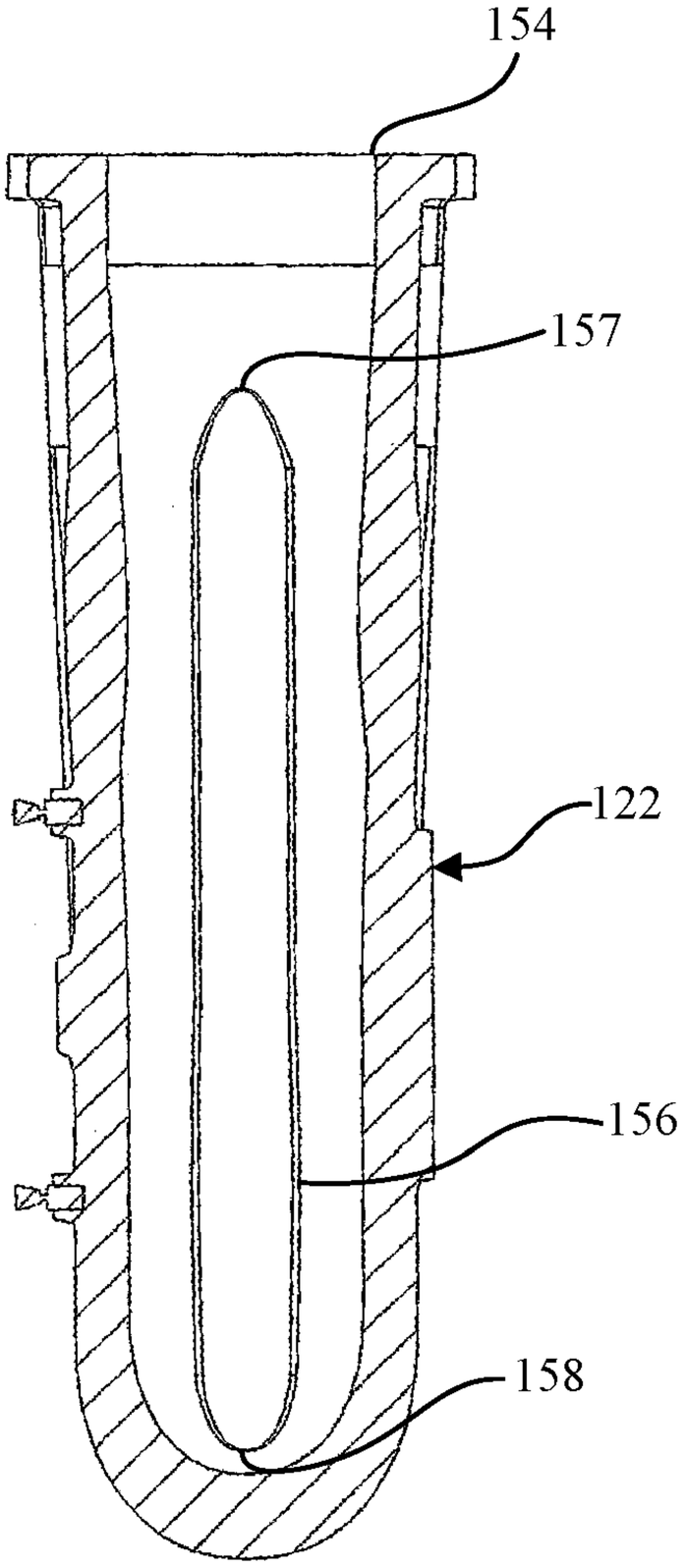
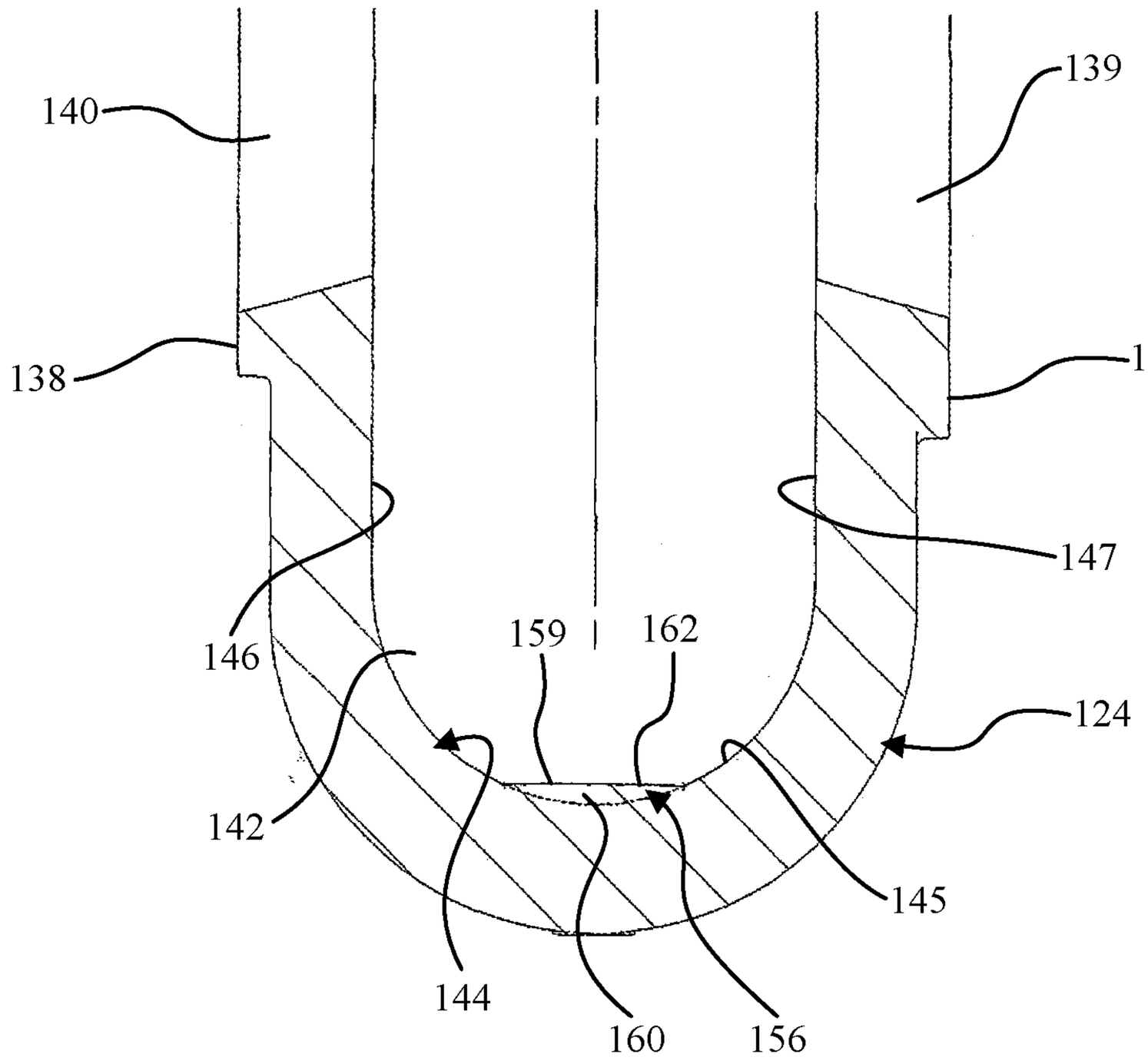


SECTION A-A

FIGURE 7



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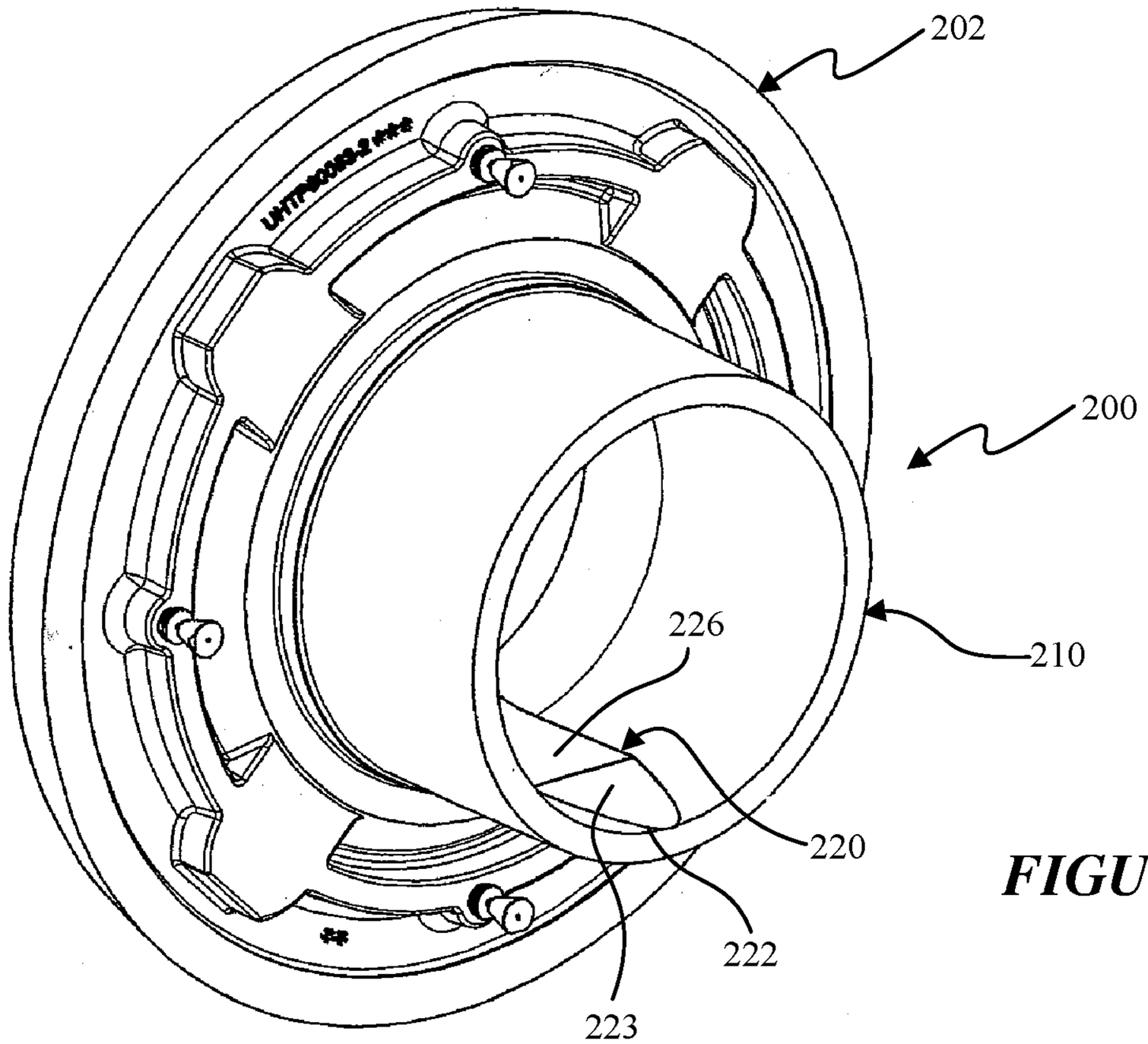
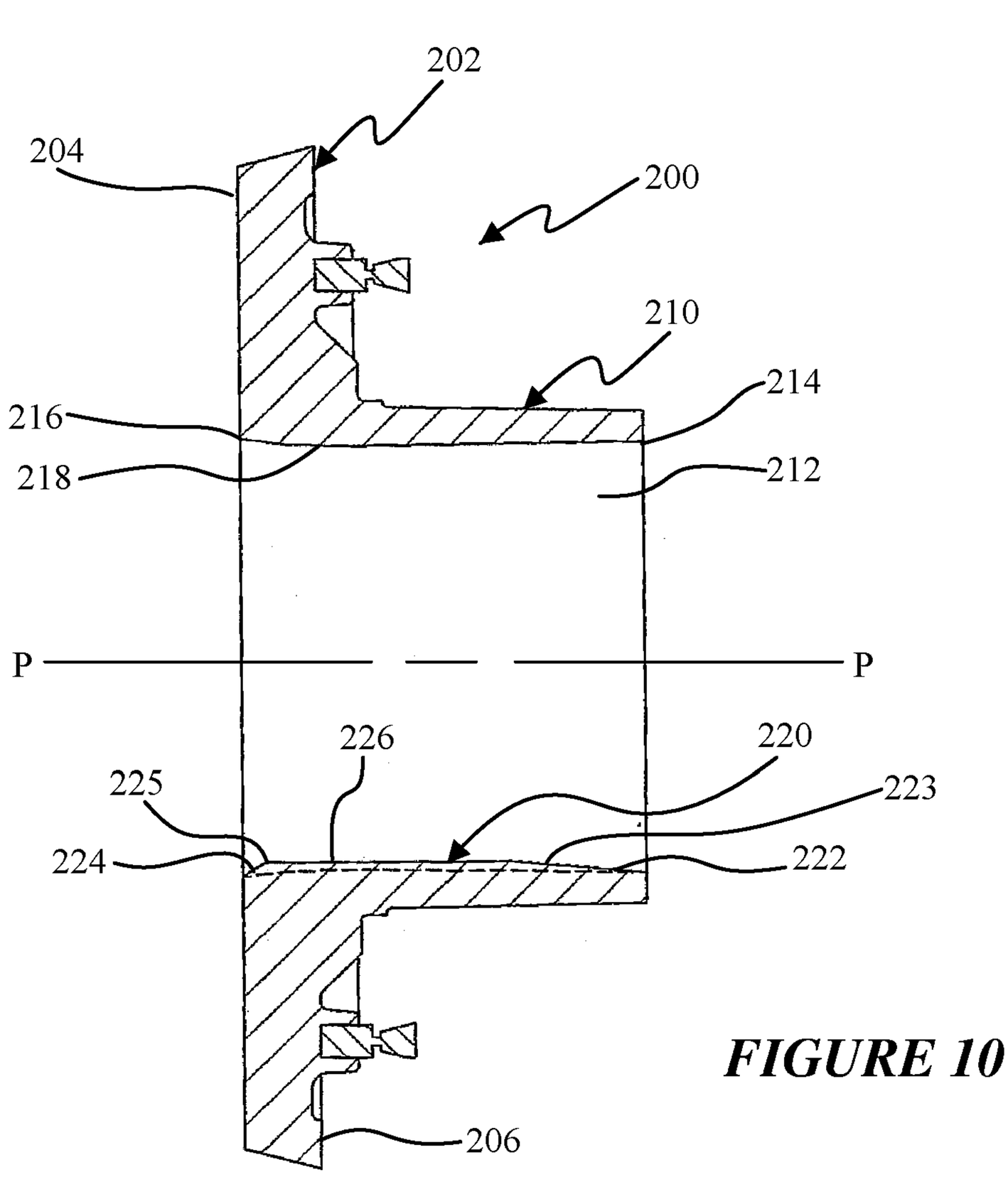


FIGURE 9



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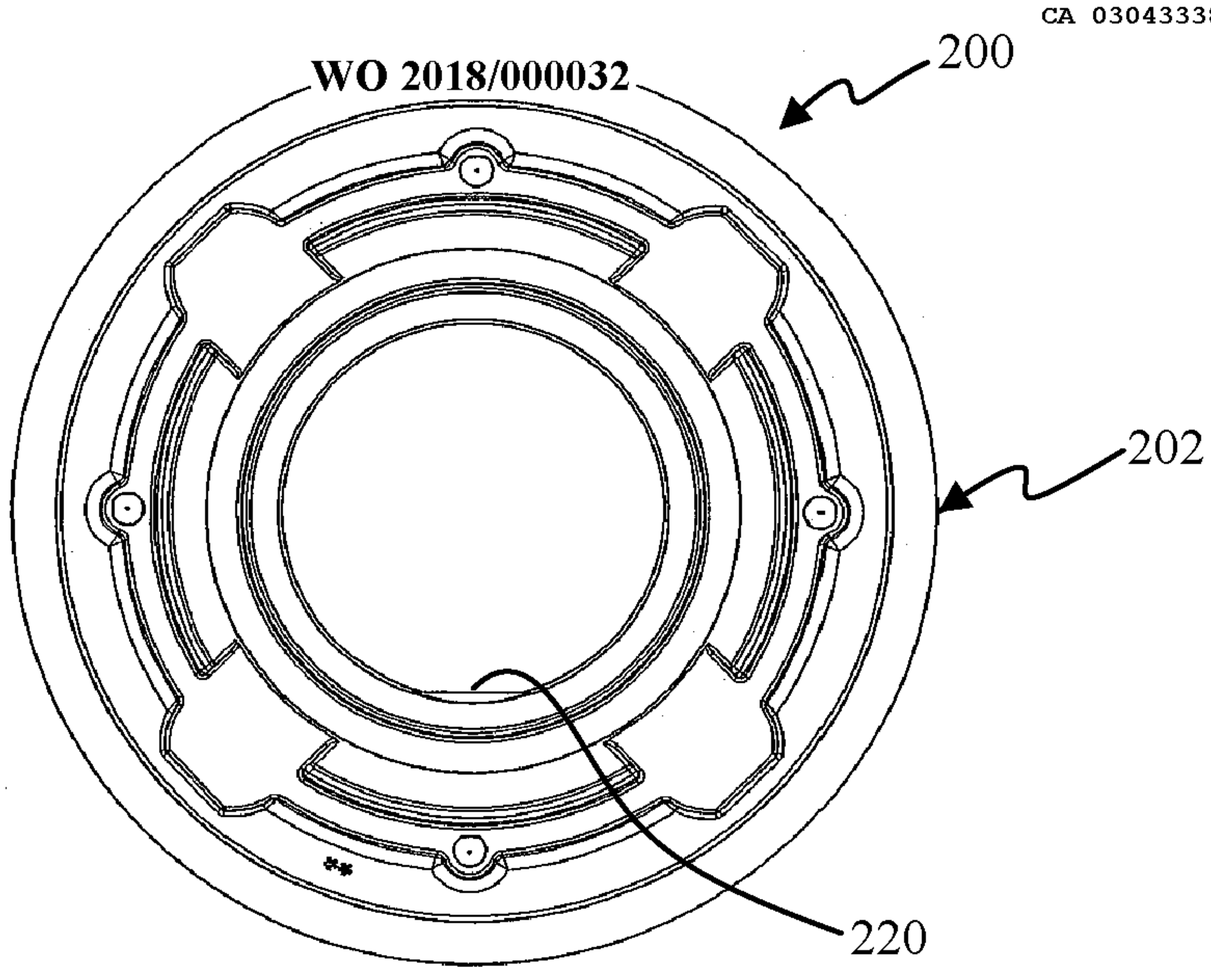
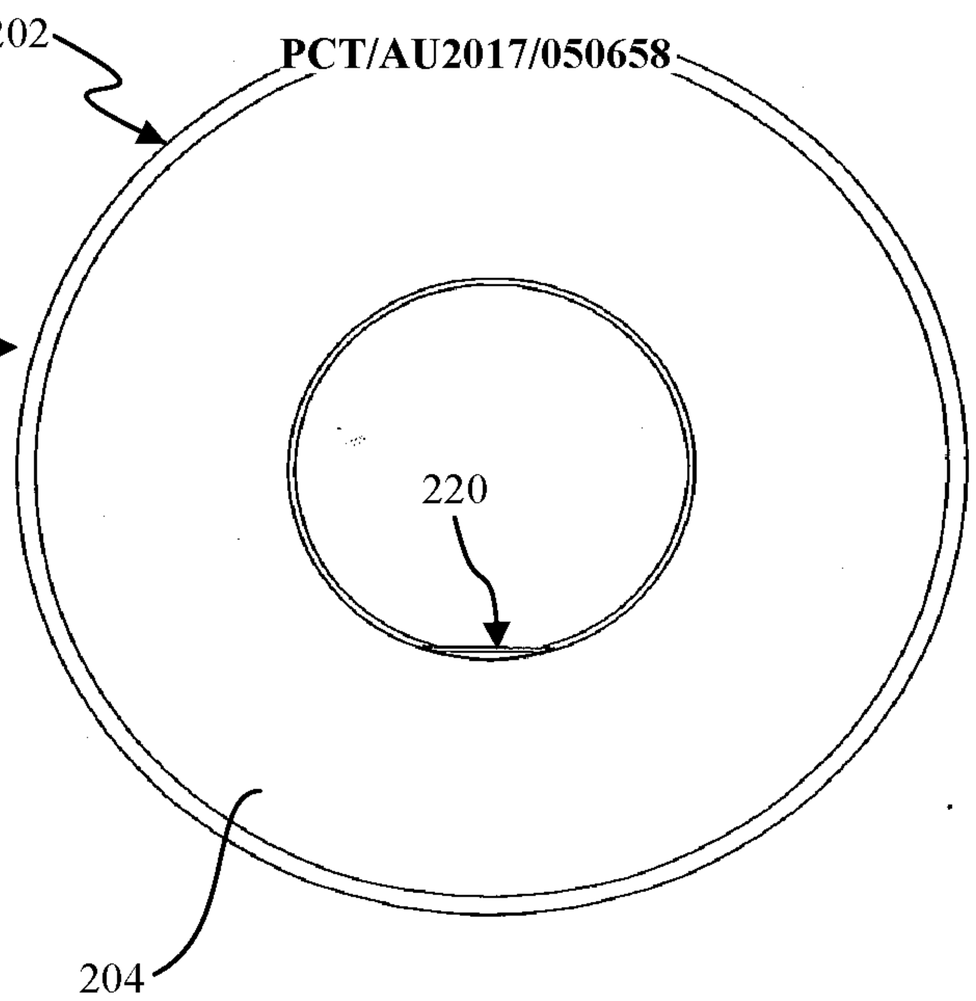


FIGURE 11



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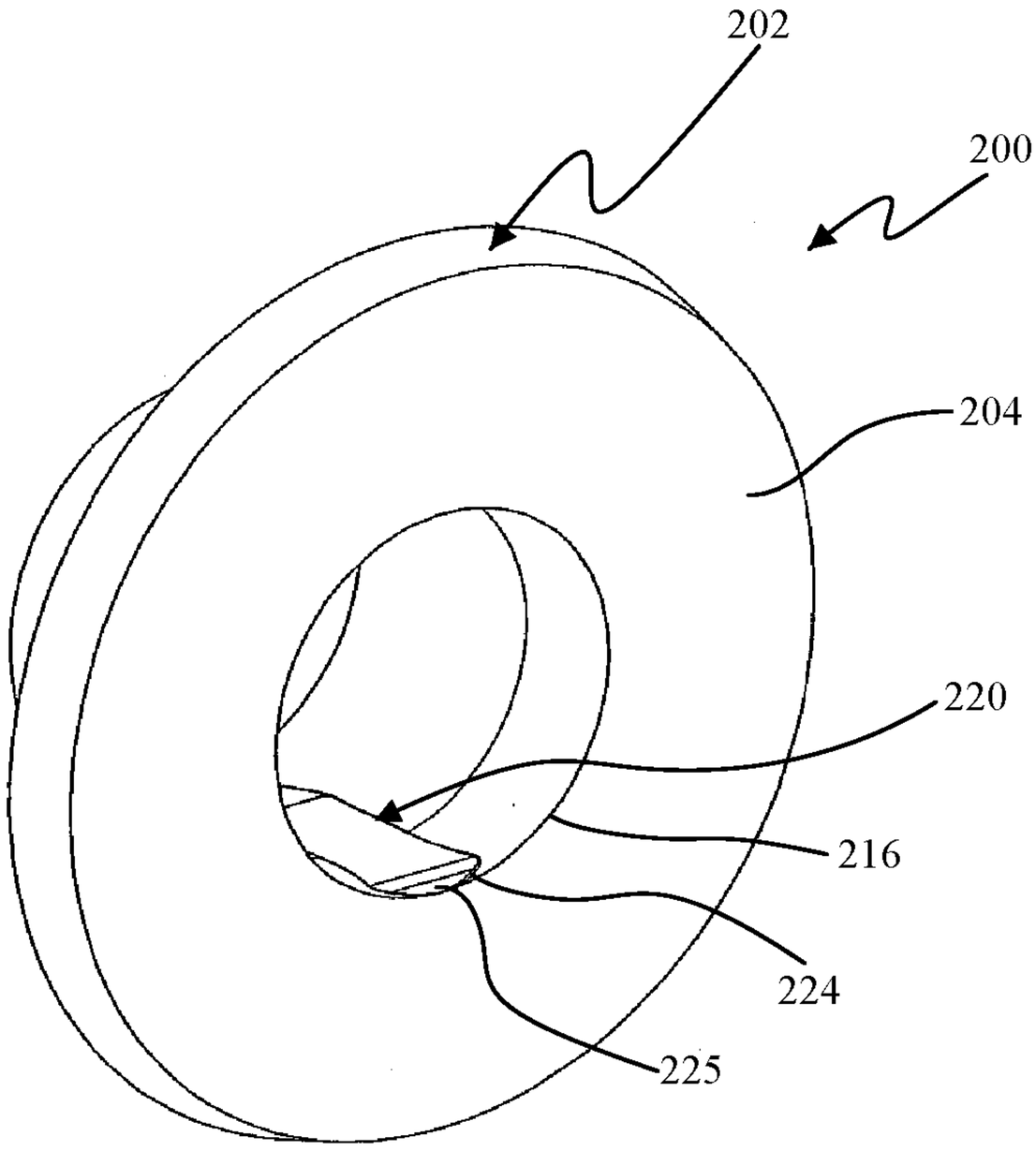
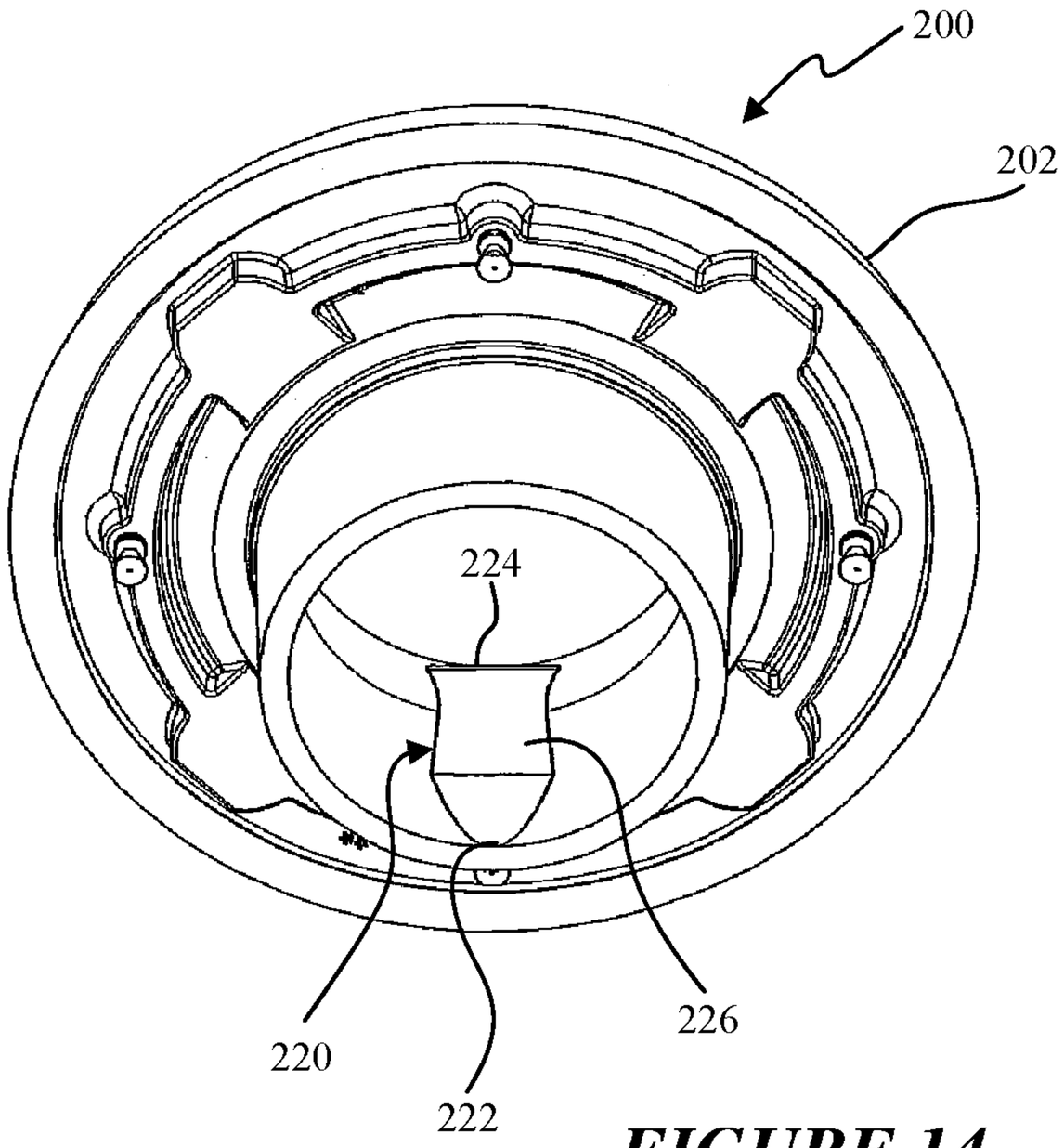


FIGURE 13



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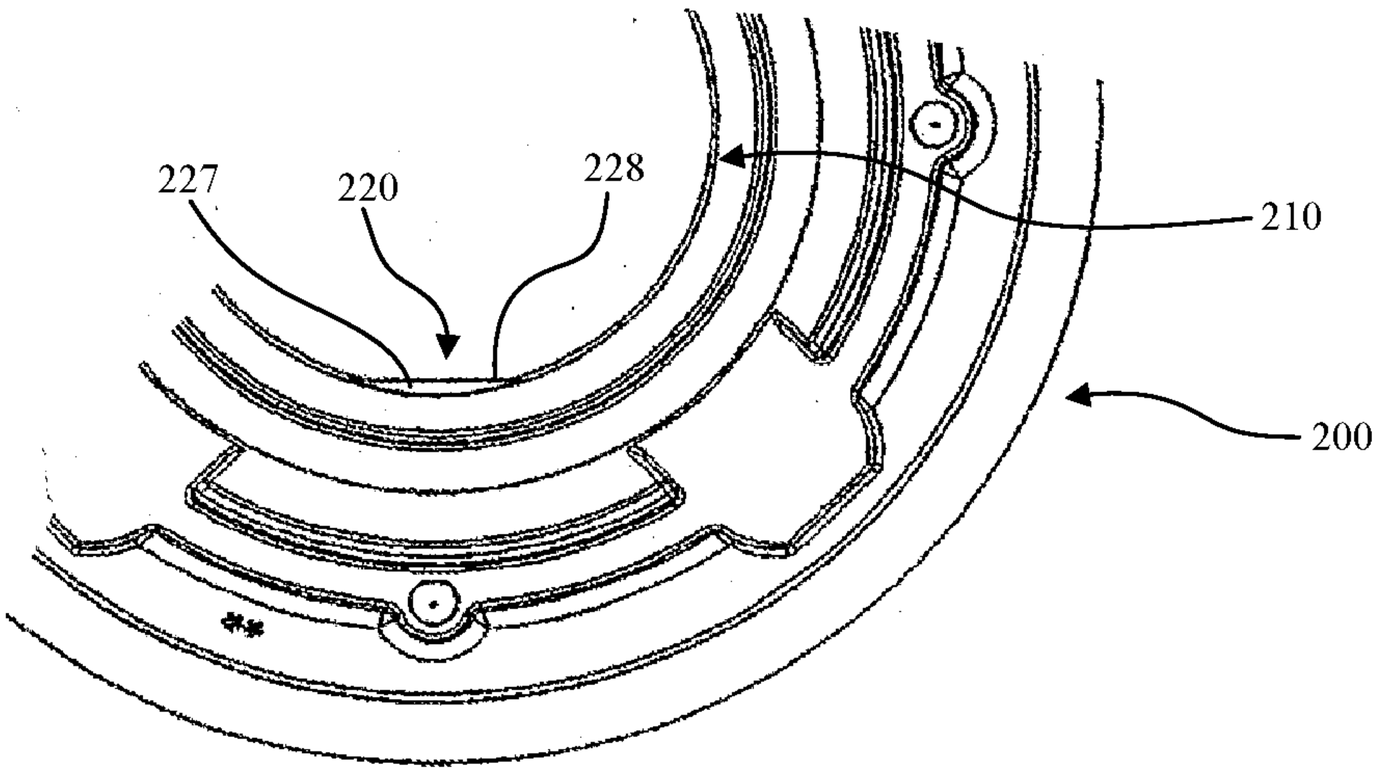

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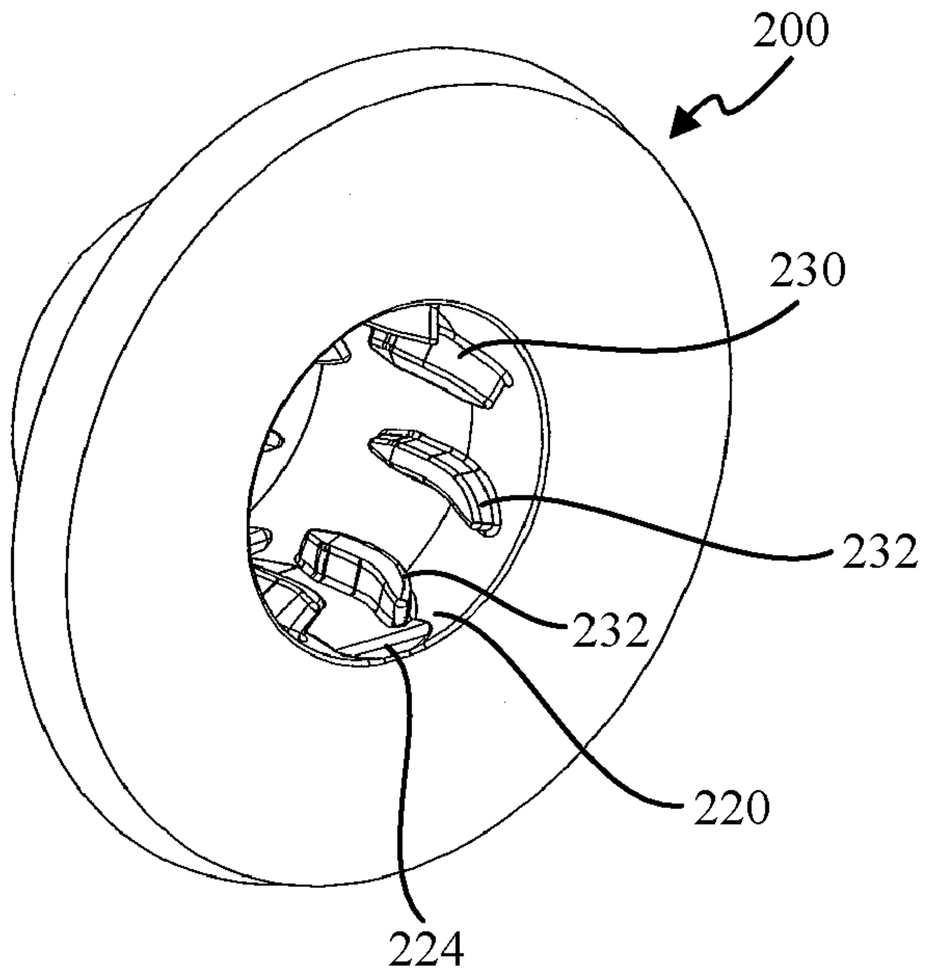

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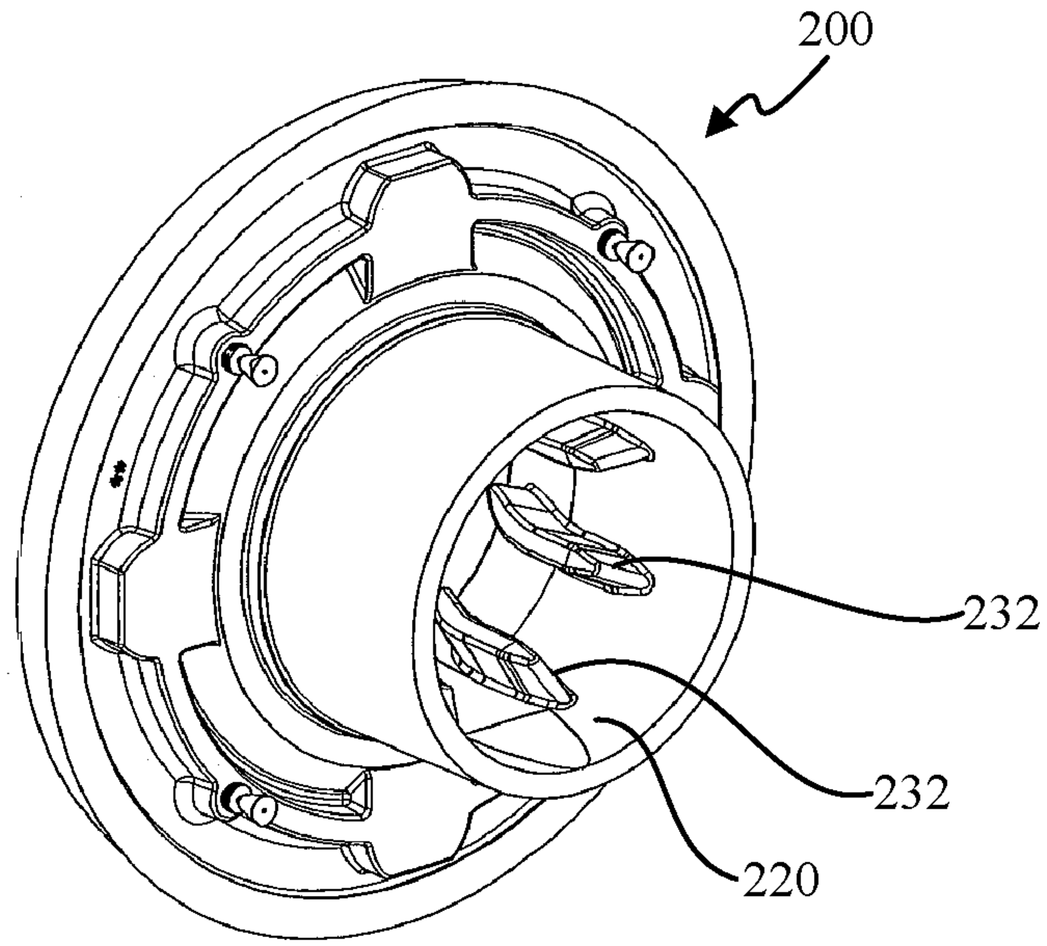

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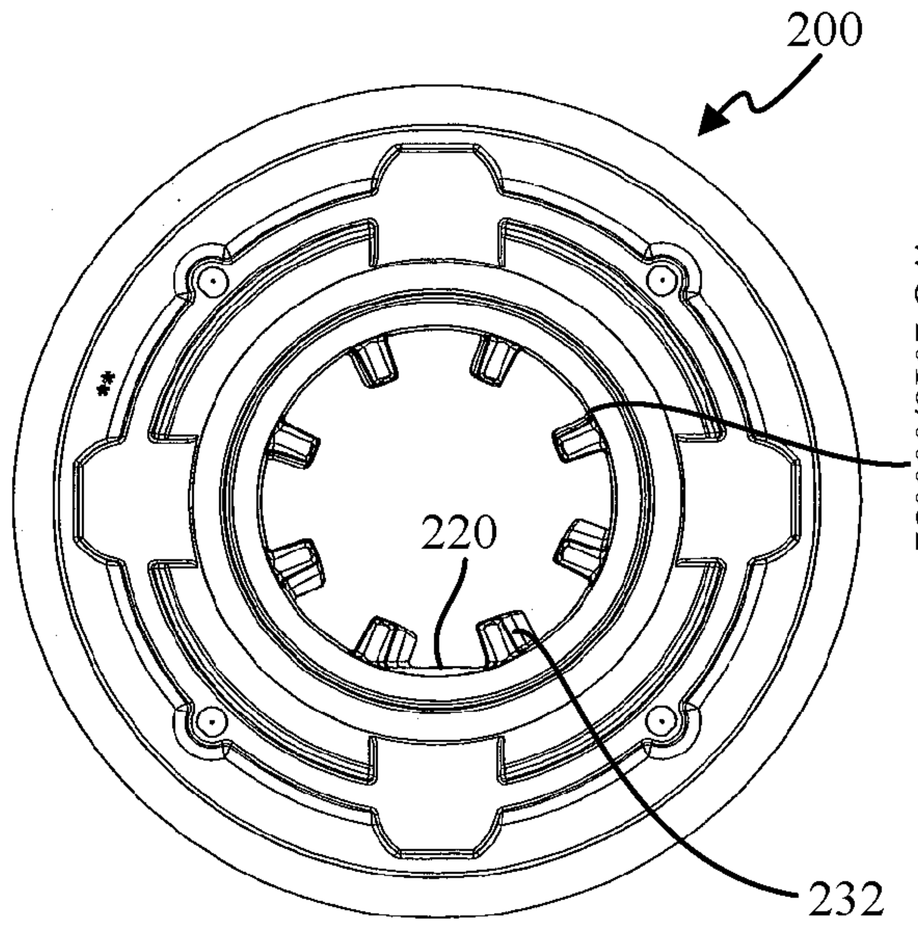

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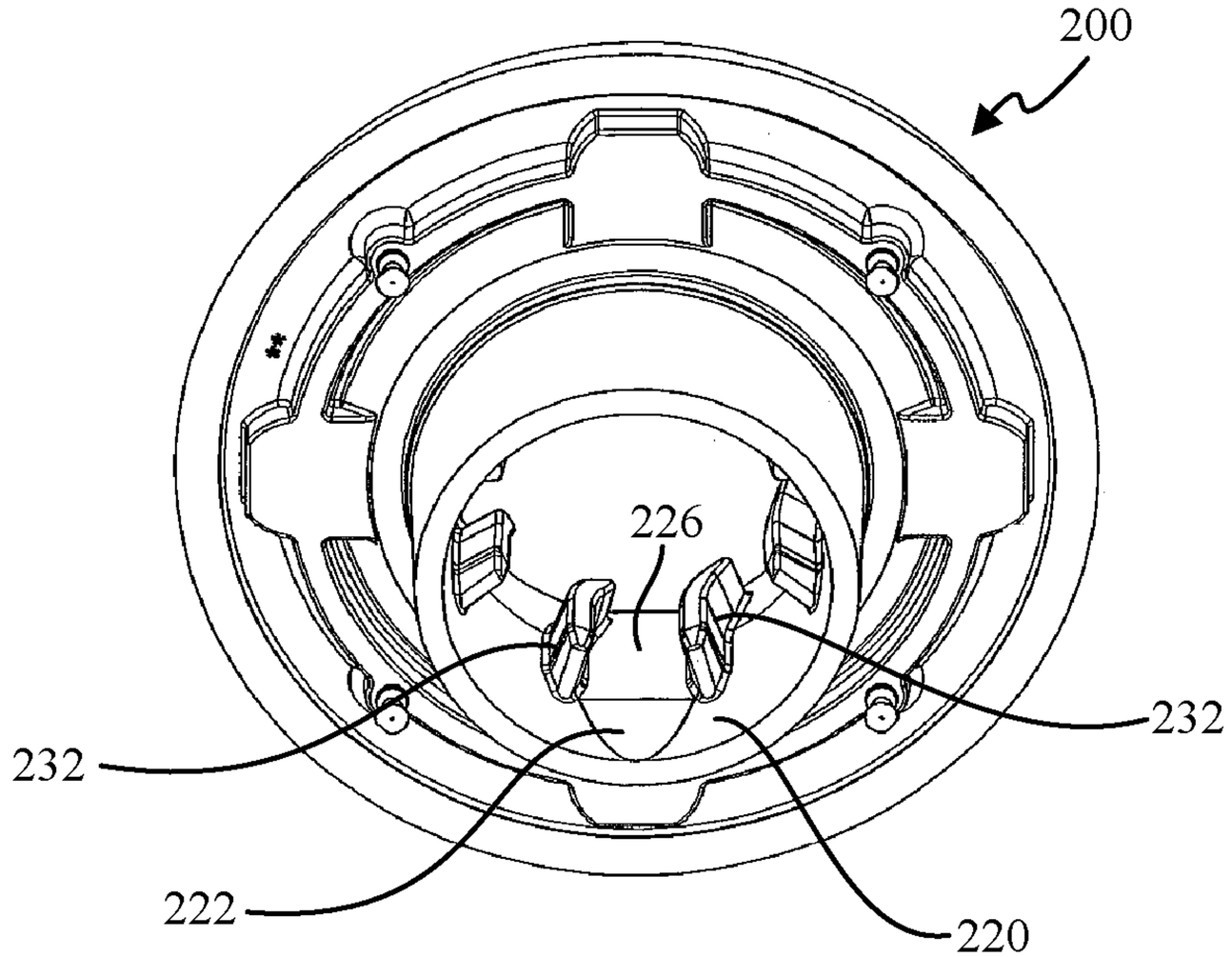

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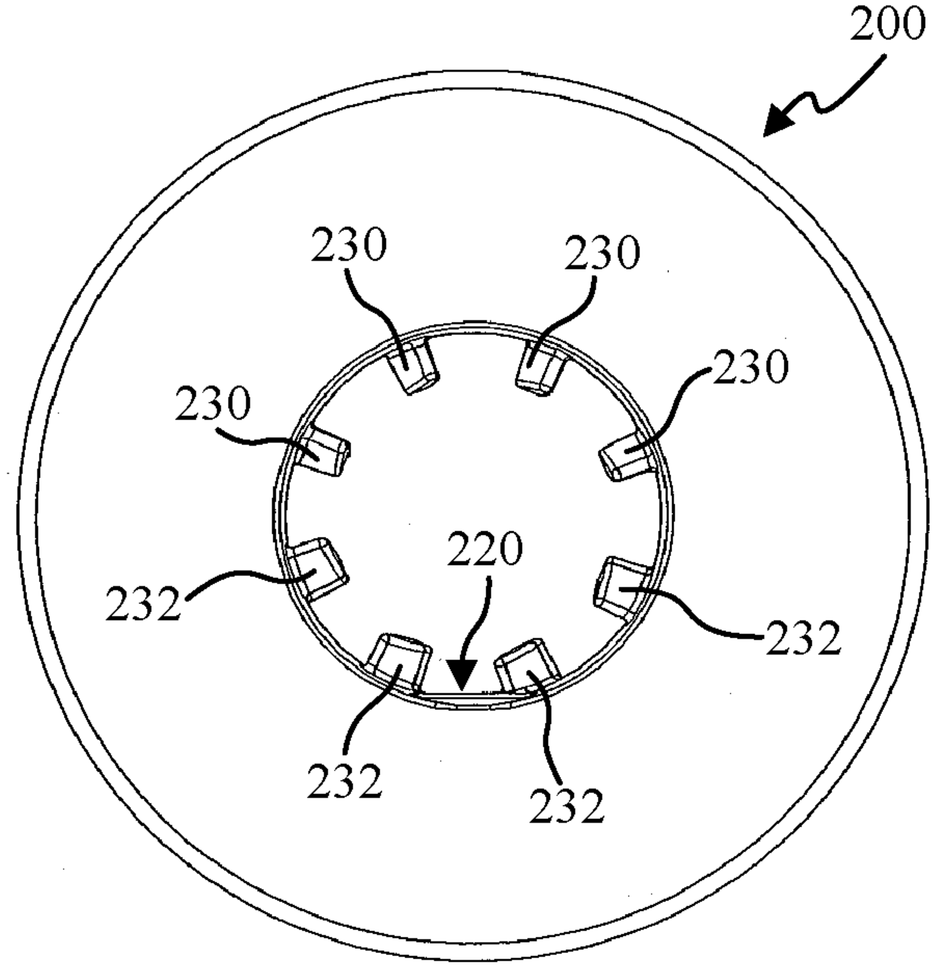

FIGURE 20

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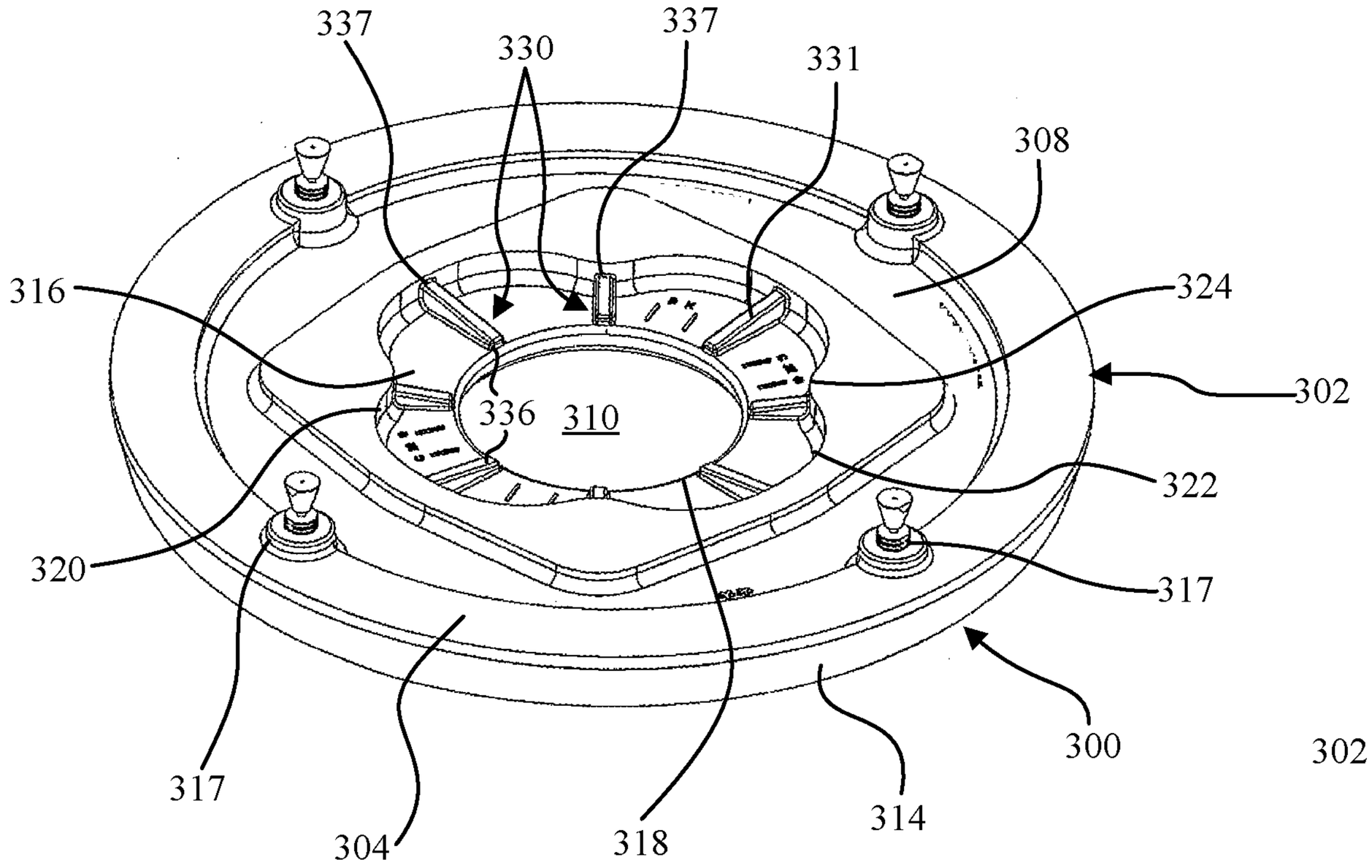
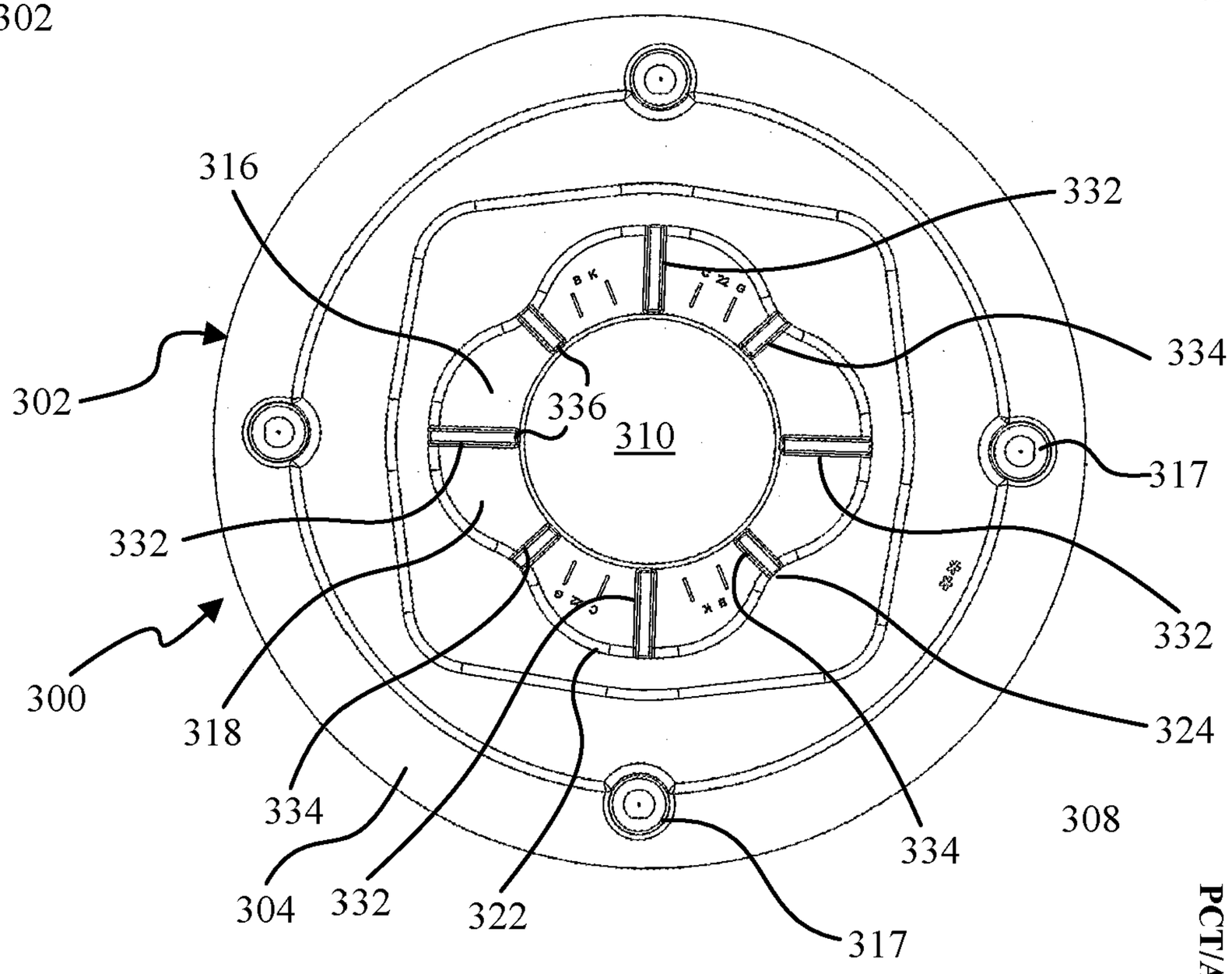


FIGURE 21



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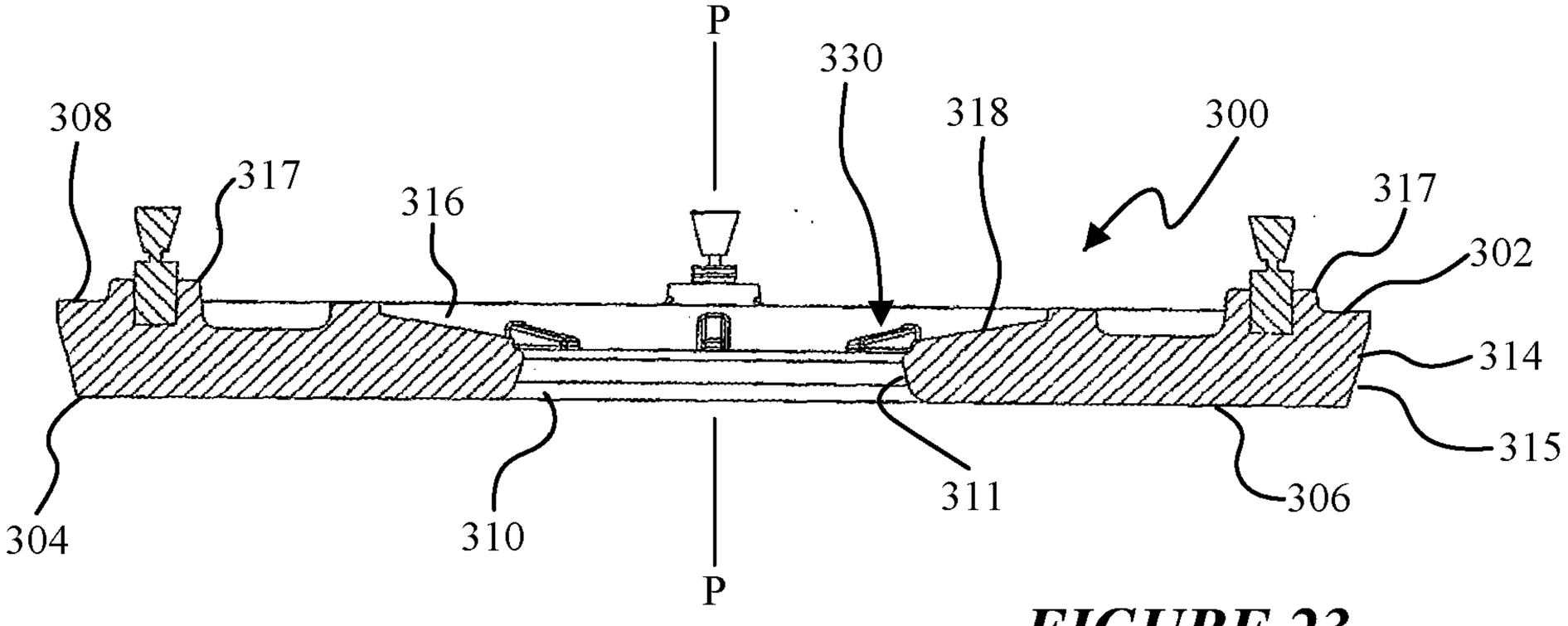

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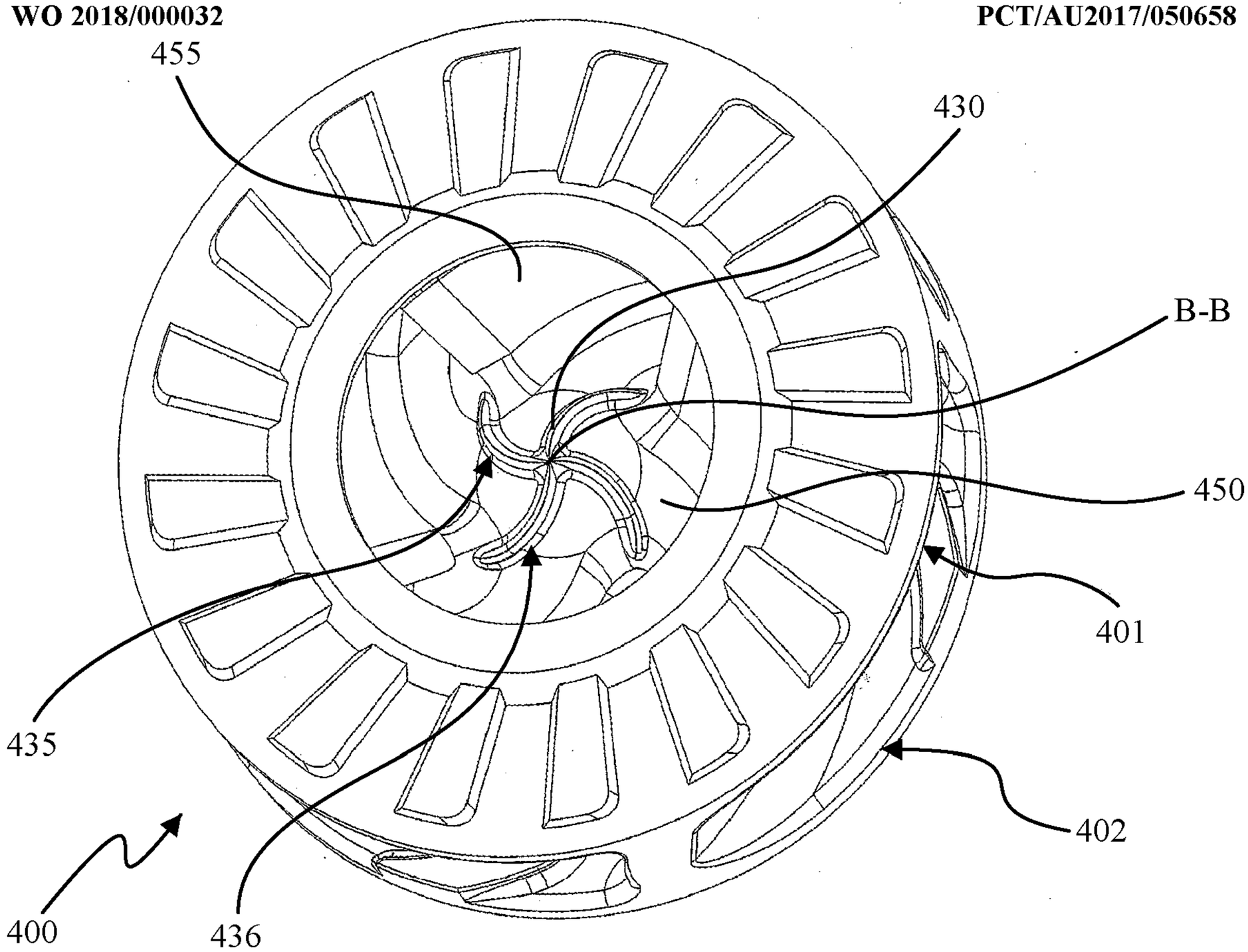
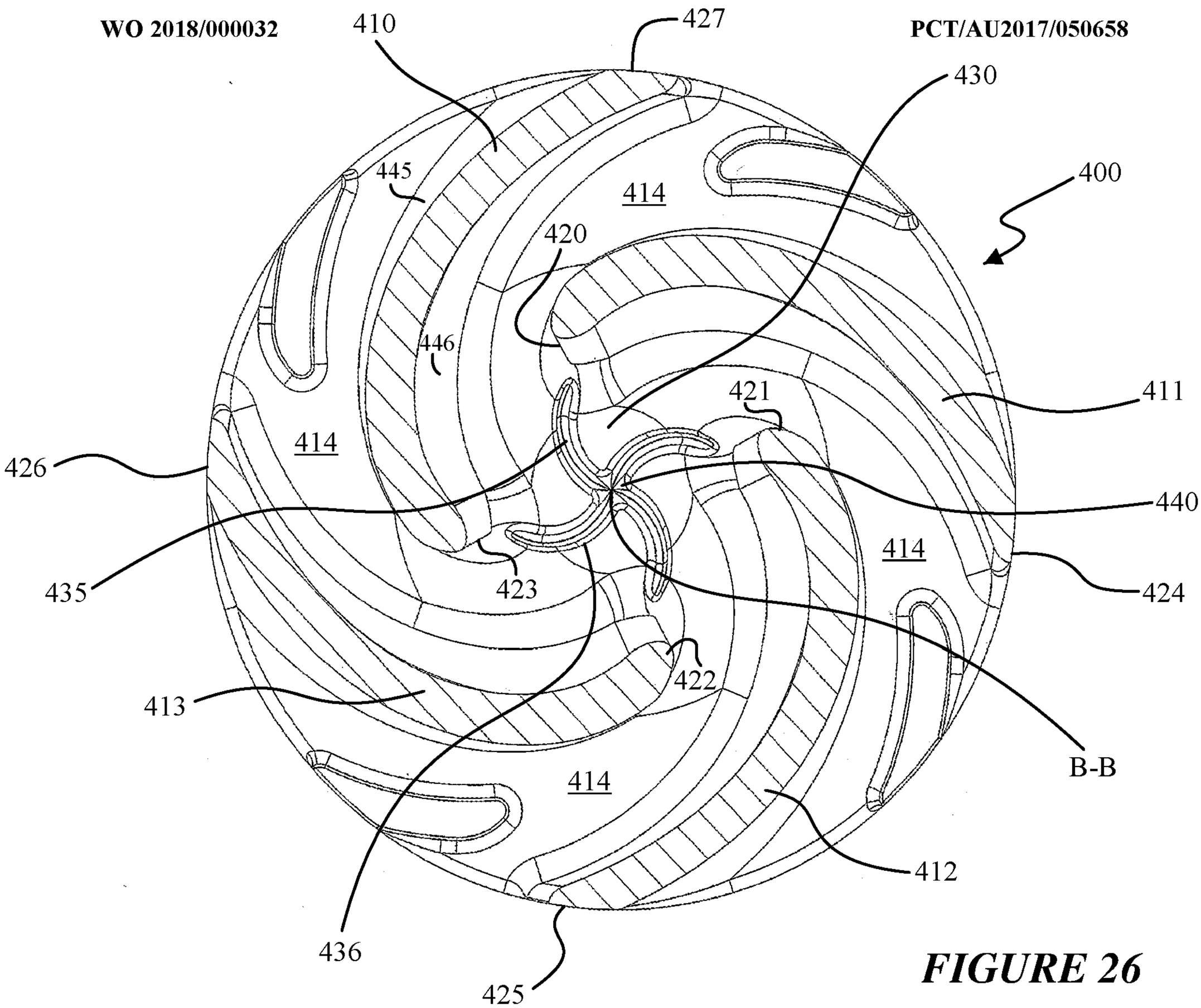


FIGURE 24

FIGURE 25



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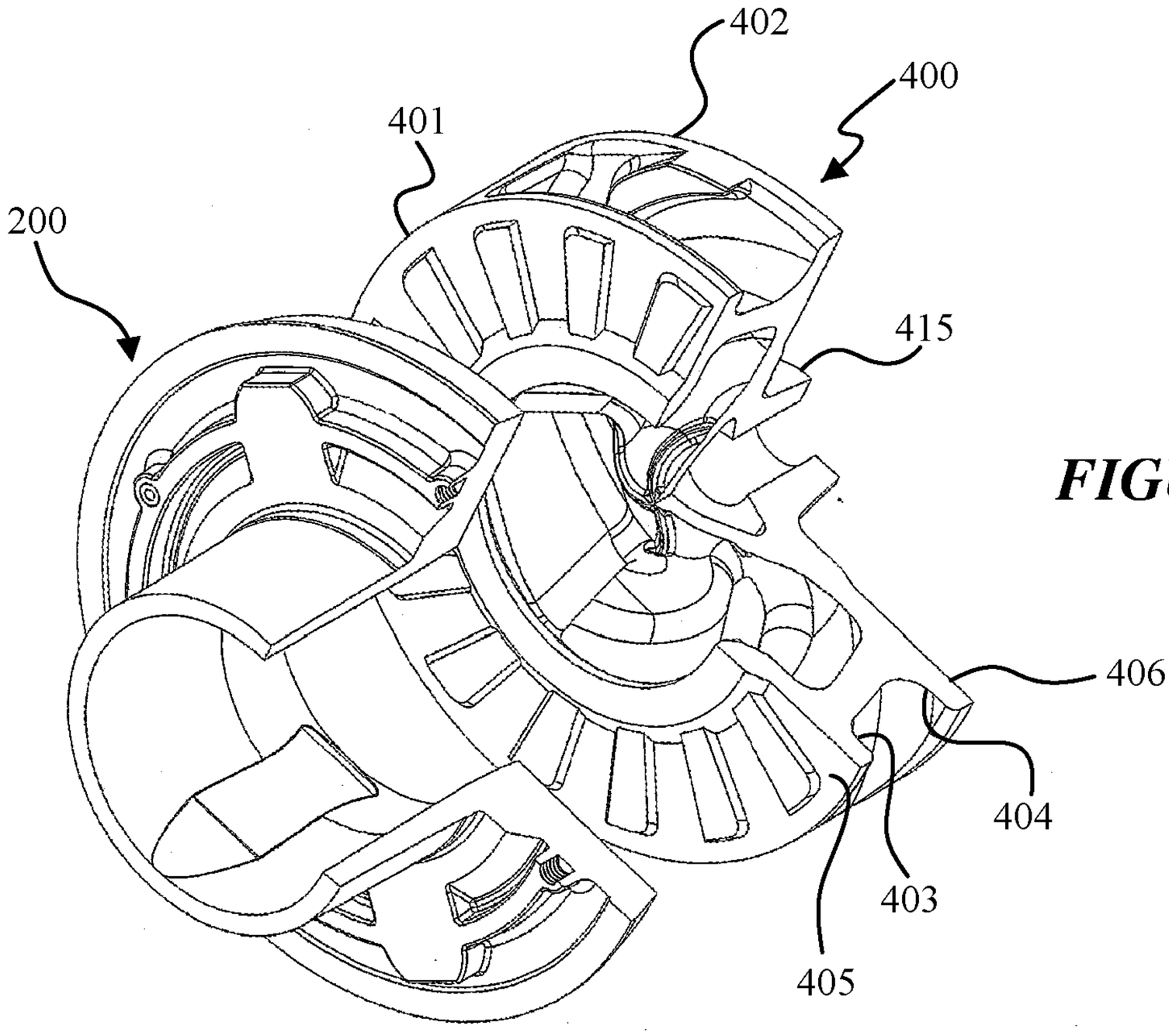

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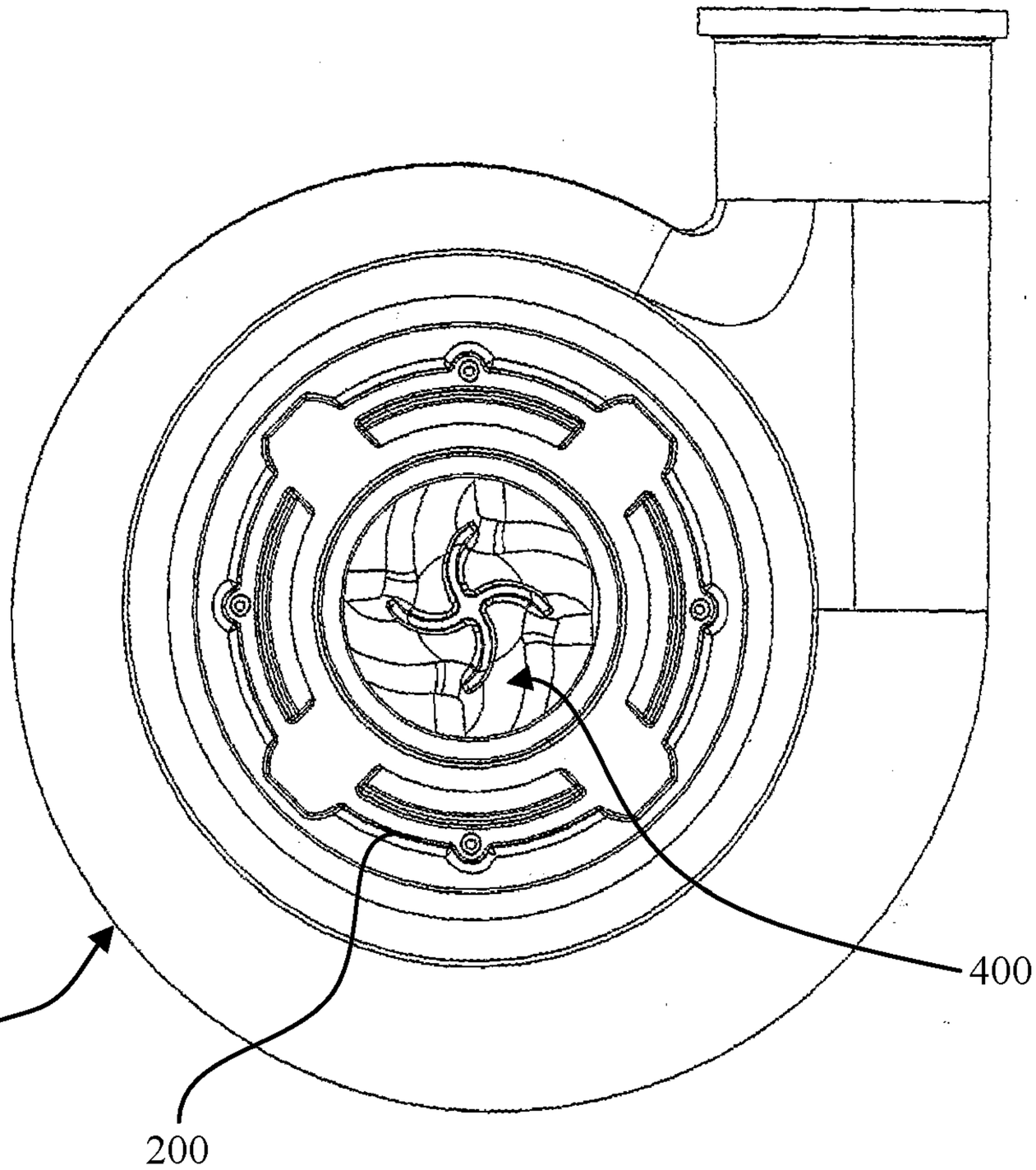
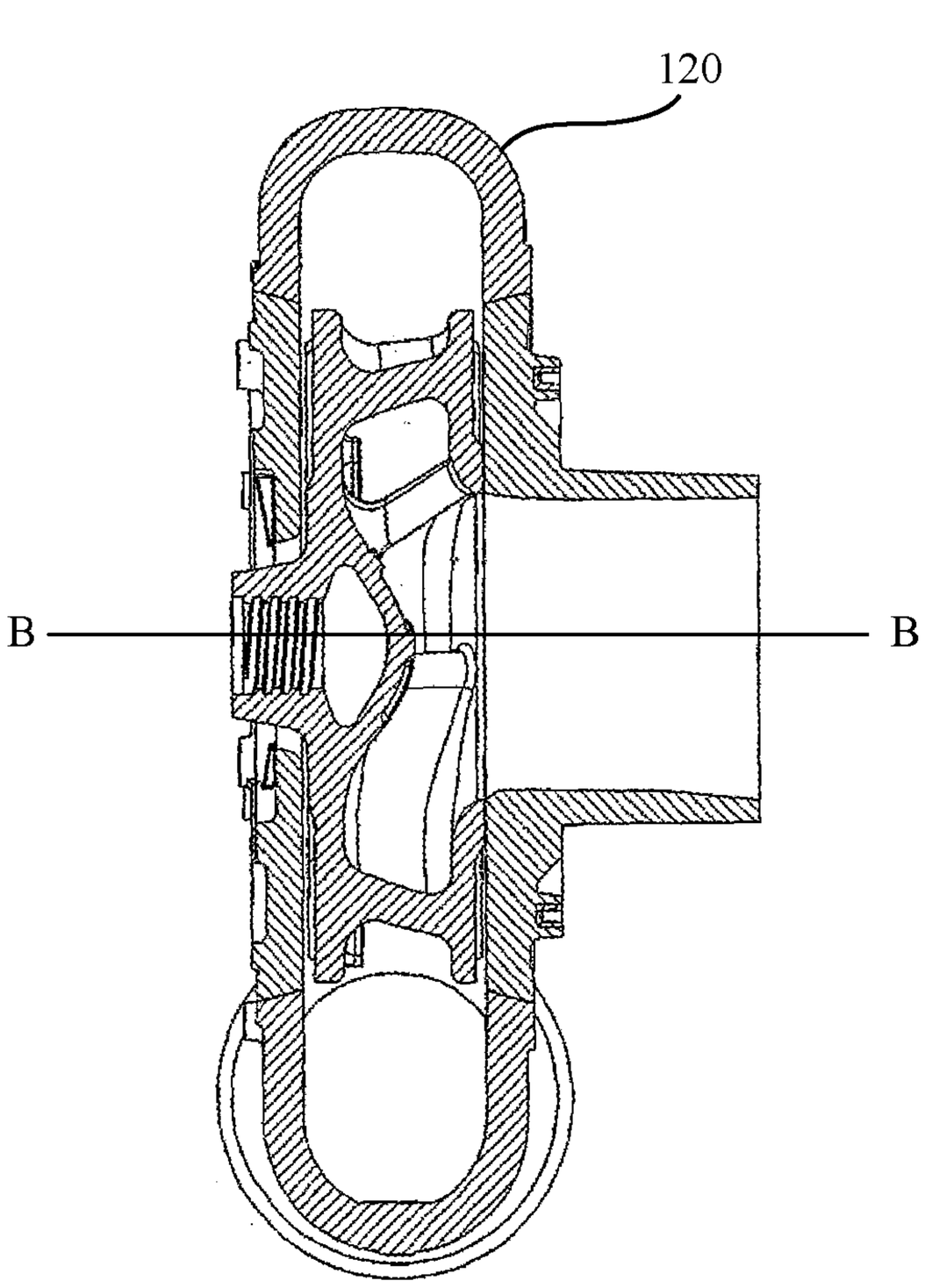


FIGURE 28



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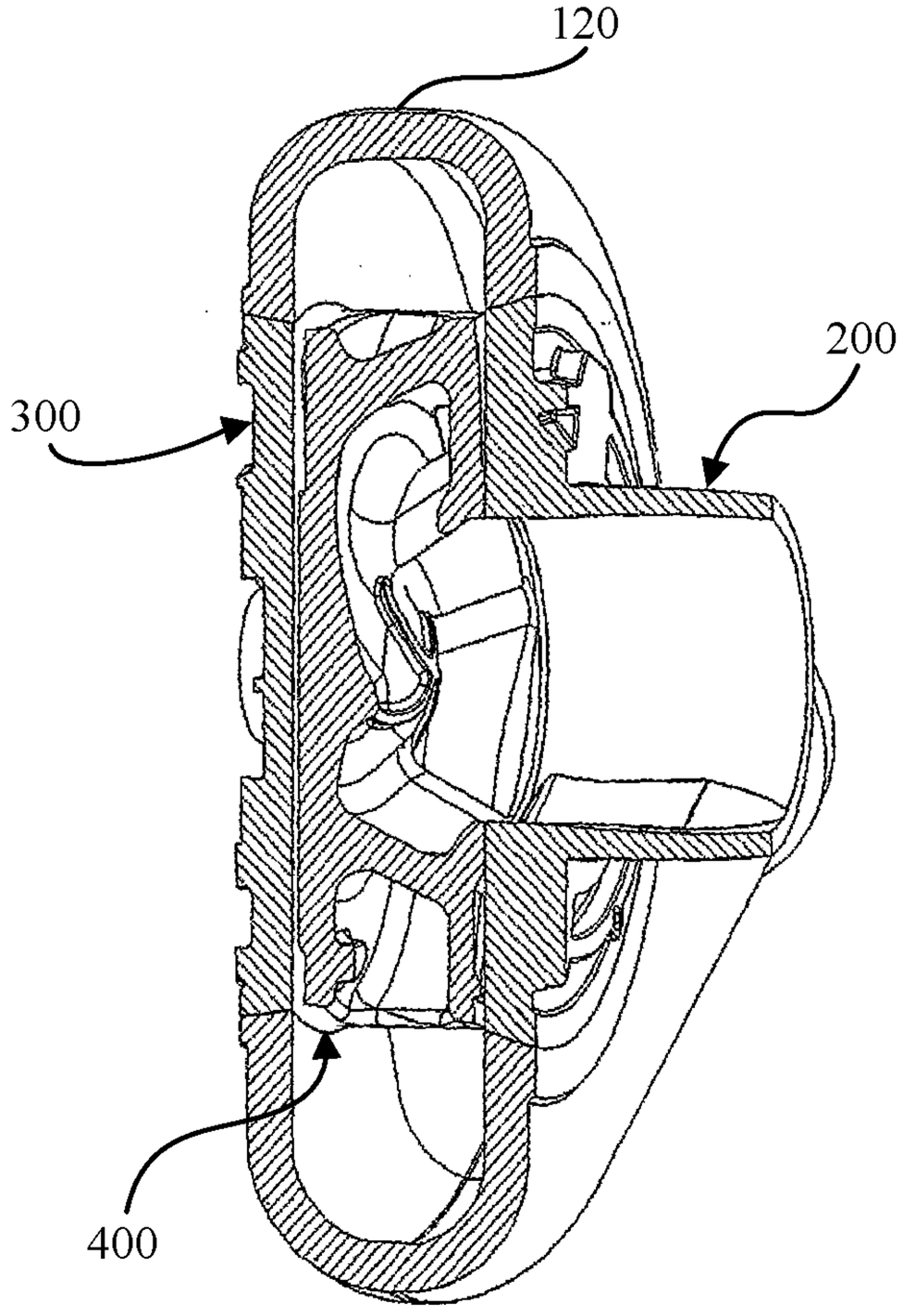
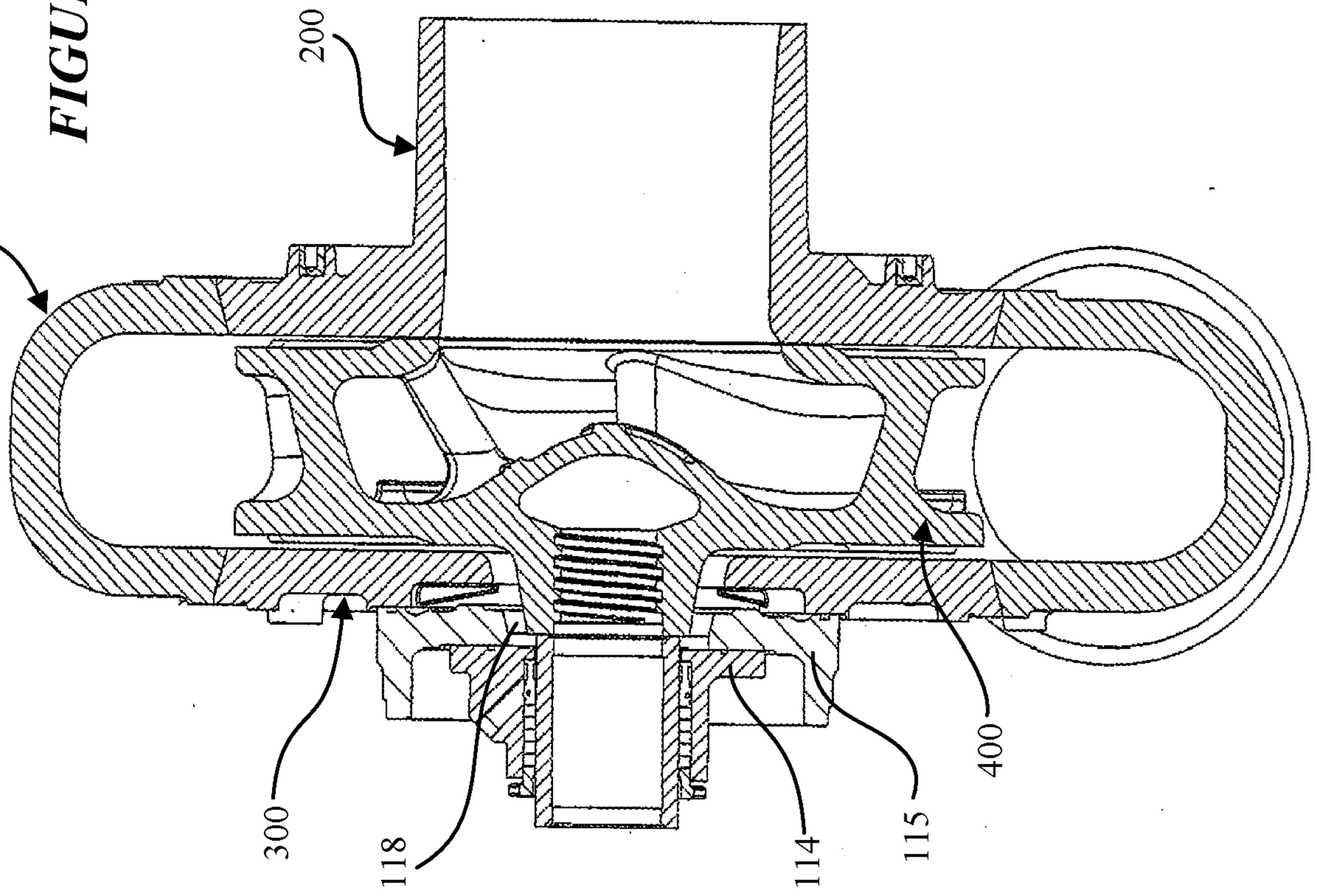


FIGURE 30

FIGURE 32



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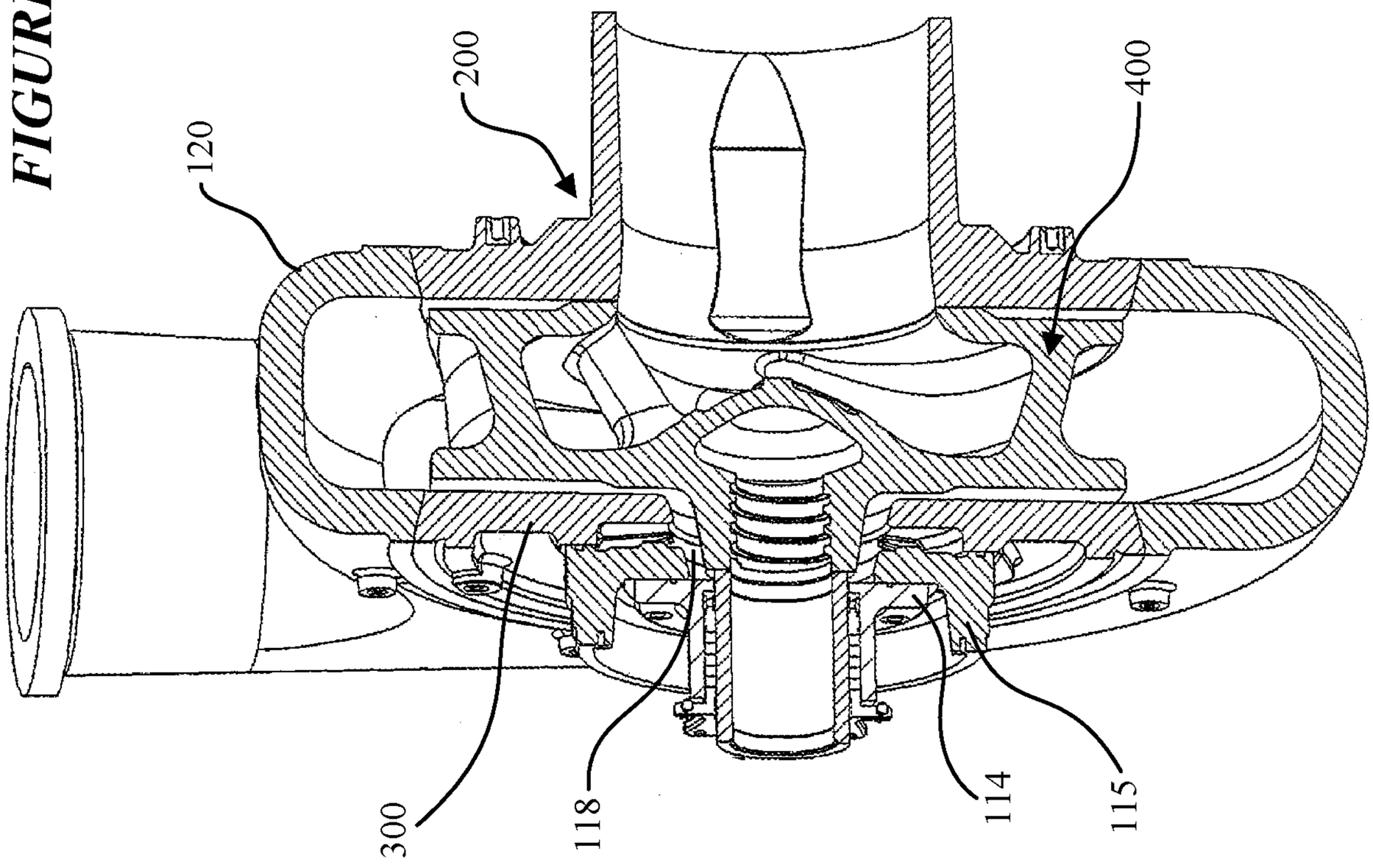

FIGURE 31