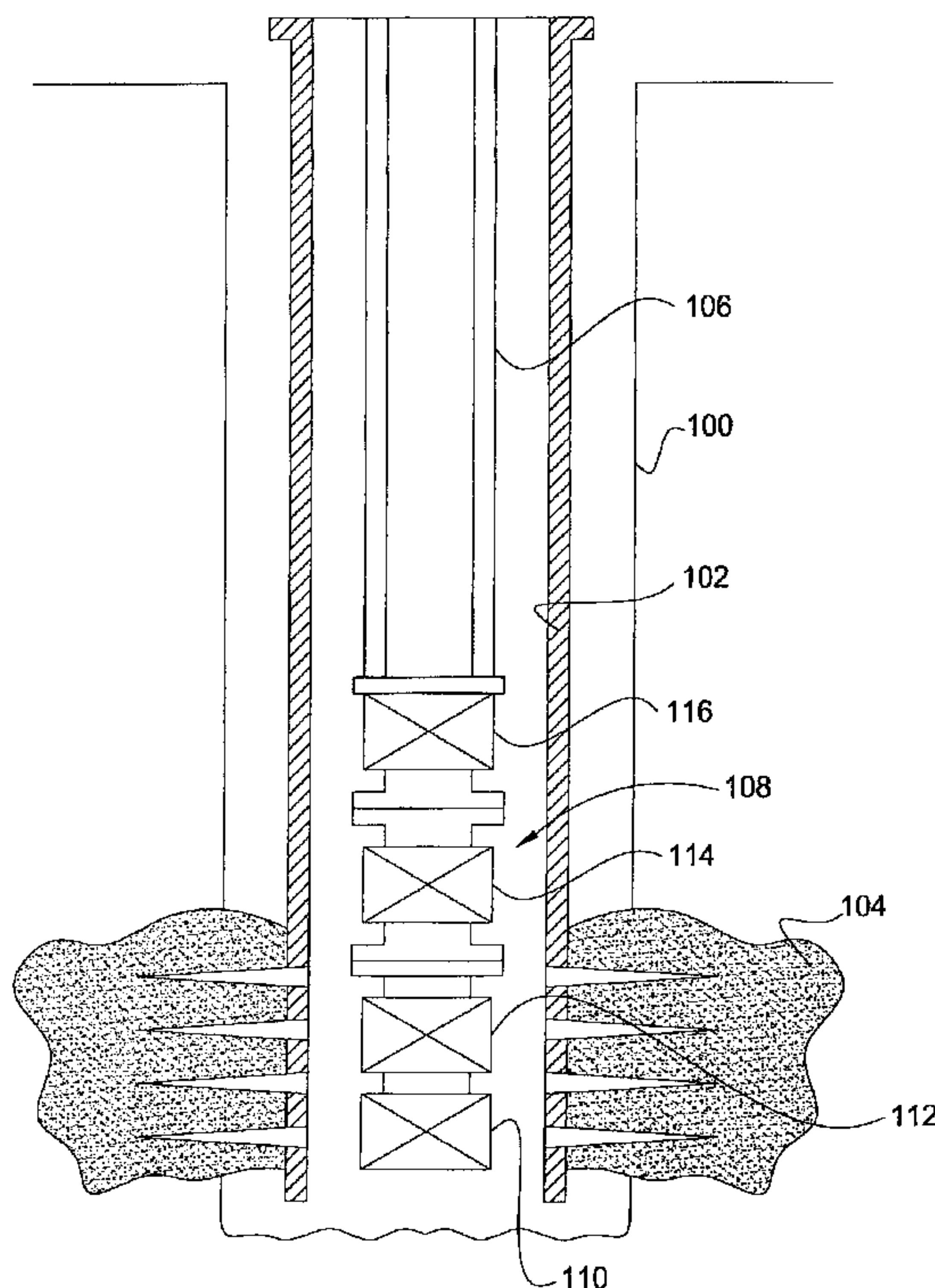




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(54) Titre : JOINT DE MOTEUR  
 (54) Title: MOTOR SEAL



(57) **Abrégé/Abstract:**

A method and apparatus for stabilizing a thrust chamber and circulating fluids within a motor seal is described herein. The apparatus includes a thrust chamber having a thrust runner and a radial bearing. A flow path exists through the radial bearing which stabilizes the thrust runner and circulates fluids in the thrust chamber. The flow path may consist of a plurality of grooves located adjacent to the radial bearing.

**ABSTRACT OF THE DISCLOSURE**

A method and apparatus for stabilizing a thrust chamber and circulating fluids within a motor seal is described herein. The apparatus includes a thrust chamber having a thrust runner and a radial bearing. A flow path exists through the radial bearing which stabilizes the thrust runner and circulates fluids in the thrust chamber. The flow path may consist of a plurality of grooves located adjacent to the radial bearing.

## MOTOR SEAL

### BACKGROUND OF THE INVENTION

#### Field of the Invention

5           Embodiments described herein generally relate to a thrust chamber for use in a wellbore. More particularly, embodiments described herein relate to a thrust chamber having a flow path configured to circulate lubricating fluids in a motor seal and stabilize a thrust runner.

#### Description of the Related Art

10           To obtain hydrocarbon fluids from an earth formation, a wellbore is drilled into the earth to intersect an area of interest within a formation. The wellbore may then be “completed” by inserting casing within the wellbore and setting the casing therein using cement. In the alternative, the wellbore may remain uncased (an “open hole wellbore”), or may become only partially cased.

15           Regardless of the form of the wellbore, production tubing is typically run into the wellbore primarily to convey production fluid (e.g., hydrocarbon fluid, which may also include water) from the area of interest within the wellbore to the surface of the wellbore.

          Often, pressure within the wellbore is insufficient to cause the production  
20           fluid to naturally rise through the production tubing to the surface of the wellbore. Thus, to carry the production fluid from the area of interest within the wellbore to the surface of the wellbore, artificial-lift means is sometimes necessary. The most prominent artificial-lift means are the use of down hole pumps and gas lift.

          Some artificially-lifted wells are equipped with electric submersible  
25           pumps. These pumps include electric motors which are submersible in the wellbore fluids. The electric motor connects to a motor seal which connects to a pump. The motor seal functions to seal the motor from the wellbore fluids while

allowing the motor to transfer torque to the pump. A motor seal typically includes a thrust protection portion. A thrust protection portion prevents downward thrust and forces created by the pump from damaging the motor. Further, a thrust protection portion prevents up-thrust created by the motor during start-up from  
5 damaging the pump or motor seal.

A thrust protection portion typically includes: a housing for containing two bearing portions, a thrust block, and a lubricating fluid. The thrust block is typically located between each of the bearing portions. The thrust block absorbs the downward forces created by the pump and the upward forces created by the  
10 motor during operation of the pump. The bearing portions prevent the thrust block from moving axially relative to the pump assembly while resisting the upward and downward forces.

The lubricating fluid in the housing is a fixed amount of fluid that circulates in the housing. The lubricating fluid lubricates the thrust block during  
15 operation of the pump assembly. During operation, the lubricating fluid absorbs energy from the thrust block and bearing portions, which causes the lubricating fluid to heat up and lose its ability to lubricate over the life of the pumping assembly.

Circulation of the lubricating fluid occurs in a large gap between the  
20 thrust block and the housing. This circulation creates turbulence near the bearing portions. The turbulence creates uneven load patterns on the bearing portion and thrust block. The uneven load patterns results in enhanced wear and vibration of the bearing portion and the thrust blocks.

Therefore, a need exists for a thrust chamber with the ability to circulate  
25 fluids into and/or out of the chamber. There is a further need for a thrust chamber configured to reduce unbalanced forces while circulating fluids.

## **SUMMARY OF THE INVENTION**

The embodiments described herein relate to an apparatus for sealing and protecting a motor for use in a wellbore. The apparatus includes a housing, a thrust runner and a radial bearing. The thrust runner is configured to fit  
5 inside the substantially cylindrical housing. The radial bearing is located between the thrust runner and the housing. A flow path is created past the thrust runner by one or more grooves between the housing and the thrust runner, wherein the one or more grooves allow a fluid to flow past the radial bearing.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

10 So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this  
15 invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

Figure 1 is a schematic view of a wellbore according to one embodiment described herein.

20 Figure 2 is a cross-sectional view of a motor seal according to one embodiment described herein.

Figure 3 is a cross-sectional view of a thrust chamber according to one embodiment described herein.

Figures 4A and 4B are a cross-sectional view of a thrust housing according to one embodiment described herein.

25 Figure 5A is a top view of a thrust runner according to one embodiment described herein.

Figure 5B is a cross-sectional view of a thrust runner according to one embodiment described herein.

Figure 6A is a perspective view of a bearing portion according to one embodiment described herein.

5 Figure 6B is a side view of a bearing portion according to one embodiment described herein.

Figure 6C is a top view of a bearing portion according to one embodiment described herein.

### **DETAILED DESCRIPTION**

10 Figure 1 is a schematic view of a wellbore 100 according to one embodiment described herein. The wellbore 100 includes a tubular 102 which is secured in the wellbore 100 using cement, not shown. The wellbore 100 and the tubular 102 intersects at least one production zone 104. The tubular 102 is typically a string of casing and/or liner; however, it could be any tubular used in  
15 downhole operations. Further, the wellbore 100 may be an open hole wellbore. As shown, a conveyance 106 is within the tubular 102 and coupled to an artificial lift assembly 108. As shown, the conveyance is production tubing; however, it should be appreciated that the conveyance could be any conveyance for delivering the artificial lift assembly 108 into the wellbore 100 for example: a wire  
20 line, a slick line, a coiled tubing, a co-rod, a drill string, a casing, etc. The artificial lift assembly 108 pushes the production fluids from the wellbore to the surface of the wellbore 100.

The artificial lift assembly 108 includes: a motor 110, a motor seal 112, an intake 114, and a pump 116. The motor 110, as shown, is an electric motor;  
25 however, it is contemplated that any motor for use in a wellbore may be used. The motor seal 112 includes a thrust chamber which includes one or more flow paths

adapted to circulate a lubricating fluid, not shown, from a seal portion of the motor seal to the thrust chamber, and optionally into the motor 110. The motor seal 112 prevents thrust loads from affecting the motor 110 and/or the pump 116 while allowing torque to transfer from the motor 110 to the pump 116. The motor seal 112 equalizes the pressure in the artificial lift assembly 108 with the wellbore fluids and lubricates the thrust chamber as will be discussed in more detail below. The pump 116 is a multistage centrifugal pump; however, it is contemplated that any downhole pump may be used. The intake 114 provides a flow path from the wellbore to the interior of the artificial lift assembly 108. The intake 114 may be any intake used in downhole operations. It is contemplated that the parts of the artificial lift assembly 108 be arranged in any order so long as the wellbore fluids are pushed to the surface by the pump 116.

Figure 2 shows a cross-sectional view of the motor seal 112 of the artificial lift assembly 108 according to one embodiment of the present invention. The motor seal 112 includes three seal portions 200, 202, and 204 in series coupled to the thrust chamber 206. Although shown as having three seal portions 200, any number of seal portions may be used including one. A shaft 208 runs through the seal portions 200, 202, and 204 and the thrust chamber 206. The motor seal 112 includes a first connector end 210 and a second connector end 212. As shown the first connector end 210 couples to the motor 110, and the second connector end 212 couples to the intake 114 and/or the pump 116, as shown in Figure 1. The motor 110 includes a motor drive shaft, not shown, which couples to the shaft 208 near the first connector end 210 of the motor seal 112. The pump 116 includes a pump drive shaft, not shown, which couples to the shaft 208 near the second connector end 212 of the motor seal 112. The connection between at least one of the motor shaft or the pump shaft and the shaft 208 may include an axial slip, not shown, which allows the shaft 208 to move at least partially in the axial direction, such as a splined connection while the motor 110 transfers torque to the shaft 208. The shaft 208 transfers torque from the motor

shaft to the pump shaft. The pump shaft operates the pump in order to push the wellbore fluids to the surface of the wellbore 100.

The seal portions 200, 202, and 204, as shown, are a labyrinth type motor seal. Each of the seal portions 200, 202, and 204 include a chamber 214, a  
5 mechanical seal 216 and a series of ports 218. The series of ports 218 are in fluid communication with the thrust chamber 206, as will be discussed in more detail below. Prior to being placed in the wellbore, the motor seal 112 is filled with a lubricating fluid, not shown. The lubricating fluid, in one embodiment, is a dielectric fluid having a specific gravity lower than typical wellbore fluids. Further,  
10 any lubricating fluid may be used.

The thrust chamber 206 includes a thrust housing 219, a thrust runner 220, an up-thrust bearing 222, and a down thrust bearing 224. The thrust runner 220 couples to the shaft 208 in a manner that allows it to rotate with the shaft 208, while preventing relative axial movement between the shaft 208 and the thrust  
15 runner 220. The up-thrust bearing 222 and a down thrust bearing 224 are fixed relative to the thrust housing 219. The up-thrust bearing 222 and the down thrust bearing 224 prevent axial force in the shaft 208 from transferring to the motor 110 or the pump 116 during operation. Between the thrust housing 219 and the thrust runner 220 is a radial bearing 226. The radial bearing 226 is a fluid bearing which  
20 prevents the thrust runner 220 from contacting the thrust housing 219 during operation. The fluid bearing consists of the lubricating fluid which is a relatively non-compressible fluid and is located in a relatively small radial clearance between the thrust housing 219 and the thrust runner 220 in one embodiment. The thrust housing 219 and/or the thrust runner 220 include a flow path through the radial  
25 bearing 226, as will be discussed in more detail below.

Figure 3 shows a cross-sectional view of the thrust chamber 206 and the seal portion 204. The mechanical seal 216 is a typical mechanical seal used in a motor seal. The thrust housing 219, as shown, couples to the first connector

end 210 and the seal portion 204. Seal rings 300 prevent fluid from leaking into or out of the thrust chamber 206 from the wellbore 100. The thrust runner 220 couples to the shaft 208 via couplings 302. The couplings 302 prevent relative axial movement between the thrust runner 220 and the shaft 208. The upper thrust bearing 222 has one or more load pads 304 and a coupling 306 for coupling the up-thrust bearing 222 to the thrust housing 219. The coupling 306 prevents the upper thrust bearing 222 from moving in a substantially axial or rotational direction during operation. The downward thrust bearing 224 may be substantially the same as the upper thrust bearing 222; therefore, only details of the upper thrust bearing 222 will be discussed in detail. The coupling 306 may be accomplished in any manner for example by bolts, screws, welding, etc.

Figures 4A and 4B show cross-sectional views of the thrust housing 219, according to one embodiment of the present invention. The thrust housing 219 includes two or more housing grooves 400 in an inner surface 402 of the housing. The housing grooves 400 may be a portion of the flow path which will be described in more detail below. Two grooves 400 are shown; however, any number of grooves may be provided so long as the grooves 400 are symmetrical around inner surface 402 of the thrust housing 219.

Figures 5A and 5B show a top and cross-sectional side view of the thrust runner 220, respectively. As shown, the thrust runner 220 includes two or more grooves 500 on an outer surface 502 of the thrust runner 220. In one embodiment, the grooves 500 may be used in conjunction with the housing grooves 400 to form a part of the flow path. Three grooves 500 are shown; however, it should be appreciated that any number of grooves may be provided so long as the grooves 500 are substantially symmetrical around outer surface 502 of the thrust runner 220. At least one of the sets of grooves 400 or 500 is optional. That is, there may be only grooves 500, or only housing grooves 400, or there may be both. The thrust runner 220 may include a profile 504 which corresponds with

a matching profile, not shown, on the shaft 208. The profile 504 transfers torque from the shaft 208 to the thrust runner 220.

The housing grooves 400 and the grooves 500 are shown as being substantially parallel with the shaft 208. This arrangement allows for bi-directional flow of fluids across the thrust runner 220. The housing grooves 400 and the grooves 500 are also shown as being rectangular grooves in the thrust runner 220 and the thrust housing 219; however, it should be appreciated that the grooves may have any geometry so long as the grooves 400 and 500 allow fluids to flow past the thrust runner 220 during operation, such as: rounded, triangular, polygonal, etc. The Fluid flows through the housing grooves 400 and the grooves 500 to stabilize the thrust runner 220 as it rotates in the thrust housing 219.

Figures 6A-6C show views of the upper thrust bearing 222. The upper thrust bearing 222, as shown, has six load pads 304 symmetrically located around the bearing; however, there could be any number of load pads 304. The upper thrust bearing 222 includes a bore 600 through which the shaft 208 and lubricating fluid passes. Further, the upper thrust bearing 222 includes a gap 602 between each of the load pads 304 that provide an area for the lubricating fluid to flow during operation. The load pads 304 in operation may have a fluid film, not shown, between the thrust runner 220 and the load pads 304 that aids in reducing friction between the two surfaces. The fluid film is formed from a thin layer of the lubricating fluid on each of the load pads 304. The fluid film reduces friction between the thrust runner 220 and the load pads 304 during rotation.

In operation, the wellbore 100 is formed and the formation is perforated. Production fluids then fill the wellbore 100. To enhance recovery of production fluids to the surface of the wellbore 100, the artificial lift assembly 108 is run into the wellbore on the conveyance 106. Before the artificial lift assembly 108 is lowered into the wellbore 100, the motor seal 112 is filled with the lubricating fluid. The artificial lift assembly 108 is lowered into the wellbore 100 and may be

submersed in wellbore fluids. The intake 114 and/or pump 116 allow the wellbore fluids and/or the production fluids to enter the artificial lift assembly 108. When at a desired location, the motor 110 actuates in order to operate the pump 116.

5 The actuation of the motor 110 turns the motor shaft which transfers torque to the shaft 208. The torque in the shaft 208 causes the shaft 208 to rotate within the motor seal 112. The rotation of the shaft 208 is transferred to the thrust runner 220 thereby causing the thrust runner 220 to rotate. The radial bearing 226 substantially prevents the thrust runner 220 from contacting the thrust housing 219 during rotation. The flow path which consists of either the housing grooves 400,  
10 the grooves 500, or both, circulates the lubricating fluid upon rotation of the thrust runner 220. The rotation of the thrust runner 220 creates a pressure drop in the flow path across the thrust runner 220 causing the lubricating fluids in the thrust chamber 206 to move toward the pump 116. Additionally, the lubricating fluid may flow past the thrust runner 220 toward the motor in a space, not shown, between  
15 the shaft 208 and the thrust runner 220 which replenishes the lubricating fluid on the motor side of the thrust runner 220. As the speed of rotation increases the pressure drop across the thrust runner 220 increases thereby increasing the circulation speed.

Initially the motor 110 and thrust runner 220 begin to rotate and cause  
20 shaft 208 and thrust runner 220 to move up toward the pump 116. The upward movement creates an up-thrust force which is absorbed by the upper thrust bearing 222. The fluid film between the thrust runner 220 and the upper thrust bearing 222 transfers it to the load pads 304 while reducing friction between the thrust runner and the upper thrust bearing 222. The load pads 304 transfer the up  
25 thrust to the upper thrust bearing 222 which in turn transfers the load to the thrust housing 219. This prevents the up thrust from transferring up the shaft 208 and into the pump 116. The circulation of the lubricating fluids past the radial bearing 226 decreases turbulence around the load pads 304. The decrease in turbulence

decreases the vibration and wear on the load pads 304 during operation, thereby enhancing the life of the thrust runner 220 and the upper thrust bearing 222.

As the motor 110 continues to turn the shaft 208 and the pump shaft, the pump eventually begins to push wellbore fluids and/or production fluids toward the surface of the wellbore 100. This pushing/pumping of the fluids toward the surface of the wellbore causes reactive down thrust on the pump shaft and in turn the shaft 208. The down thrust transfers down the shaft 208 to the thrust runner 220. The thrust runner 220 transfers the down thrust to the down thrust bearing 224. The down thrust bearing 224 absorbs the load in the same way as the upper thrust bearing absorbed the up thrust. The circulation of the lubricating fluid reduces the turbulence around the down thrust bearing 224 in the same manner as described above.

The circulation of the lubricating fluid by the thrust runner causes circulation between the seal portions 200, 202, and 204 and the thrust chamber 206 through the series of ports 218. The lubricating fluid, which is pushed upward by the rotation of the thrust runner 220, flows up a first port 250 toward the seal portion 204. The lubricating fluid enters chamber 214 near the upper end of the chamber 214. The additional lubricating fluid in the full chamber 214 causes lubricating fluid to flow up the second port 252 and into the chamber 214 of the seal portion 202. This circulation continues and eventually the lubricating fluid interacts with the wellbore fluids and/or production fluids near the connection between the seal portion 200 and the intake 114 and/or the pump 116. The interaction between the wellbore fluids and the lubricating fluids causes some wellbore fluids to enter the motor seal 112. As discussed above, the wellbore fluids may have a higher specific gravity than the lubricating fluids. Thus during circulation, the wellbore fluids will flow toward the bottom of each of the seal portions 200, 202, 204. As the wellbore fluids reach the bottom of the first seal portion 200 some of the wellbore fluids will flow down a third port 254 and into the

seal portion 202. The mechanical seals 216 prevent the wellbore fluids from flowing out of the seal portions 200, 202, and 204 along the shaft 208. The ports 250, 252 and 254 are bi-directional, that is fluids can flow up or down the ports 250, 252 and 254. The lubricating fluids will substantially remain in the upper portions of the seal portions 200, 202, and 204. Because the first port 250 has an entry/exit near the upper portion of the seal portion 204, wellbore fluids and production fluids are substantially prevented from entering the thrust chamber 206. The circulation of the lubricating fluids in the seal portions 200, 202, and 204, with the lubricating fluids in the thrust chamber 206, increase the cooling of the lubricating fluids in the thrust chamber. That cooling enhances the life of the upper thrust bearing 222 and the down thrust bearing 224. The flow path in the thrust chamber 206 and the radial bearing allow the artificial lift assembly 108 to operate longer in a wellbore 100 than conventional motor seals.

In one embodiment, the radial bearing clearance between the thrust housing 219 and the thrust runner 220 is in the range of .002 to .008 inches. In an alternative embodiment, the radial bearing clearance is less than or equal to .008 inches. In yet another alternative embodiment, the radial bearing clearance is greater than or equal to .002 inches. The radial bearing effect may be lost if the radial bearing clearance is too large.

In an alternative embodiment, the motor seal comprises of a bag motor seal rather than the labyrinth motor seal described above. The operation of the thrust chamber 206 is the same as described above; however, the motor seals operate with bags.

In yet another embodiment, the flow path are in the shape of spiraled grooves, not shown. Thus, the housing grooves 400 or the grooves 500, or both, have a spiraled configuration. As described above, either housing grooves 400 or grooves 500 are optional. The spiraled flow path decreases the pressure drop across the thrust runner 220. The spiraled flow pushes the lubricating fluid in one

direction past the thrust runner 220. The spiraled flow may be arranged to push the lubricating fluids toward the pump 116, thereby creating a circulation as described above. Further, the spiraled flow path may push the lubricating fluids toward the motor 110. As the lubricating fluids flow toward the motor 110, they  
5 circulate with fluid in the motor 110. This circulation in the motor 110 increases the life and reliability of the motor 110 during the lifting operation. The circulation between the seal portions 200, 202, and 204 and the thrust chamber 206 remain substantially the same as described above.

In yet another embodiment, one of the sets of grooves 400 or 500 may  
10 be spiraled while the other sets of grooves 400 or 500 is substantially parallel with the shaft 208.

While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims  
15 that follow.

**Claims:**

1. An apparatus for sealing and protecting a motor for use in a wellbore, comprising:
  - a housing;
  - a thrust runner configured to fit inside the housing, wherein the thrust runner is substantially cylindrical;
  - a radial bearing between the thrust runner and the housing; and
  - one or more grooves between the housing and the thrust runner, wherein the one or more grooves allow a fluid to flow past the radial bearing.
2. The apparatus of claim 1, wherein the radial bearing is a pressurized fluid between the housing and the thrust runner.
3. The apparatus of claim 2, wherein the distance between the thrust chamber and the thrust runner is no greater than .002".
4. The apparatus of claim 1, wherein the one or more grooves are cut into the thrust runner.
5. The apparatus of claim 1, wherein the one or more grooves are cut into the housing.
6. The apparatus of claim 1, wherein the one or more grooves are cut into a combination of the housing and the thrust runner.
7. The apparatus of claim 1, wherein the grooves run substantially parallel to a longitudinal axis of the apparatus.

8. The apparatus of claim 1, wherein the grooves form a spiral pattern past the thrust runner.
9. The apparatus of claim 1, further comprising a first thrust bearing configured to withstand an up thrust on the thrust runner.
10. The apparatus of claim 9, further comprising a second thrust bearing configured to withstand an up thrust on the thrust runner.
11. The apparatus of claim 1, wherein the thrust chamber is a part of a motor seal.
12. The apparatus of claim 11, wherein the motor seal further comprises a one or more fluid reservoirs configured to initially contain a lubricating fluid.
13. The apparatus of claim 12, wherein the lubricating fluid is a dielectric fluid having a lower specific gravity than a wellbore fluid.
14. The apparatus of claim 13, wherein the one or more fluid reservoirs are configured to circulate the lubricating fluid in the motor seal and the housing.
15. The apparatus of claim 12, further comprising a pump coupled to the motor seal, the pump adapted to be driven by the motor which is couple to the motor seal.
16. The apparatus of claim 15, further comprising a drive shaft in the motor seal which is coupled to the motor at one end and the pump at the other.
17. The apparatus of claim 16, wherein the drive shaft travels through an aperture in the thrust runner.

18. The apparatus of claim 17, wherein the aperture has a profiled portion configured to transfer torsion from the drive shaft to the thrust runner.

19. The apparatus of claim 11, wherein the motor is an electric submersible motor.

20. The apparatus of claim 15, wherein the pump is one or more centrifugal pumps.

21. An apparatus for stabilizing a motor seal for use with an electric submersible

pump in a wellbore, the apparatus comprising:

a motor;

a pump; and

a motor seal configured to absorb a force created by the pump, the motor seal including:

a drive shaft configured to transfer a torque from the motor to the pump;

a thrust chamber including:

a housing;

at least one thrust bearing;

a thrust runner configured to transfer the force from the drive shaft to the thrust bearing;

a radial bearing between the housing and the thrust runner;

a flow path through the radial bearing, wherein the flow path comprises a plurality of grooves configured to move a lubricating fluid within the thrust chamber; and

one or more seal portions.

22. The apparatus of claim 21, wherein the grooves are formed in the thrust runner.
23. The apparatus of claim 21, wherein the grooves are formed in the housing.
23. The apparatus of claim 21, wherein the grooves are formed in both the thrust runner and the housing.
24. The apparatus of claim 21, wherein the grooves form a spiraled pattern.
25. The apparatus of claim 21, wherein the grooves run substantially parallel to the drive shaft.
26. A method of lubricating the stabilizing a thrust runner, the method comprising: actuating an electric motor in a wellbore;  
rotating a drive shaft in a motor seal with the electric motor;  
transferring the rotation from the drive shaft to a thrust runner;  
preventing the thrust runner from wearing against a housing with a fluid pressure between the thrust runner and the housing; and  
flowing a lubricating fluid between the thrust runner in a plurality of grooves, wherein the flowing is initiated by the rotation of the thrust runner.
27. The method of claim 26, wherein the flowing of lubricating fluid includes circulating the lubricating fluid toward the electric motor in order to lubricate the electric motor.

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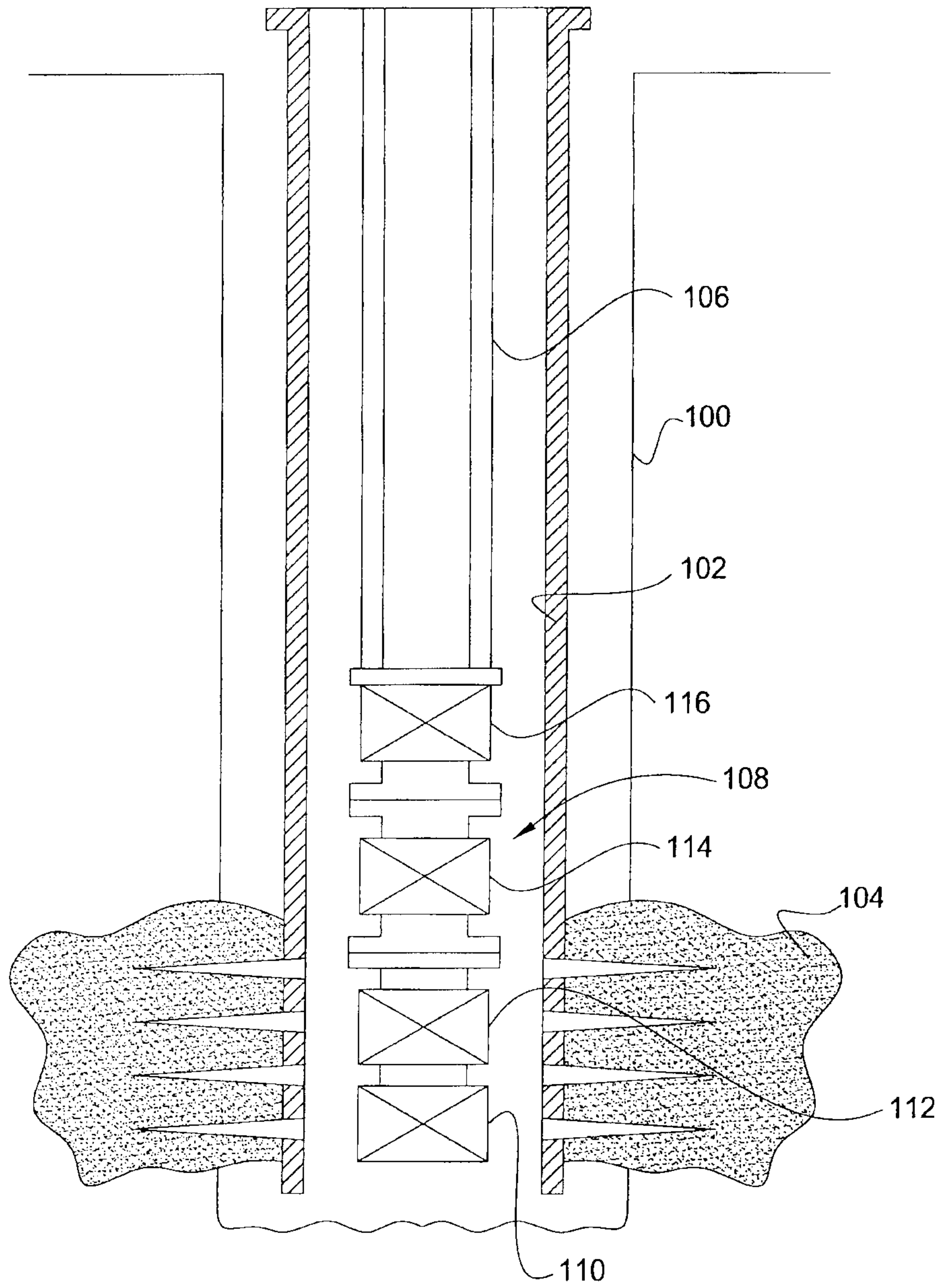


FIG. 1

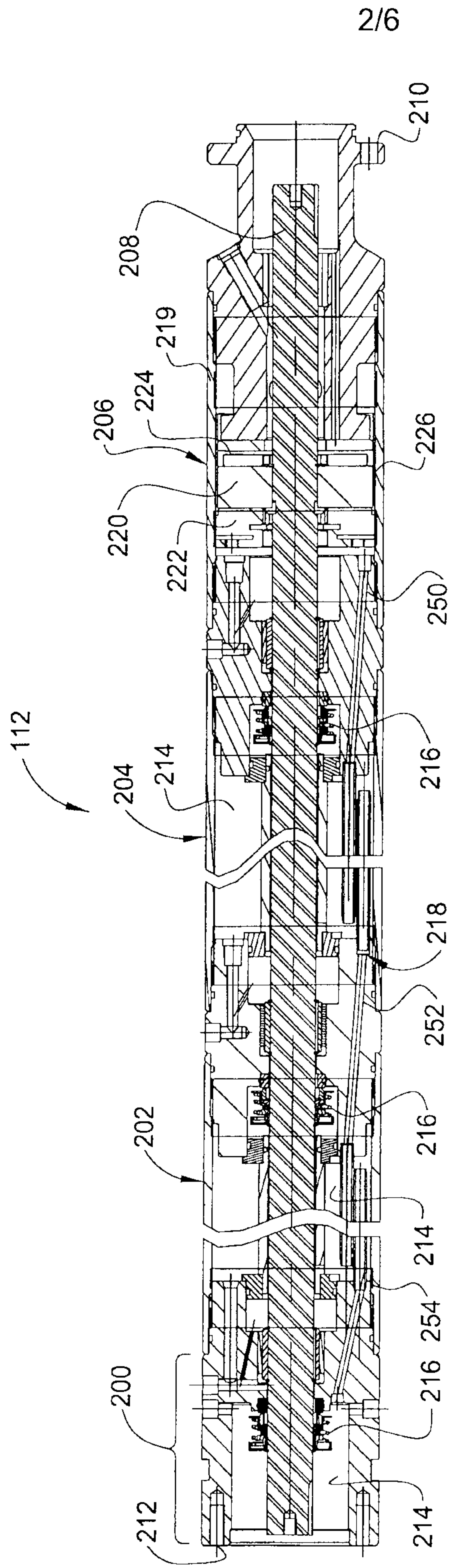


FIG. 2

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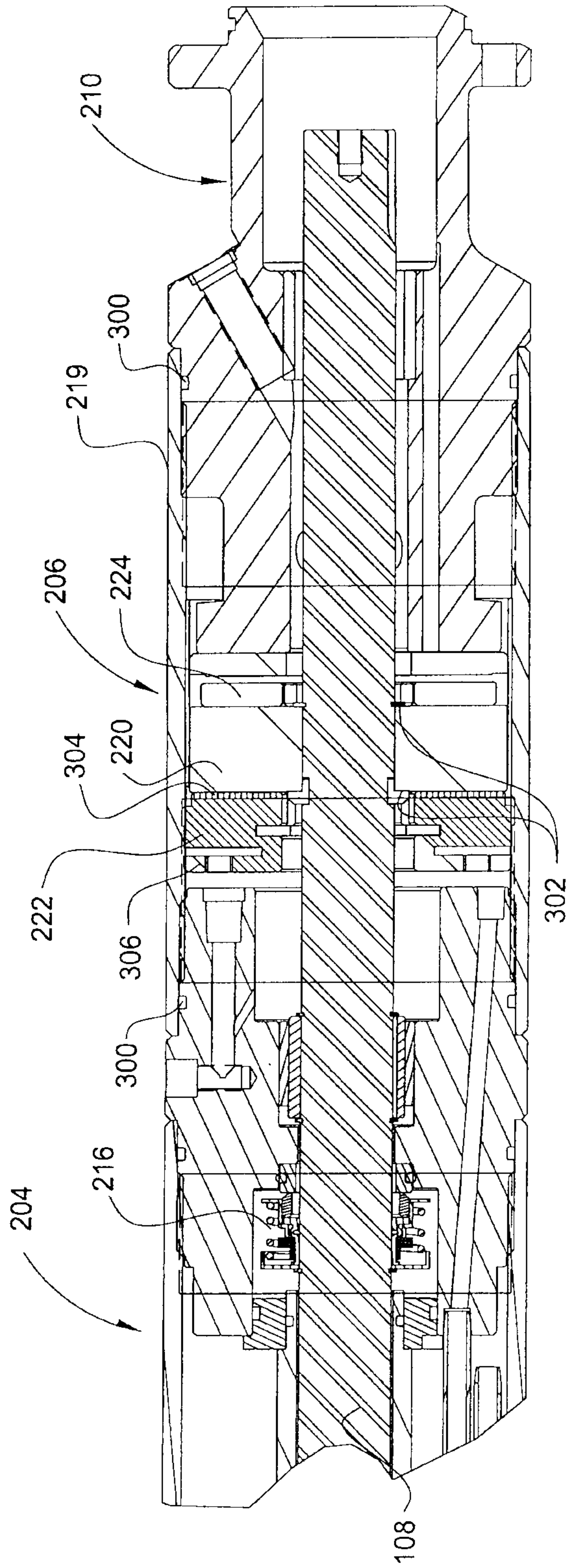


FIG. 3

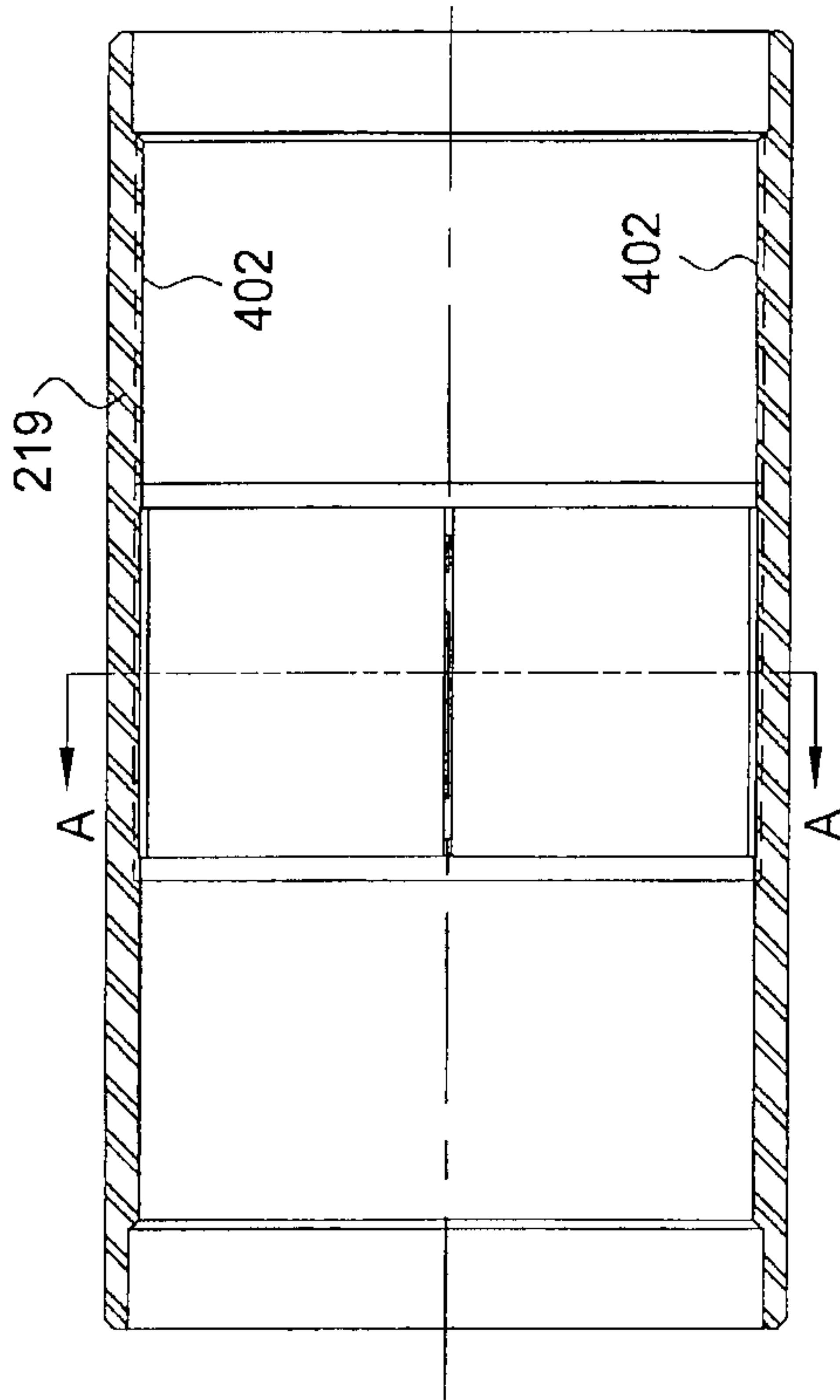


FIG. 4A

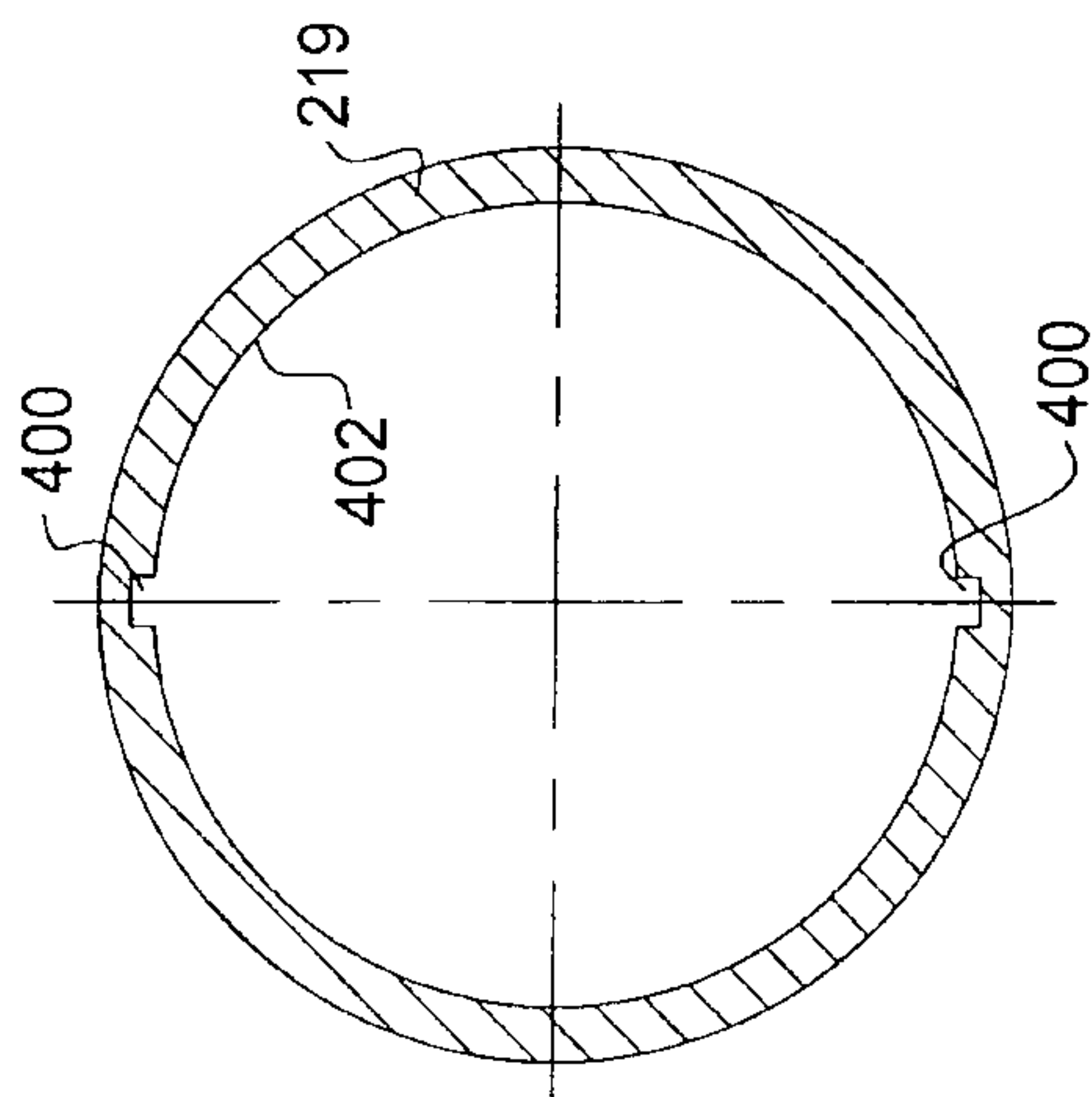


FIG. 4B

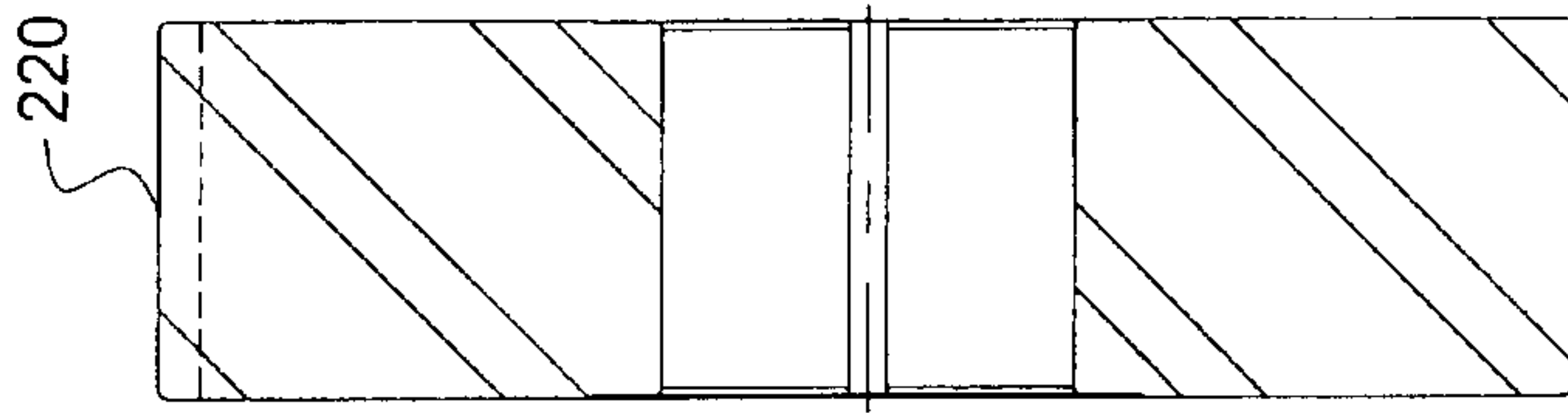


FIG. 5B

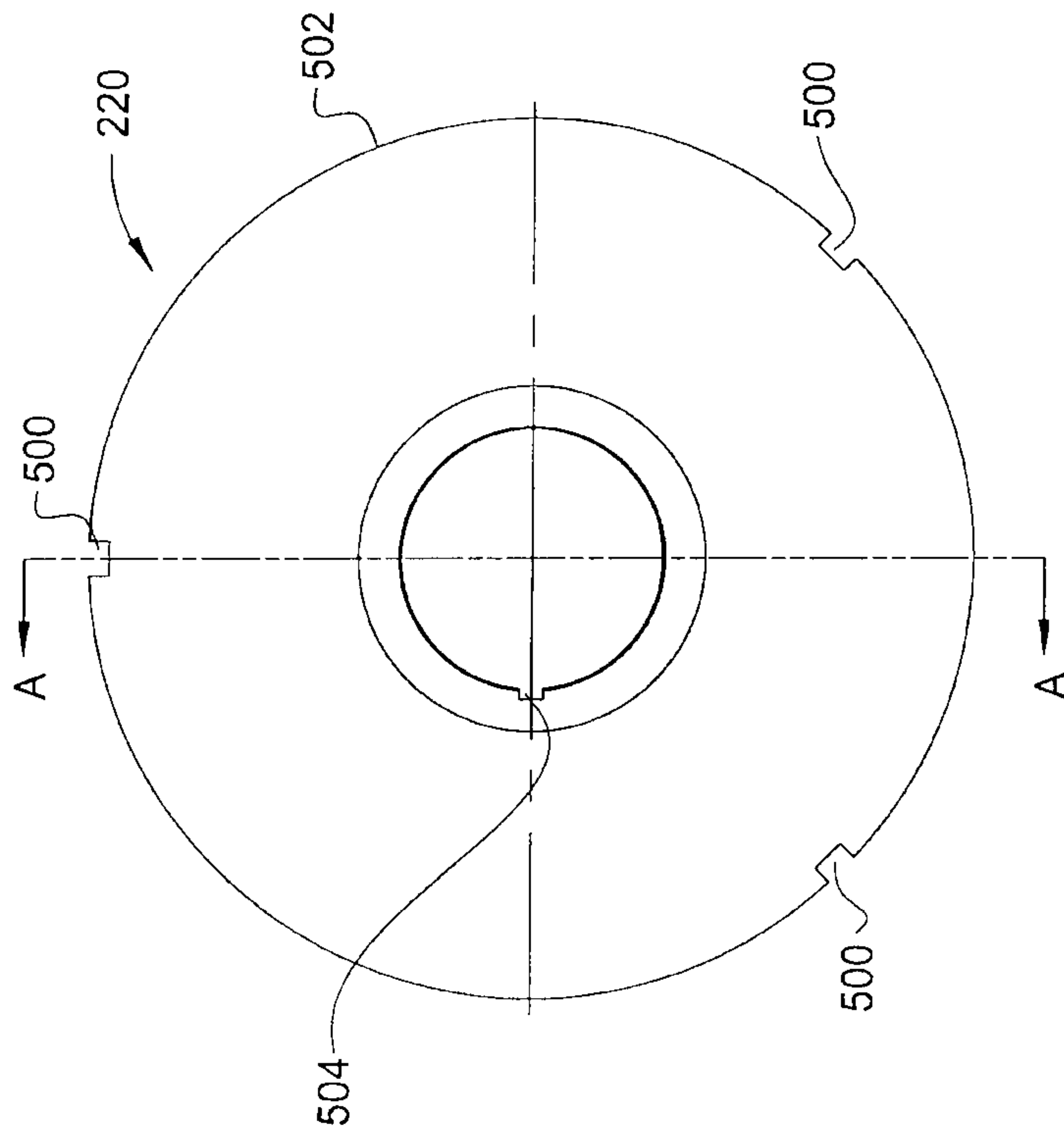


FIG. 5A

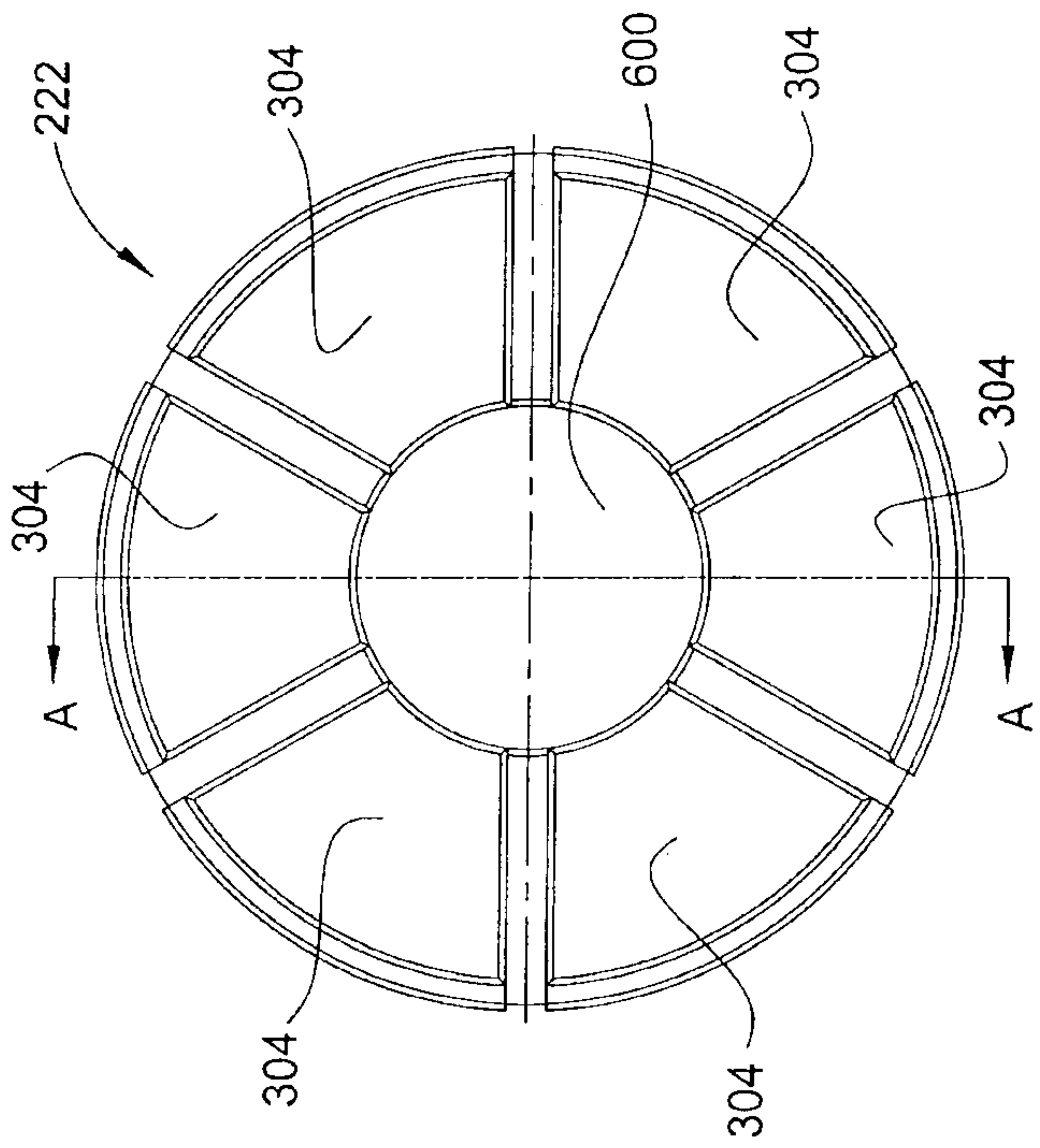


FIG. 6C

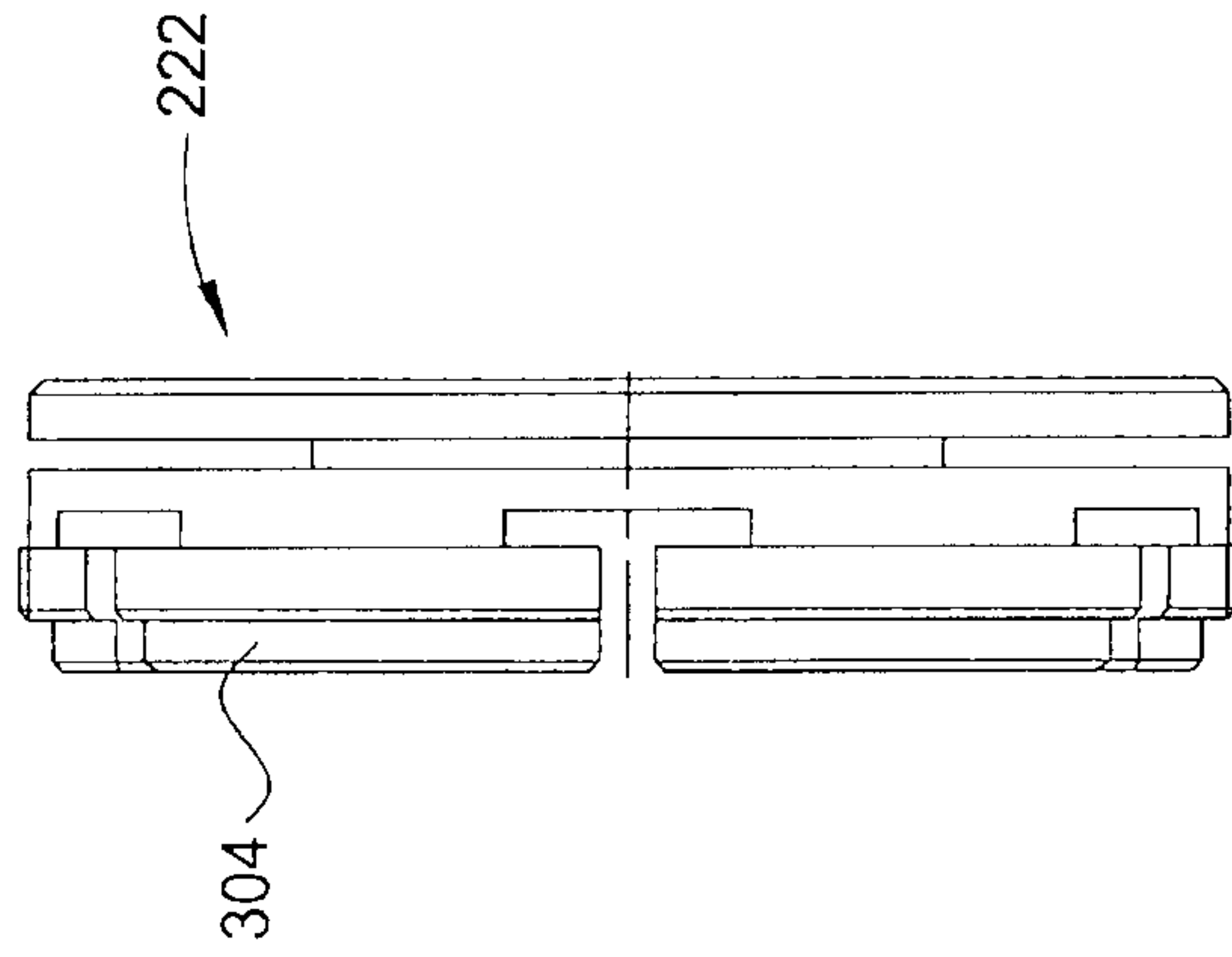


FIG. 6B

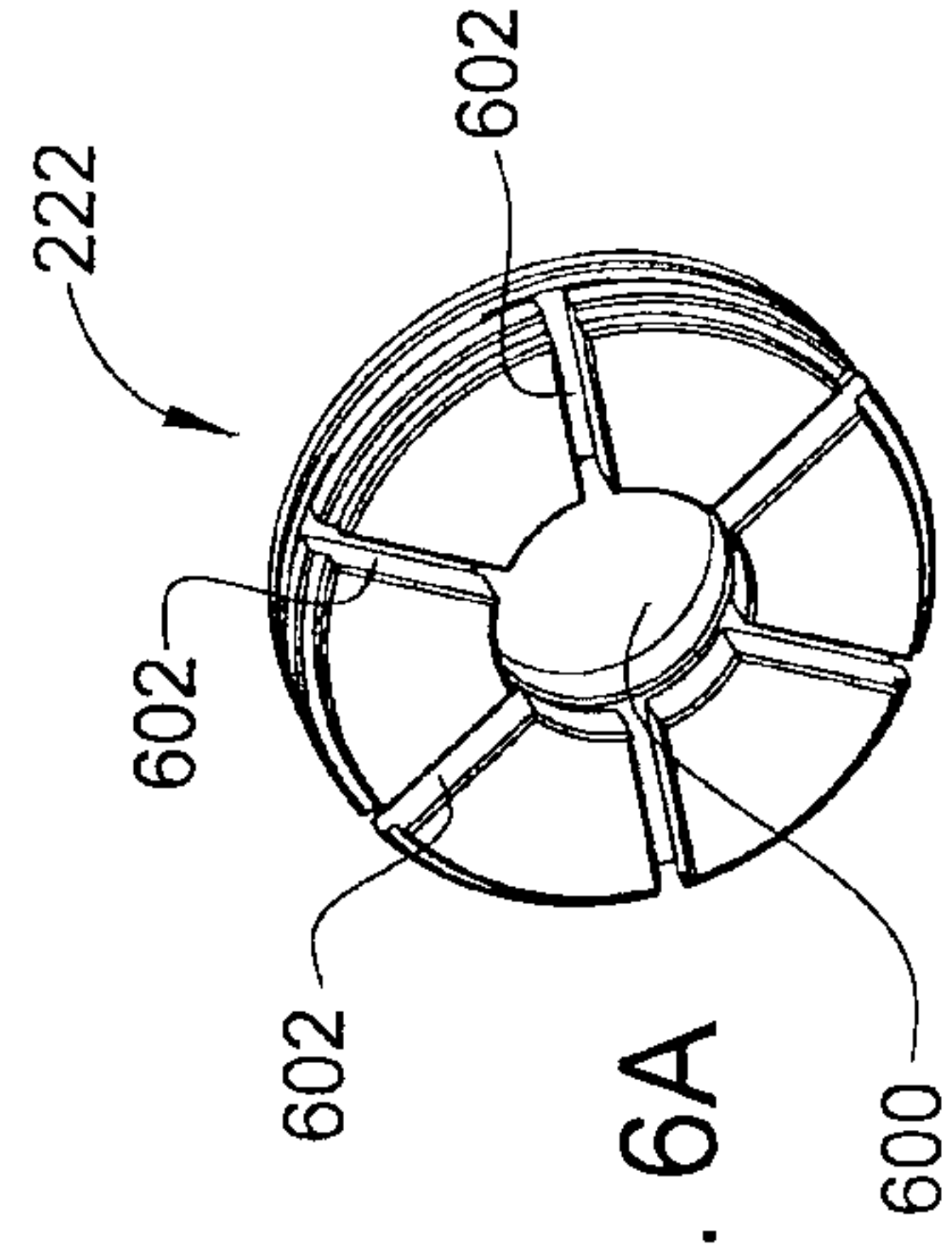


FIG. 6A

