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**Su**

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(54) **FLUID DRIVEN DRILLING MOTOR**

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U.S.C. 154(b) by 478 days.

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14, 2013.

(51) **Int. Cl.**  
**E21B 4/14** (2006.01)  
**E21B 1/02** (2006.01)  
**E21B 4/02** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **E21B 4/14** (2013.01); **E21B 1/02**  
(2013.01); **E21B 4/02** (2013.01)

(58) **Field of Classification Search**

CPC ..... E21B 4/14; E21B 1/02; E21B 4/02; E21B  
4/06

See application file for complete search history.

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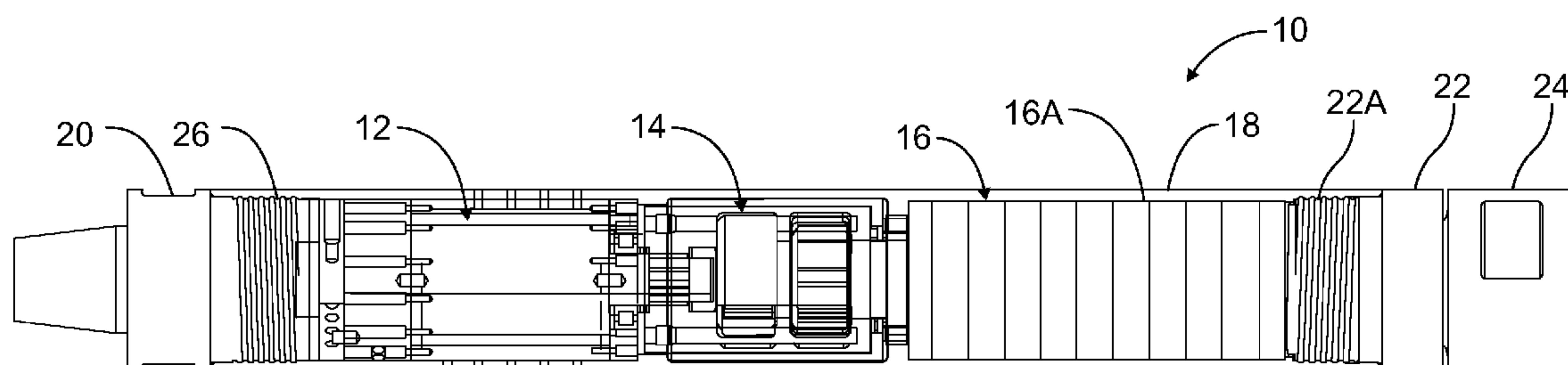
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(57) **ABSTRACT**

A motor assembly is disclosed that includes a vane motor  
coupled to an output shaft by a drive section. The drive  
section includes hammers that engage the output shaft to  
provide improved torque.

**14 Claims, 10 Drawing Sheets**



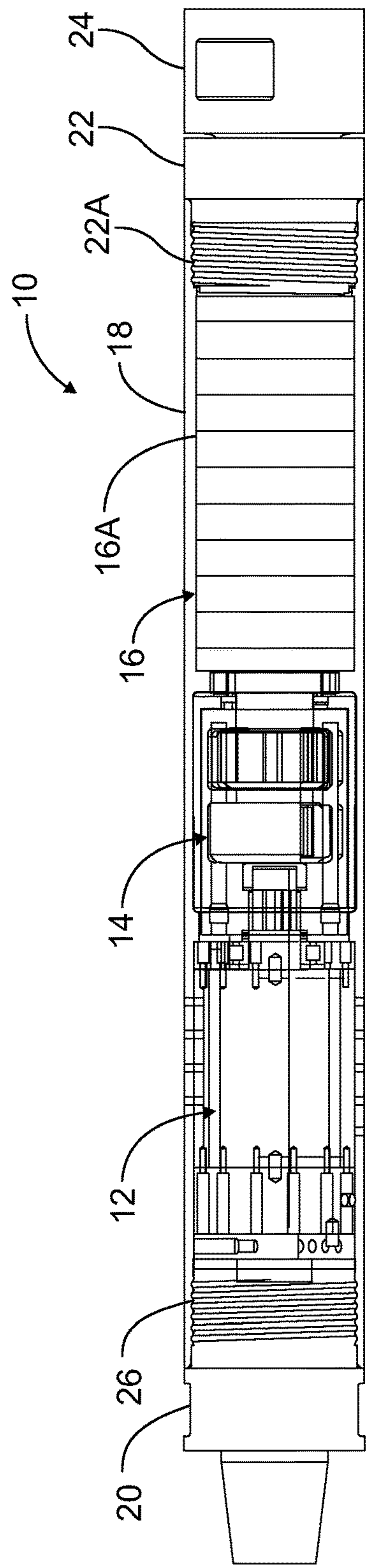


Figure 1

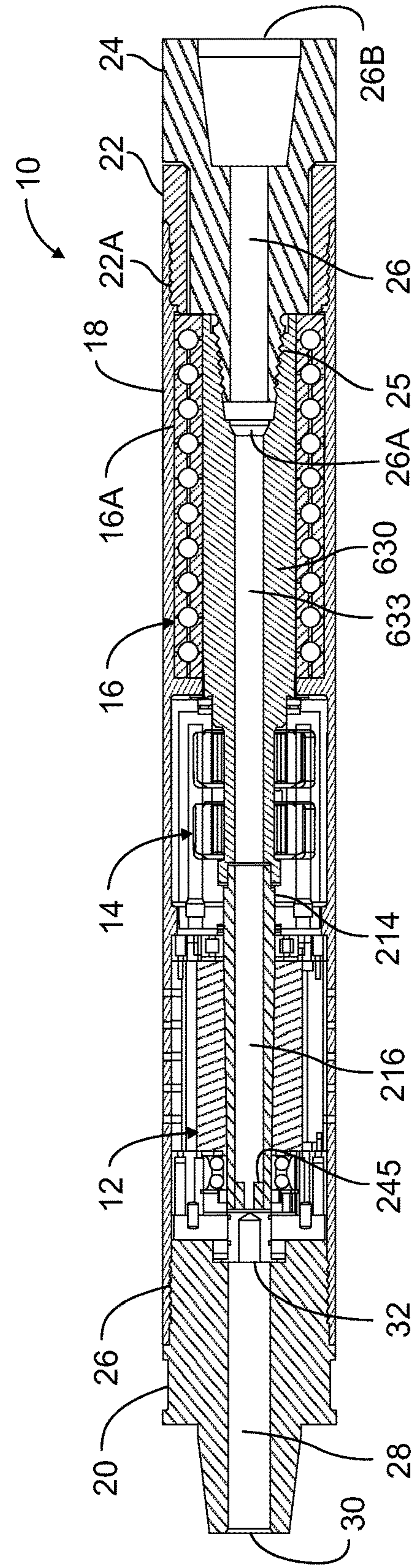


Figure 2



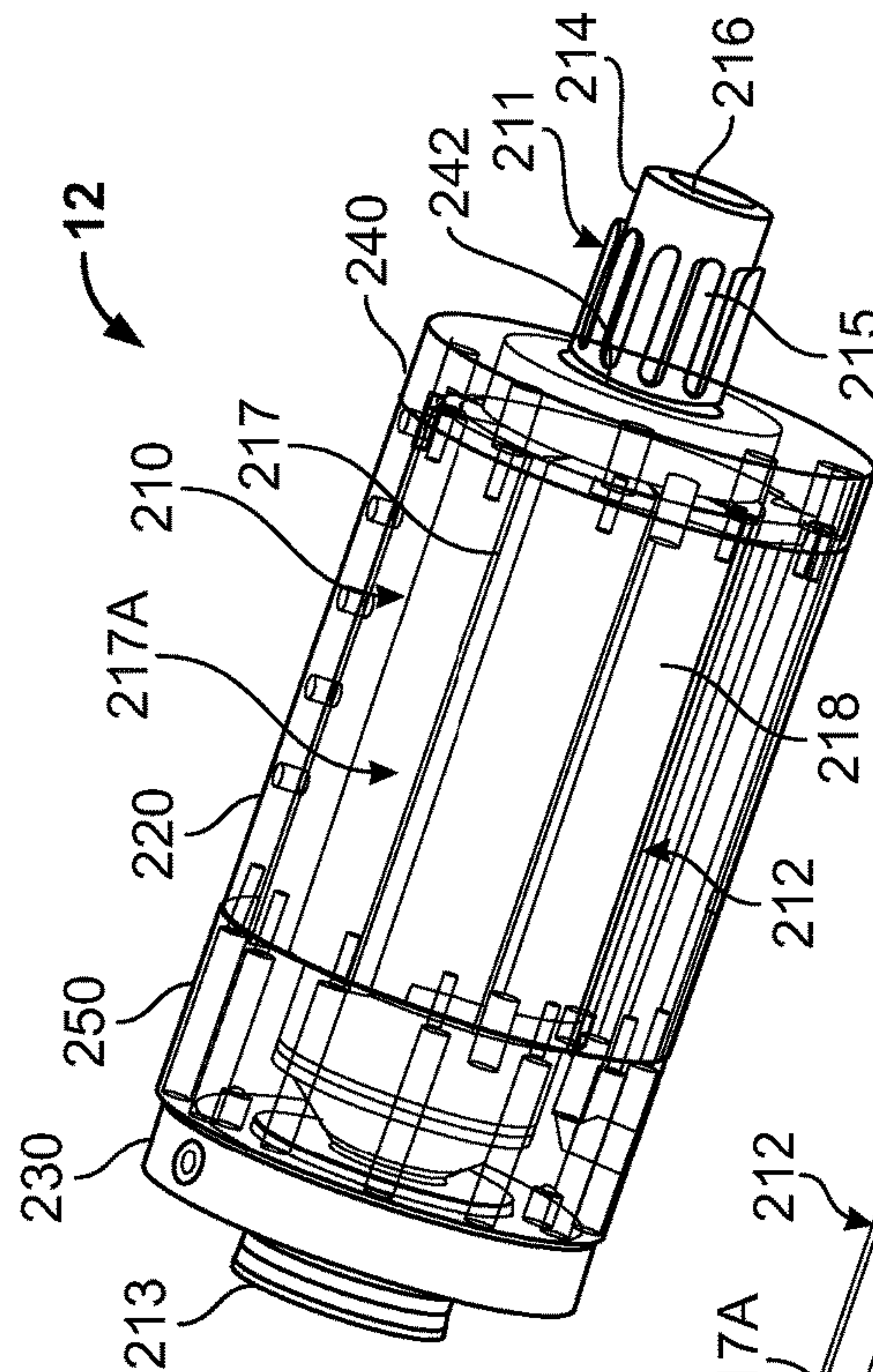


Figure 3

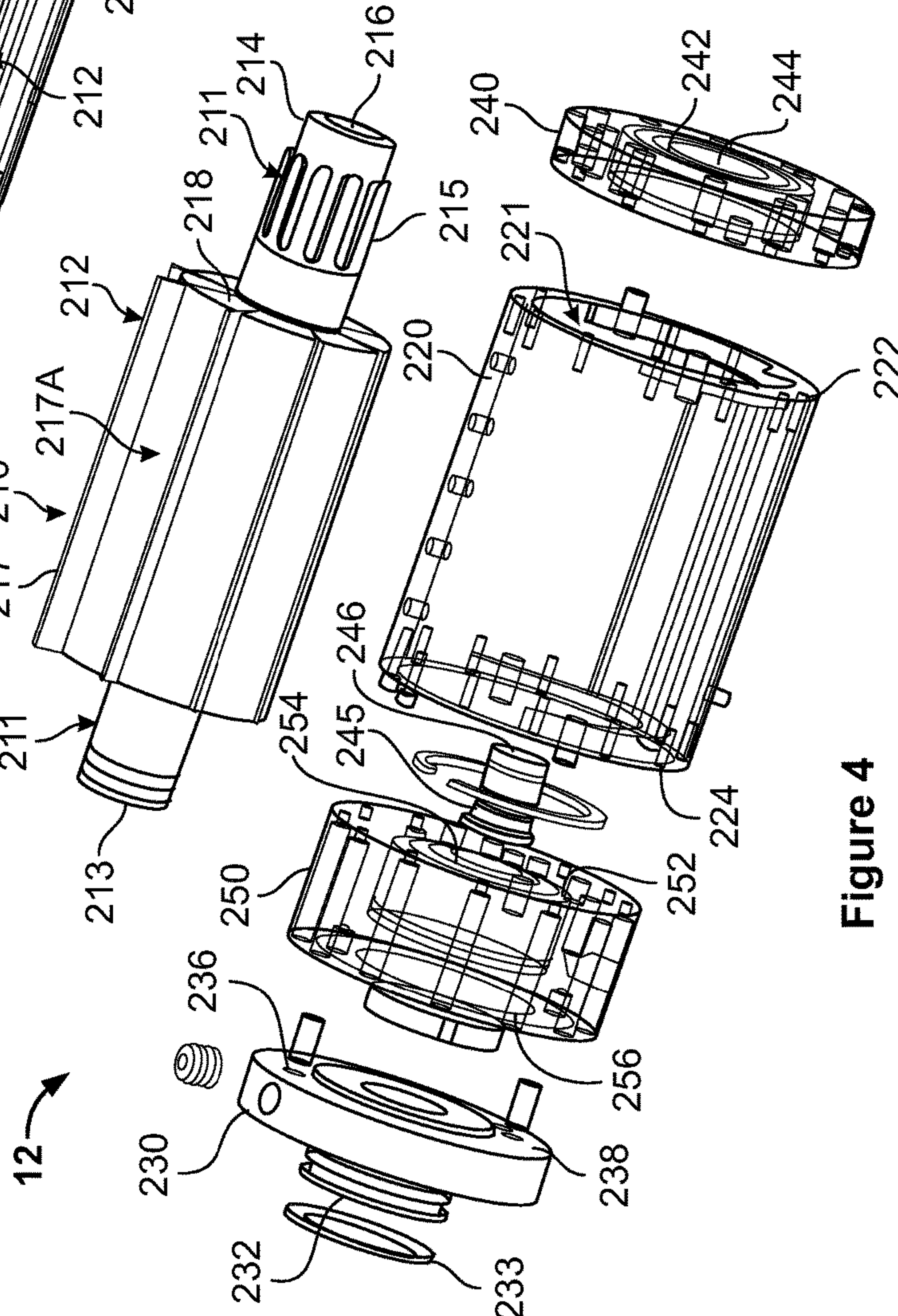


Figure 4

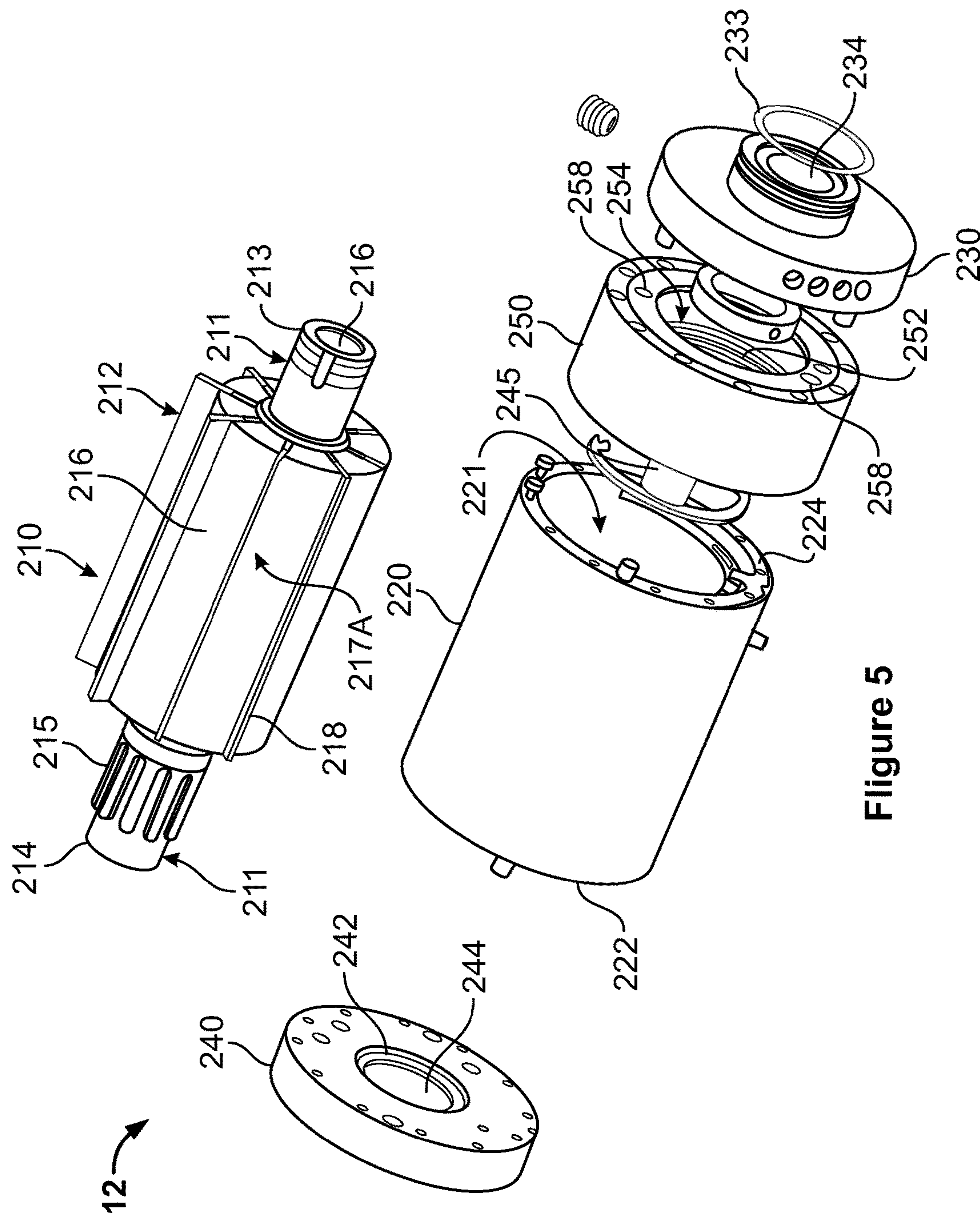
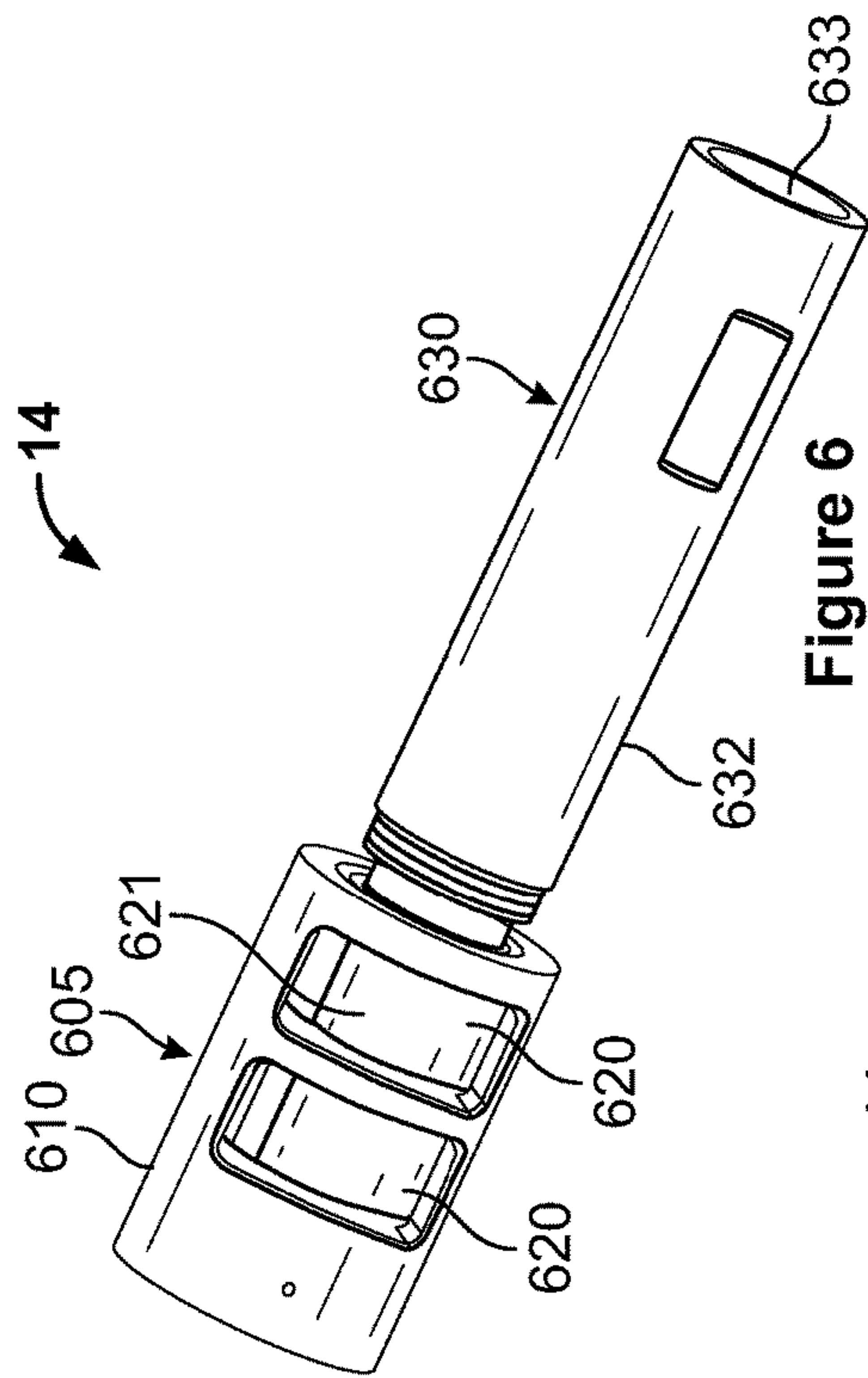
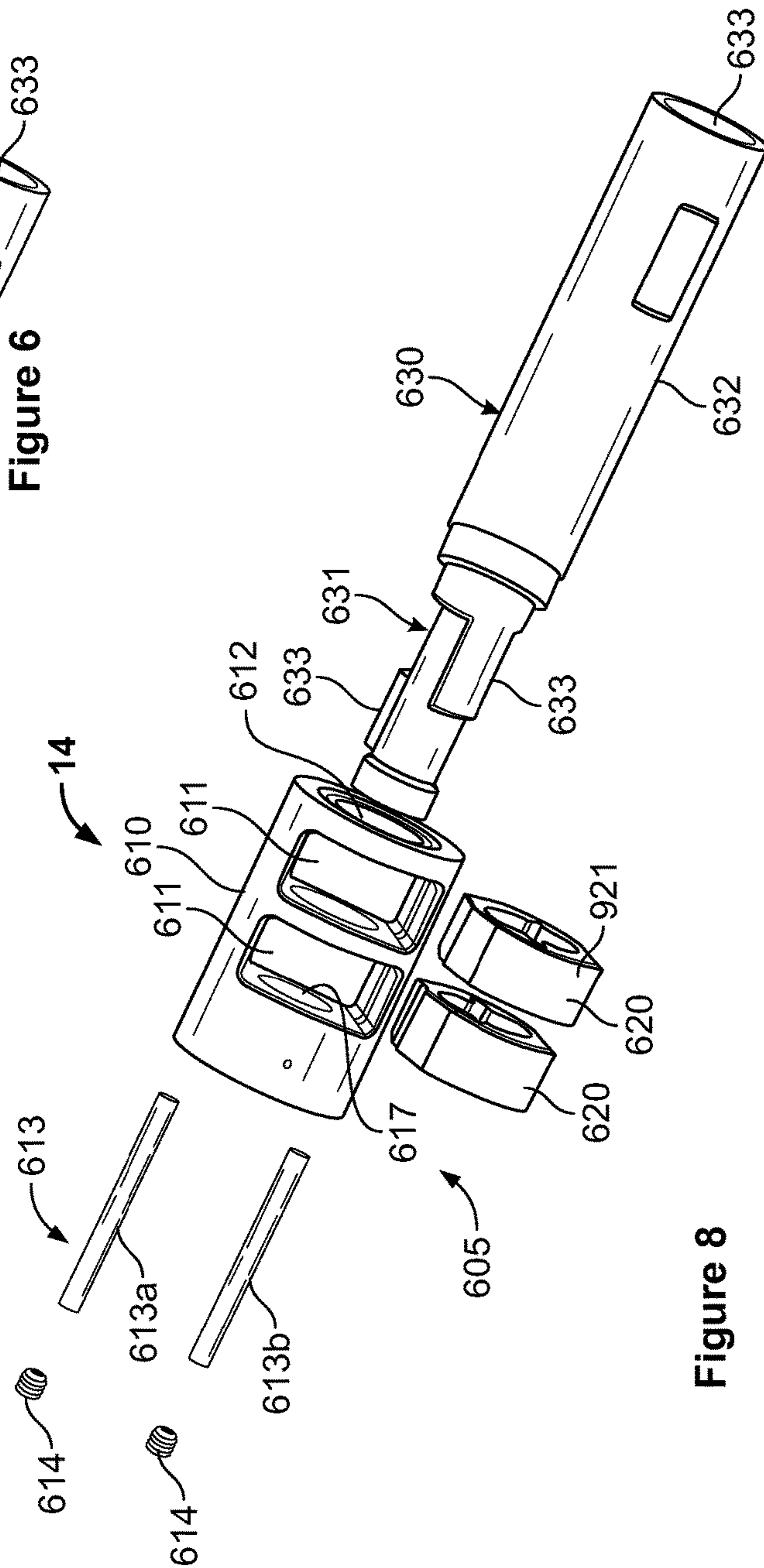


Figure 5



## Figure 6



## Figure 8



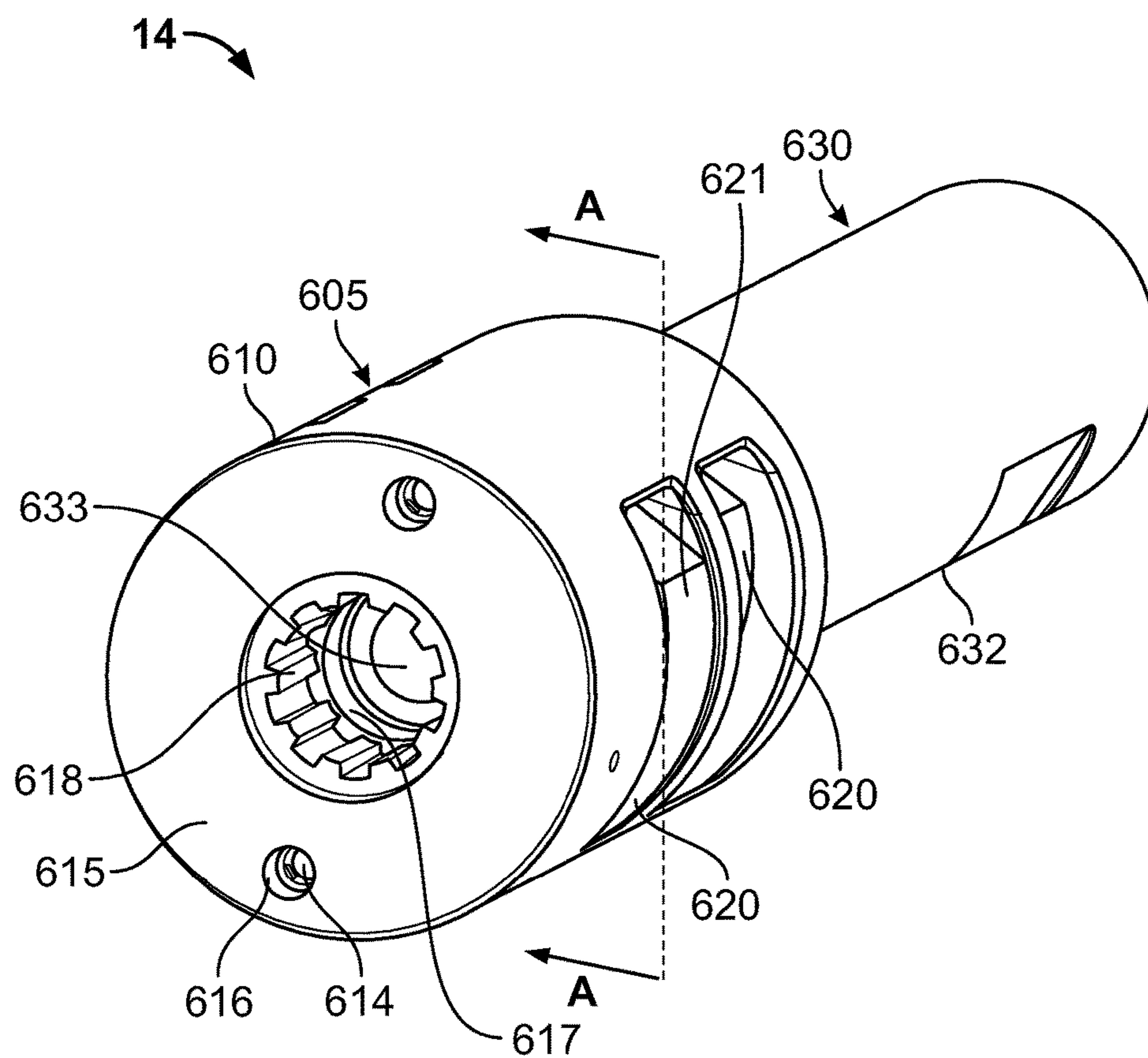


Figure 7

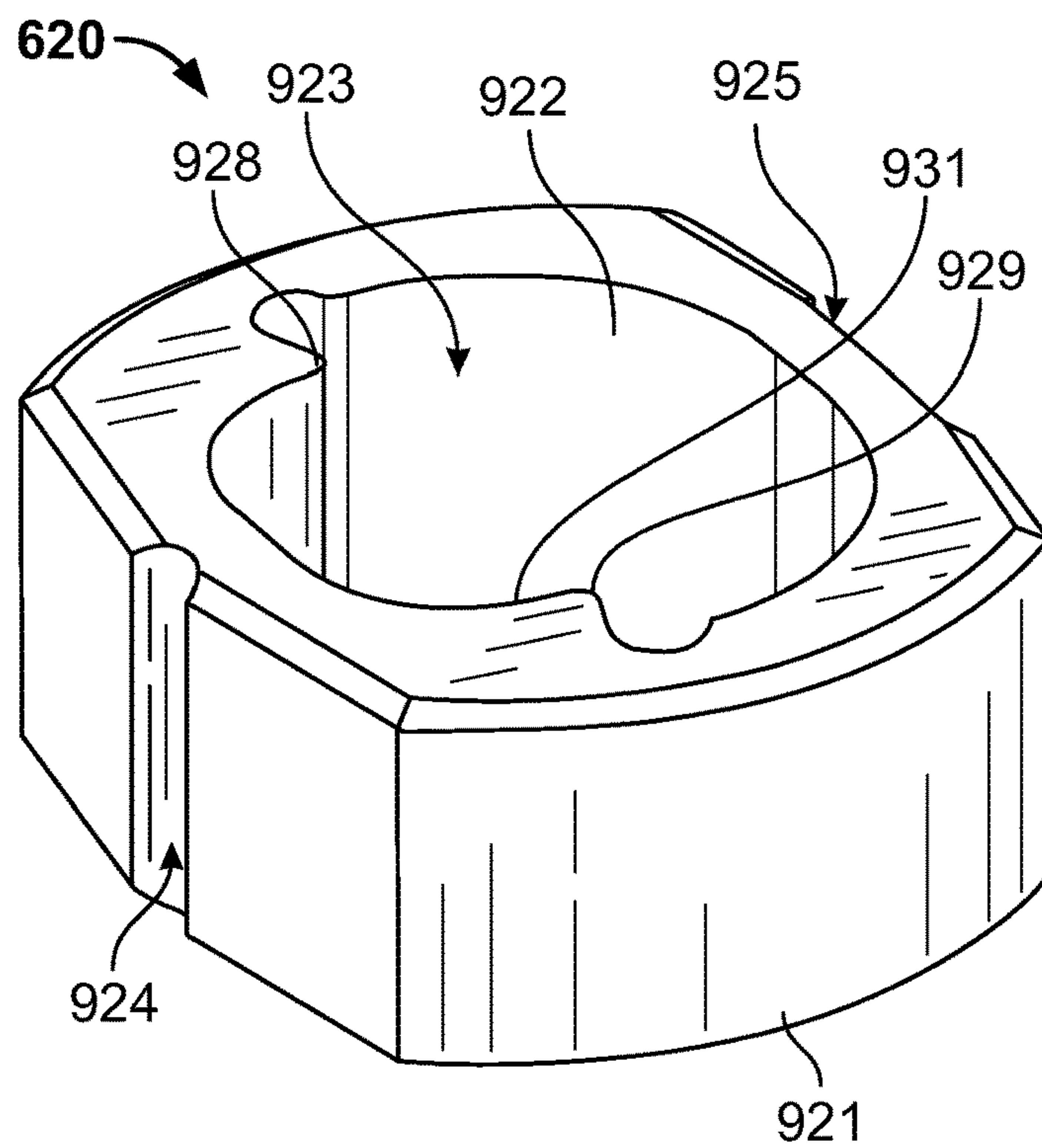


Figure 9

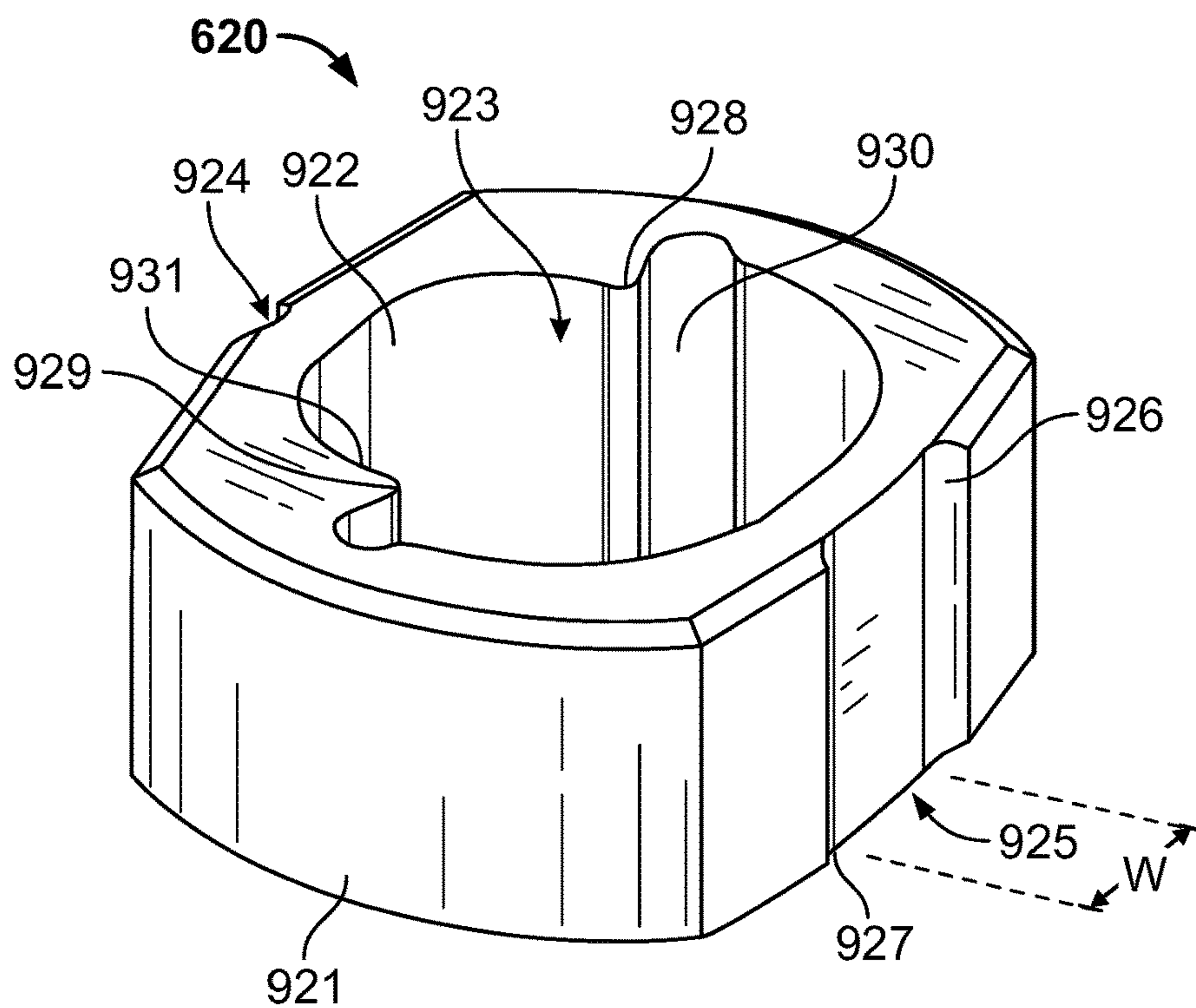


Figure 10

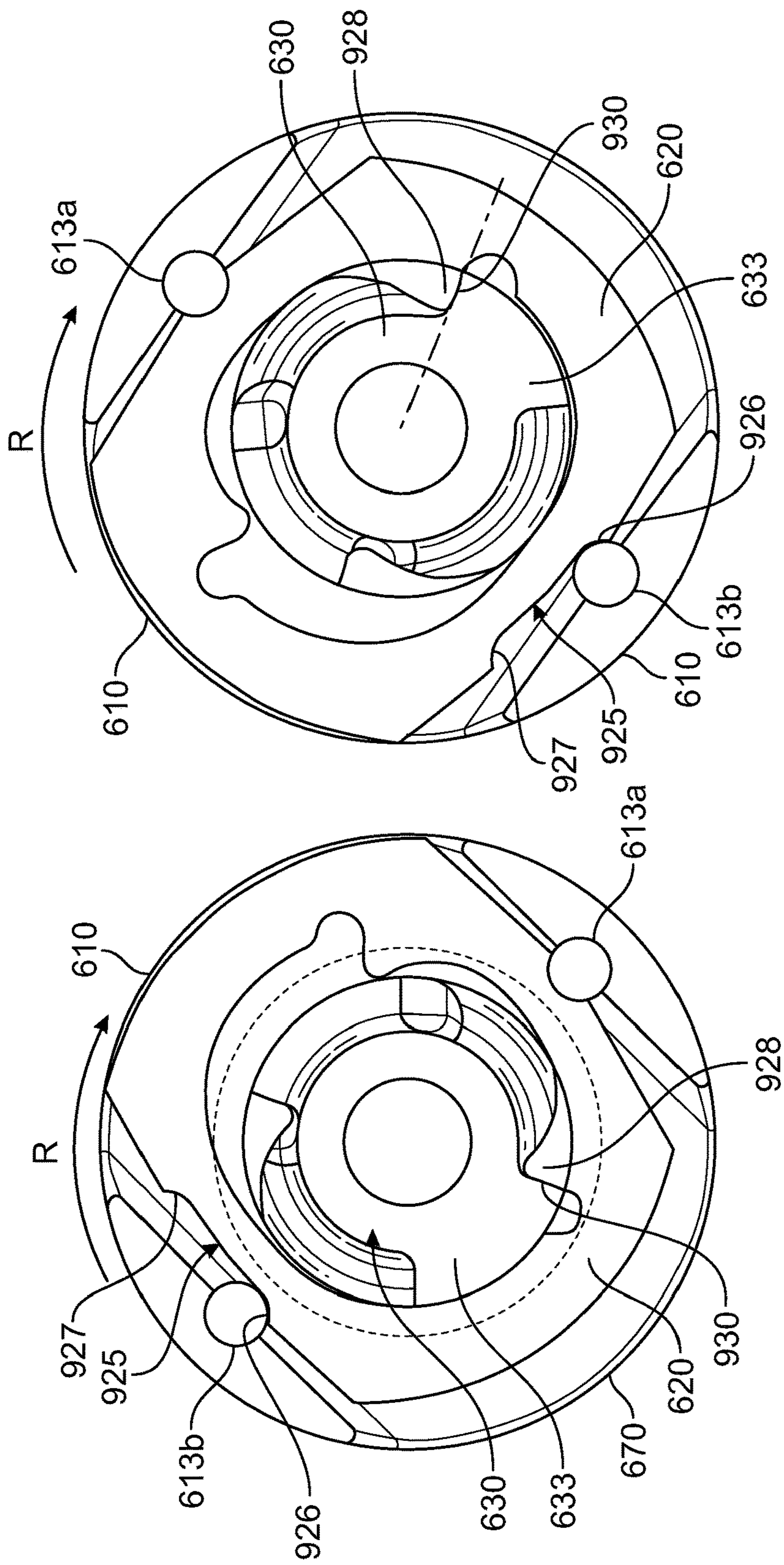


Figure 12

Figure 11



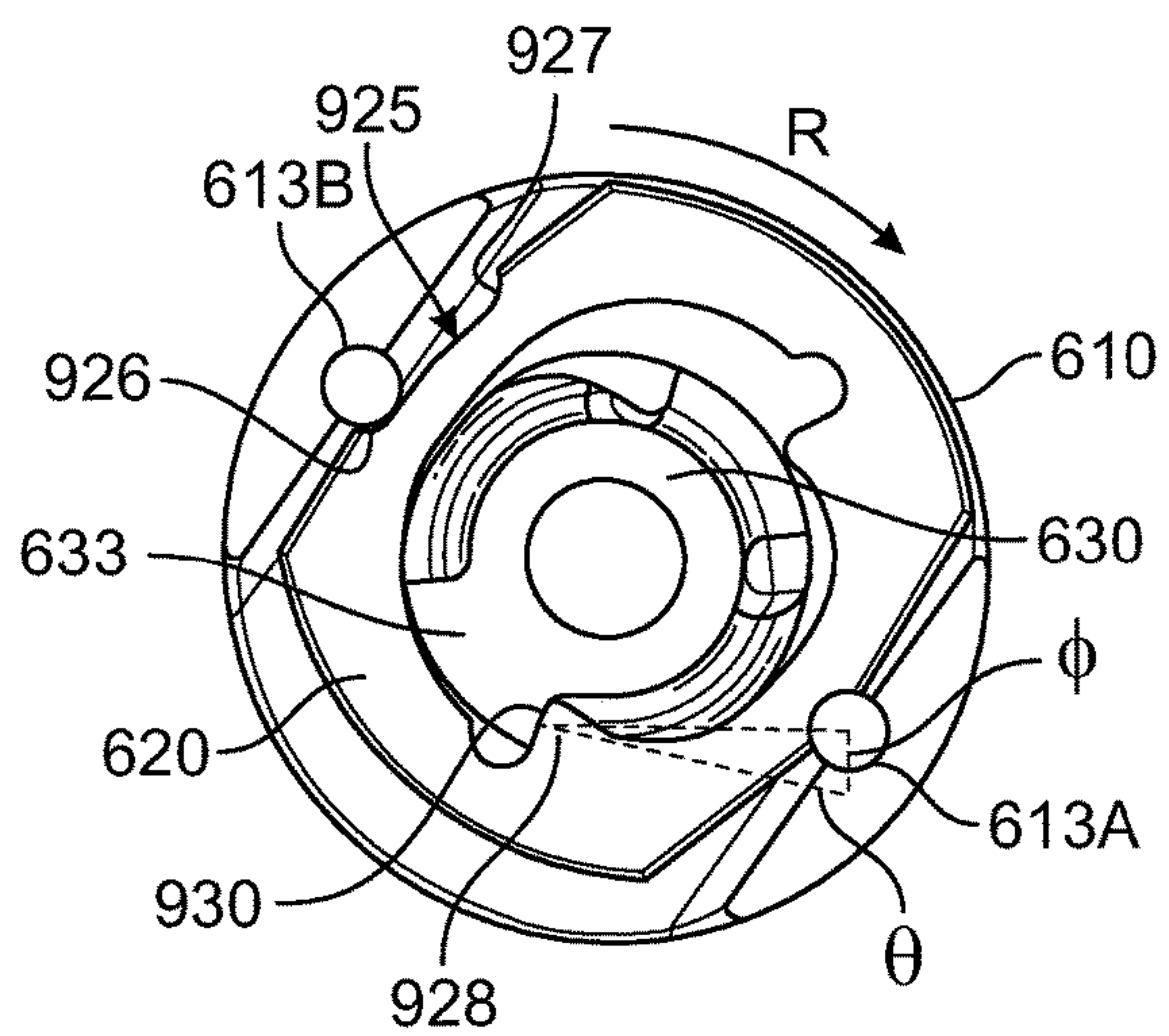


Figure 13

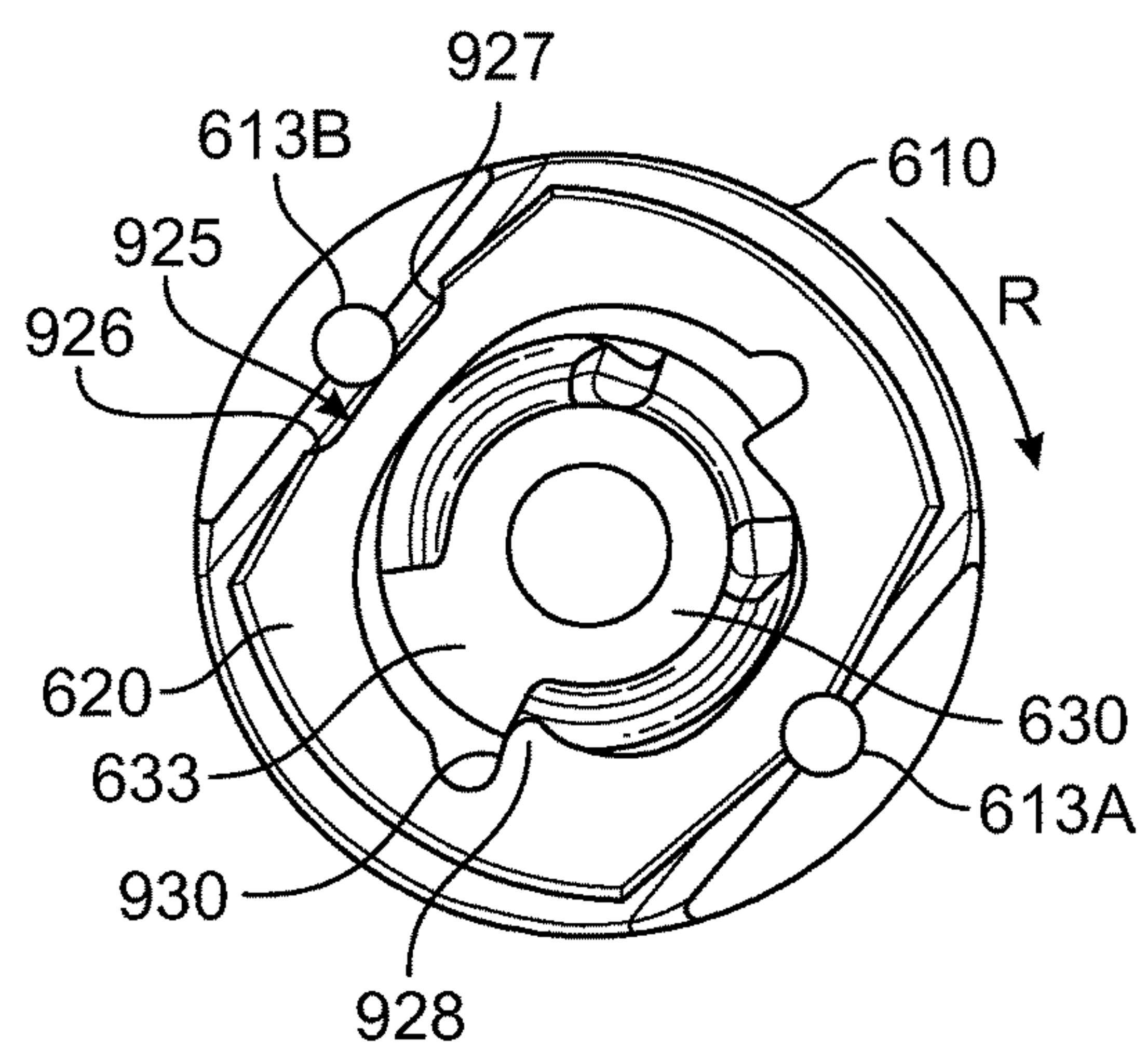


Figure 14

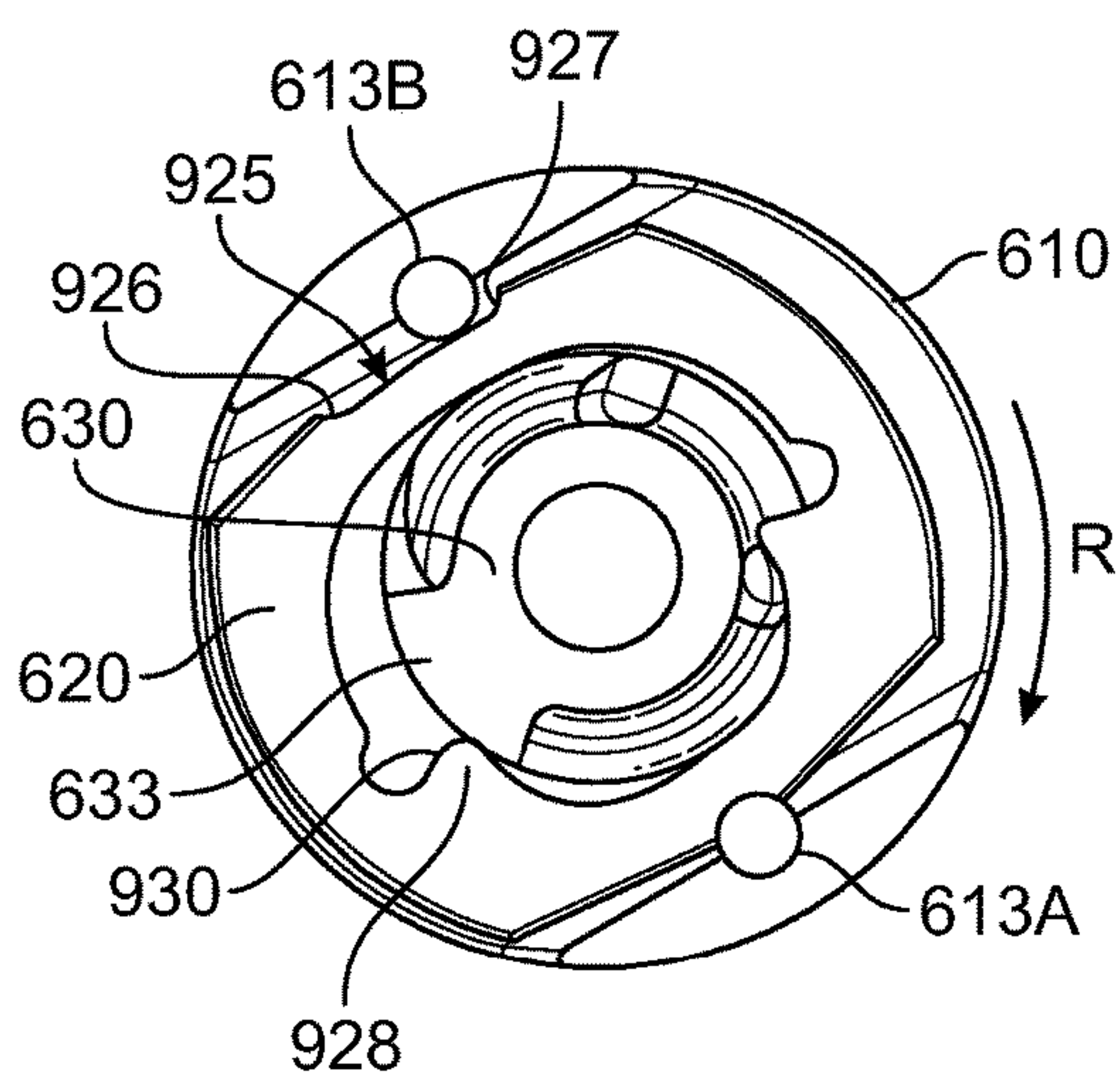


Figure 15

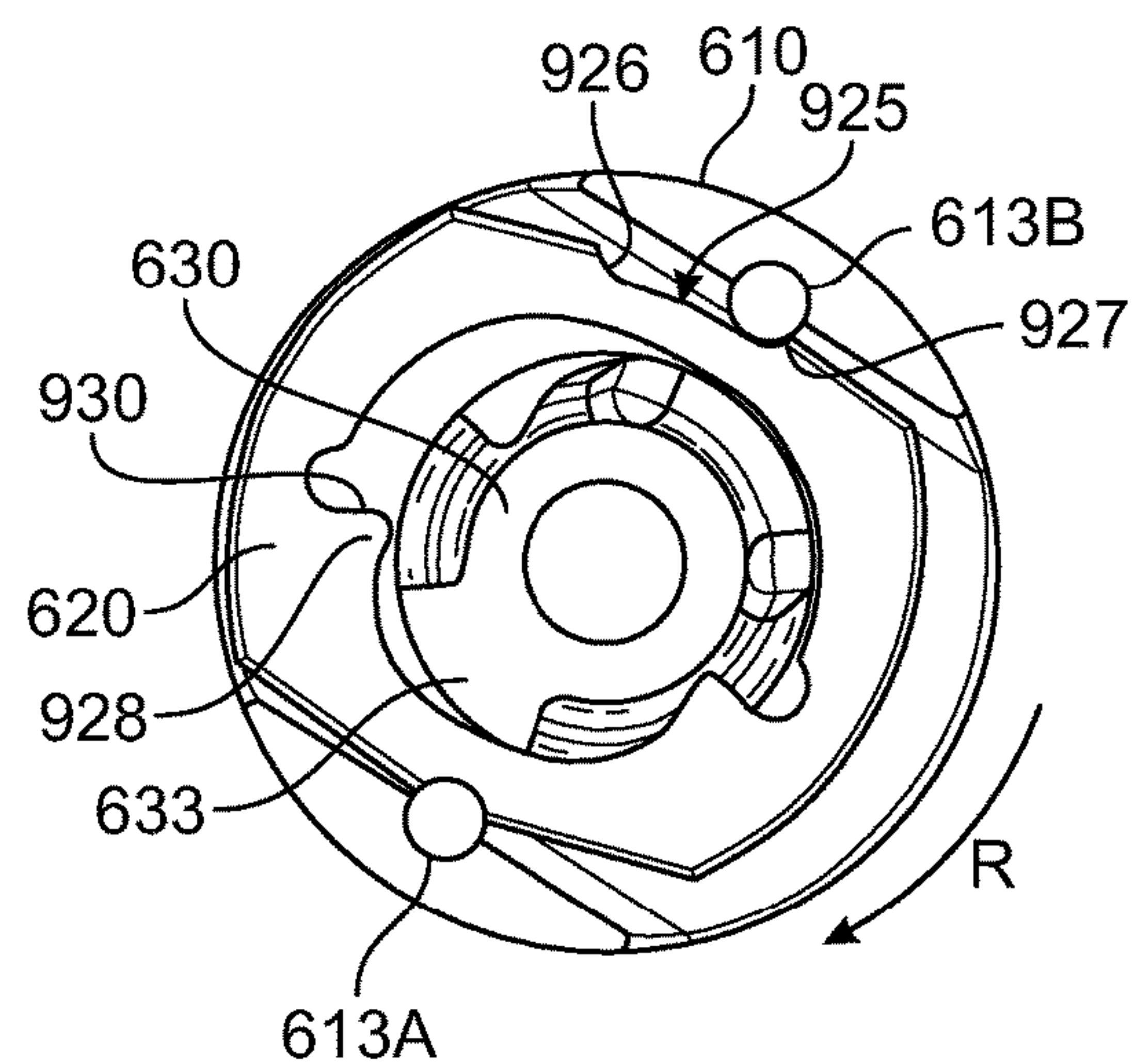


Figure 16

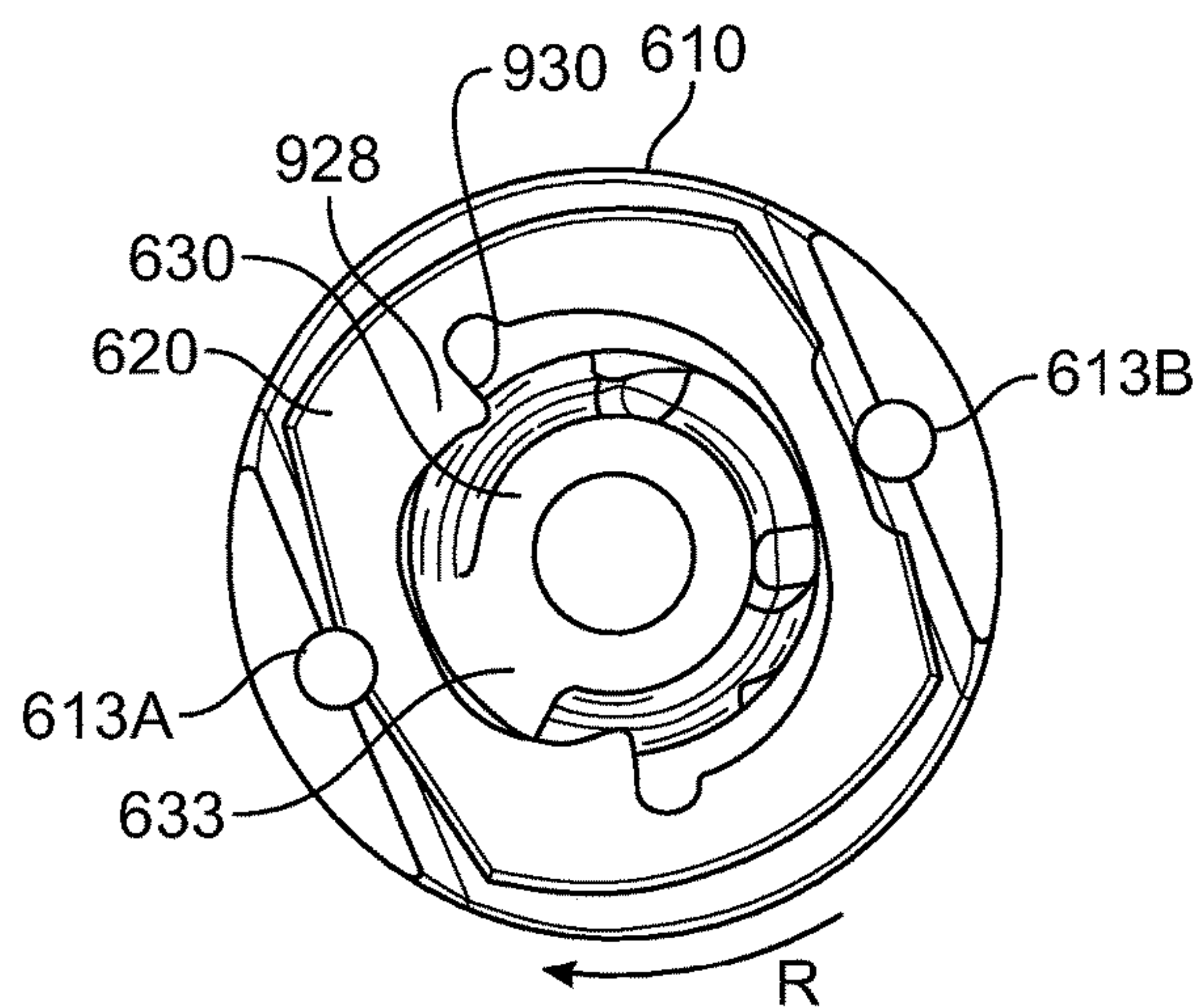


Figure 17

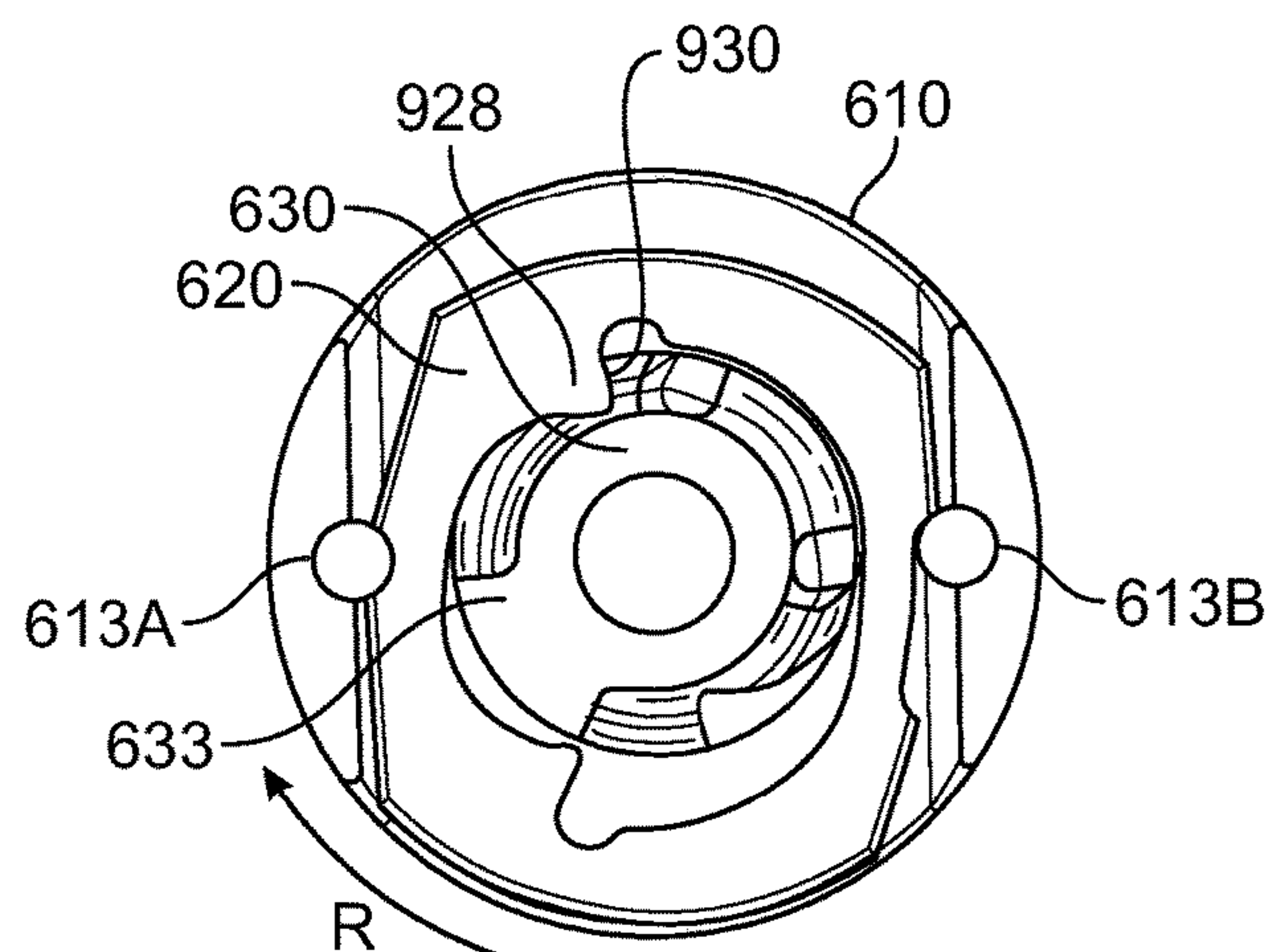


Figure 18

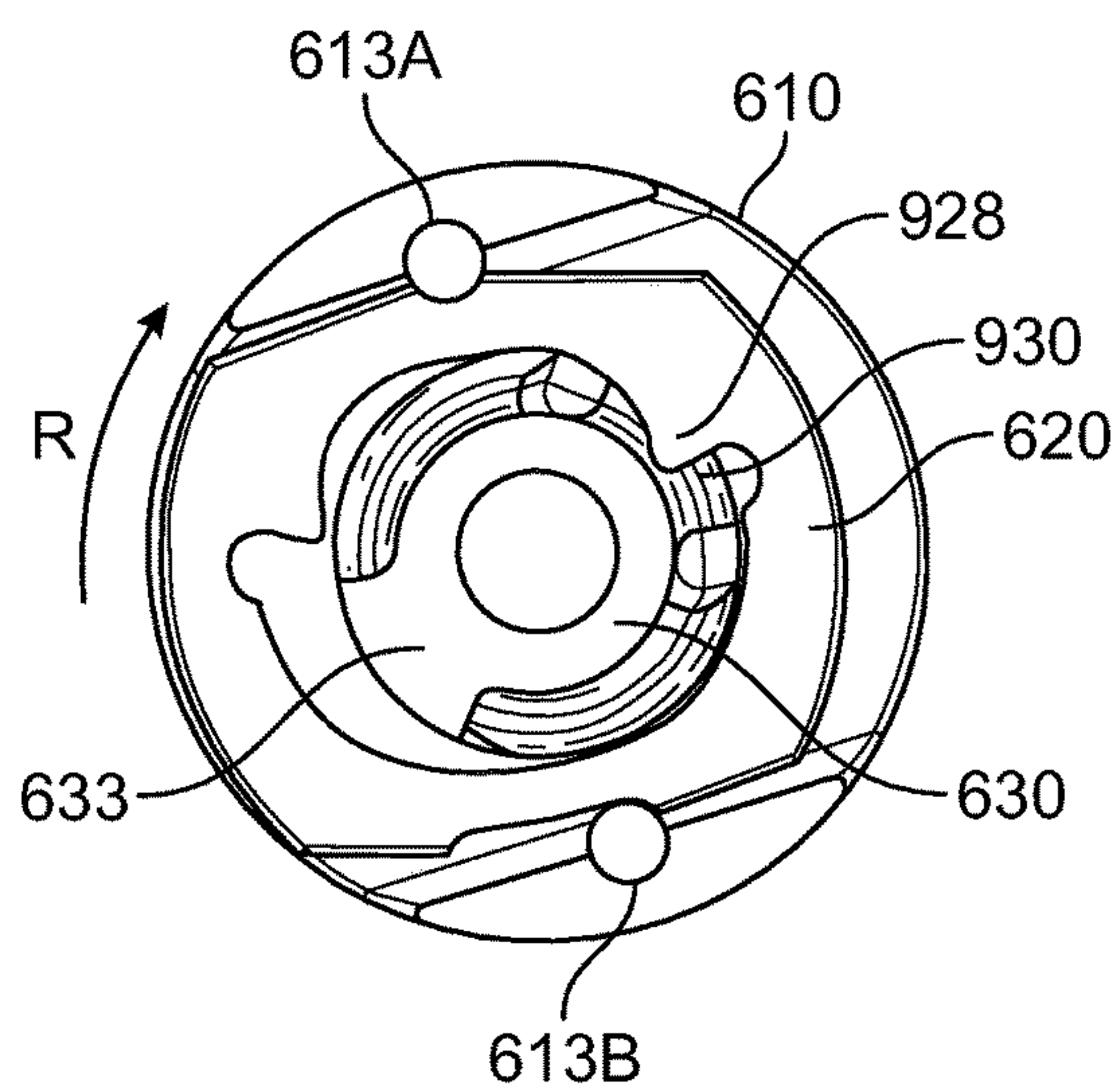


Figure 19

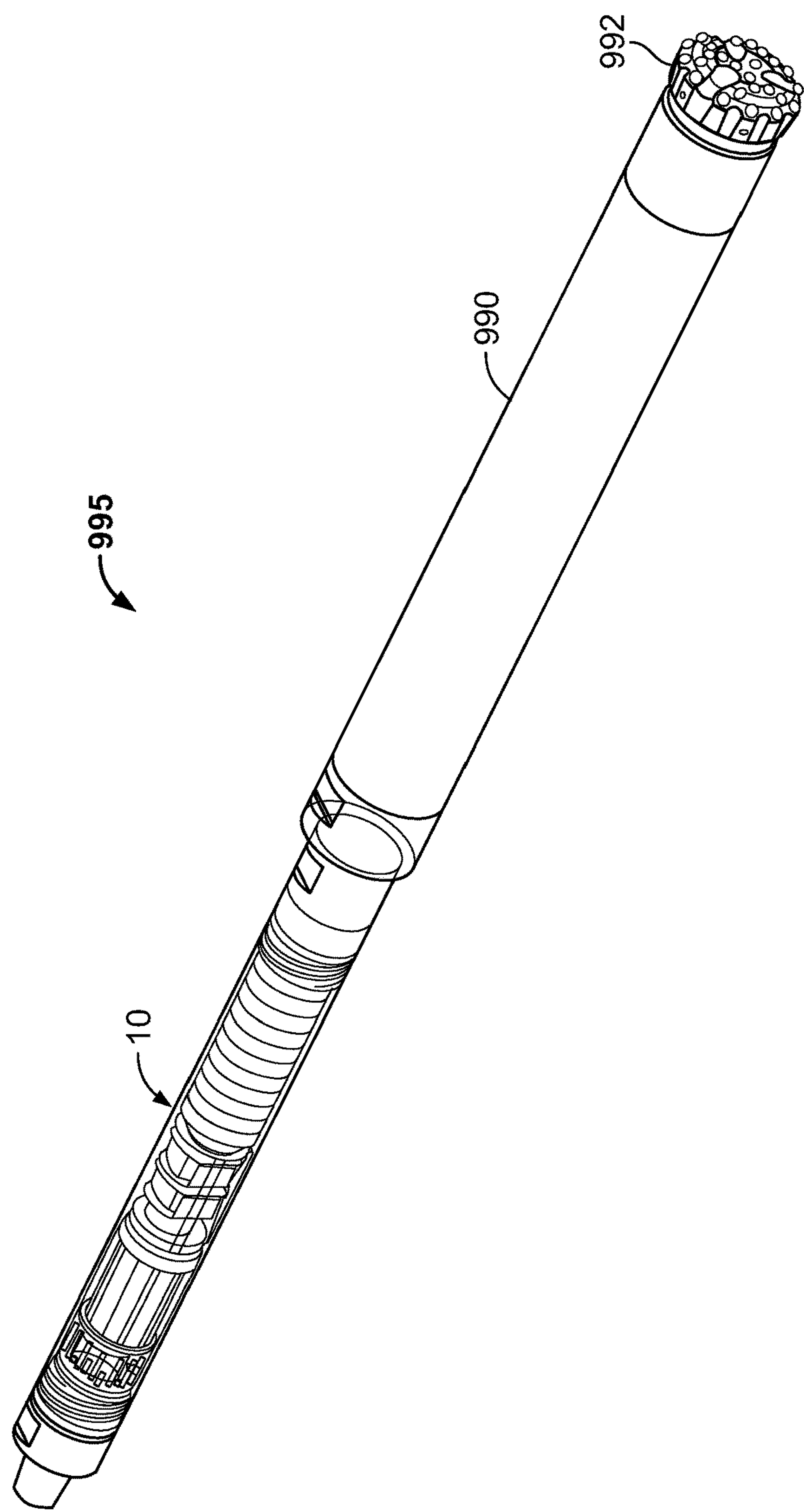


Figure 20



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## FLUID DRIVEN DRILLING MOTOR

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims benefit of U.S. Provisional Patent Application No. 61/785,431, "AIR DRIVEN DOWNHOLE DRILLING MOTOR", filed Mar. 14, 2013, which is incorporated by reference herein in its entirety.

## STATEMENT OF GOVERNMENT INTEREST

The United States Government has rights in this invention pursuant to Contract No. DE-AC04-94AL85000 between the United States Department of Energy and Sandia Corporation, for the operation of the Sandia National Laboratories.

## FIELD

The present invention relates to the field of motors, and specifically to using a pressurized fluid to drive a rotary, indexing motor for a drill assembly.

## BACKGROUND

Down-the-hole (DTH) drills are used for oil drilling, geothermal drilling, and other deep earth penetration applications. For nearly any drilling method, rotational energy must be transferred downhole in order to promote rock reduction. The drill bit may be rotated by an electric motor or fluid/hydraulic system. The rotating action can be produced either at the surface or near the drill bit. In addition to rotational cutting, drills may also be pressurized or mechanically actuated to force the drill bit to hammer against the rock/earth. Prior art rotation systems and methods are complex, require large form factors to create sufficient torque, and require a high degree of maintenance.

The most common method of downhole energy transfer is rigid drill pipe. The drill pipe is rotated from the surface, with 30 ft drilling joints added for tripping (moving in and out of the hole). For this type of system, the entire drill string rotates. Typically a rotary table system or a top drive is used to drive the drill string. Although it is well suited for vertical drilling, it has limited applications in directional drilling because the drill string curvature and thrust loads generate additional torque that the surface based motor must overcome and drill pipe survive.

Downhole techniques used to generate rotation such as positive displacement motors (PDMs) are limited in their temperature range due to the use of elastomers. Energy resources like geothermal and deep oil and gas wells lie in hot (160° C.-300° C.), and often hard rock. The high-temperatures limit the use of PDM's in those environments.

What is needed is a drill rotation system and method that overcomes the limitations of the prior art.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial cut away view of a motor assembly according to an embodiment of the disclosure.

FIG. 2 is a cut away view of the motor assembly of FIG. 1 taken along the center axis of the motor assembly

FIG. 3 is a first end perspective, partial see-through view of a vane motor according to an embodiment of the disclosure.

FIG. 4 is a first end perspective, exploded, partial see-through view of the vane motor of FIG. 3.

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FIG. 5 is a second end perspective, exploded view of the vane motor of FIG. 3.

FIG. 6 is a perspective view of a drive section according to an embodiment of the disclosure.

FIG. 7 is another perspective view of the drive section of FIG. 6.

FIG. 8 is an exploded view of the drive section of FIG. 6.

FIG. 9 is a perspective view of a hammer according to an embodiment of the invention.

FIG. 10 is another perspective view of the hammer of FIG. 9.

FIG. 11 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at a first, initial position.

FIG. 12 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at a later position in time position when the hammer 620 has rotated the drive section 14 for a partial complete rotation.

FIG. 13 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at a later position in time position when the hammer 620 has rotated the drive section 14 for a complete rotation and has now stalled in the rotation.

FIG. 14 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at another later position in time position.

FIG. 15 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at another later position in time position.

FIG. 16 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at another later position in time position.

FIG. 17 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at another later position in time position.

FIG. 18 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at another later position in time position.

FIG. 19 is a cross-sectional view taken along line A-A of FIG. 7 showing the hammer 620 engaging the drive section 14 at another later position in time position.

FIG. 20 is an embodiment of a drilling assembly according to the present disclosure.

Wherever possible, the same reference numbers will be used throughout the drawings to represent the same parts.

## SUMMARY

According to an embodiment of the disclosure, a motor assembly is disclosed that includes an engagement mechanism that provides improved peak torque to an output shaft in a compact form factor. The motor includes a vane motor coupled to a drive section. The drive section includes cam lobes releasably coupled to an output shaft.

According to another embodiment of the disclosure, a motor assembly is disclosed that includes a casing, a vane motor disposed within the casing, a drive section coupled to the vane motor; and an output shaft coupled to the drive section. The drive section includes a drive hammer coupled to the vane motor that engages the output shaft to provide rotation thereto.

According to another embodiment of the disclosure, a drill assembly is disclosed that includes a motor assembly a drill bit assembly coupled to the output shaft of the motor assembly. The motor assembly includes a casing, a vane motor disposed within the casing, a drive section coupled to



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the vane motor; and an output shaft coupled to the drive section. The drive section includes a drive hammer coupled to the vane motor that engages the output shaft to provide rotation thereto.

An advantage of the disclosed motor assembly is improved peak torque to an output shaft in a compact form factor.

Another advantage of the disclosed motor assembly is that the motor assembly is capable of generating rotation during drilling in extreme conditions such as high-temperature. This is due to the fact that it does not require elastomeric components, unlike conventional drilling motors.

Another advantage of the disclosed motor assembly is that the power delivery does not require a gear set to transmit power. The design allows high torque generation in a compact package.

Another advantage of the disclosed motor assembly is the compact packaging can allow directional control using down-the-hole hammer (DTHH).

Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

FIGS. 1 and 2 shows an embodiment of a motor assembly 10 according to the present disclosure. The motor assembly 10 includes a vane motor 12, a drive section 14 and a bearing/shaft section 16 disposed within an outer casing 18. The motor assembly 10 further includes an input end cap 20 and an output end cap 22. The motor assembly 10 is coupled to a coupler 24.

The input end cap 20 is coupled to the outer casing 18 via threads 26. In another embodiment, the input end cap 20 may be welded, brazed or fastened to the outer casing 18. The input end cap 20 includes an internal fluid passage 28 having an inlet 30 and an outlet 32 for receiving and exiting a fluid, respectively.

FIGS. 3 to 5 show various perspective and exploded views of the vane motor 12. As can be seen, the vane motor 12 includes a rotor or motor body 210, a stator or housing 220, an air distributor, 230, a first bearing plate 240, and orifice 245, and a second bearing plate 250.

The motor body 210 includes a motor shaft 211 and a vane section 212. The motor shaft 211 includes a first end 213 for centrally positioning the motor body 210 in the second bearing plate 250, which allows the motor body 210 to freely rotate adjacent the second bearing plate 250. The motor shaft 211 also includes a second end 214 for centrally positioning the motor body in the first bearing plate 240 and for coupling the vane motor 12 to the drive section 14 (see FIG. 2). The second end 214 includes tabs or protrusions 215 for engaging the drive section 14 thereby transferring rotation from the vane motor 12 to the drive section 14. In another embodiment, the second end 214 may include protrusions, slots, pins or other engagement devices for coupling the vane motor 12 to the drive section 14. The motor shaft 211 further includes a through passage 216 extending from the first end 213 to the second end 214.

The vane section 212 includes vane section body 218 attached to the motor shaft 211. The vane body section 218 may be attached to the motor shaft 211 by welding, brazing or other suitable joining method. In another embodiment, the vane body section 218 may be integral to the shaft 211. The

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vane section 212 further includes vanes 217 attached to the vane section body 218. The areas between the vanes 217 are referred to as chambers 217A. As is appreciated by one of ordinary skill in the art, the vane section body 218 is eccentric with respect to the housing 220. In this manner, the vanes 217 are mounted to the vane body section 218 at offset depths in the vane section body 218 as shown in FIGS. 3-5.

The motor body 210 is disposed or fits within the housing 220 in such a manner that the motor body 210 may freely rotate within the housing 220. The housing 220 includes a cavity 221 and has a first end 222 and a second end 224. The cavity 221 is configured to circumferentially surround the vane section 212.

The first bearing plate 240 is attached to the first end 224 of the housing 220 by screw fasteners (not shown). In another embodiment, the first bearing plate 240 may be attached to the housing 220 by welding, brazing, fasteners or other joining method. The first bearing plate 240 includes a bearing 242 and a passage 244 for receiving the motor shaft 211 and allowing the motor shaft 211 to rotate, respectively.

The second bearing plate 250 is attached to the second end 224 of the housing 220 by screw fasteners (not shown). In another embodiment, the second bearing plate 250 may be attached to the housing 220 by welding, brazing, fasteners or other joining method. The second bearing plate 250 includes a bearing 252 and a passage 254 for receiving the motor shaft 211 and allowing the motor shaft 211 to rotate. The second bearing plate 250 also includes channels 258 for distributing a fluid provided by the air distributor 230 to the motor body 210.

The air distributor 230 is attached to the second bearing plate 250 by screw fasteners (not shown). In another embodiment, the air distributor 230 may be attached to the housing 220 by welding, brazing, fasteners or other joining method. The air distributor 230 includes an inlet 232 for receiving a fluid from the fluid passage 28 of the input end cap 20 (see FIG. 2). The air distributor 230 may include one or more seals 233 for fluidly sealing the air distributor 230 to the input end cap 20. The air distributor 230 further includes a passage 234 for allowing a fluid to travel from the input end cap 20 to the passage 254 of the second bearing plate 250. The air distributor 230 further includes one or more channels 236 between the passage 234 and a first surface 238 of the air distributor.

In such a manner, fluid may flow from the passage 234 of the air distributor 230 to the second bearing plate passage 254, or fluid may flow from the passage 234 into the channels 236 and then into channels 258 of the second bearing plate 250. The amount of fluid that flows through the second bearing plate passage 254 is controlled by orifice 245.

Orifice 245 is disposed within the first end 213 of the motor shaft 211. In another embodiment, the orifice 245 may be disposed within the motor shaft 211, the passage 254 of the second bearing 250, or both. The orifice 245 includes a passage 246 that allows a predetermined amount of fluid to pass through the orifice 245 from the passage 254 of the second bearing to the through passage 216 of the shaft 211. In another embodiment, the orifice 245 may have no passage 246 and functions as a plug to prevent any fluid from entering the through passage 216.

During operation, fluid enters the inlet 30 of inlet section 20, passes through fluid passage 28 and exits the outlet 32 into the inlet 232 of the passage 234 of the air distributor 230. The fluid then enters the channels 236 of the air distributor 230 to be distributed to the channels 258 of the second bearing plate 250 to be directed to the chambers



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217A of the motor body 210 or passes through the orifice 245 to enter the through passage 216 of the motor shaft 211, or both. As the fluid travels through the chambers 217A, the vane motor 12 rotates due to pressure differences in the chambers 217A. As discussed above, the vane body section 218 is mounted with an eccentricity  $E_v$  with respect to the housing 220. The eccentricity creates a variable volume between neighboring chambers 217A. The differential pressure between neighboring chambers 217A results in a non-zero net force. The seal between the vanes 217 and the housing 220 is created by either spring forces or air pressure.

The fluid may be a gas or liquid. In an embodiment, the fluid may be a pressurized gas such as, but not limited to air, nitrogen, or drilling foam. In an embodiment, the pressurized gas may be at a pressure between about 200 psi to about 500 psi. In another embodiment, the fluid may be a pressurized liquid, such as, but not limited to water, hydraulic fluid, or oil.

FIGS. 6-8 show an embodiment of the drive section 14 according to an embodiment of the disclosure. The drive section 14 includes a hammer assembly 605 including a hammer housing 610, hammers 620, and an output shaft 630. In this exemplary embodiment, the drive section 14 includes 2 hammers 620. In another embodiment, the drive section 14 may include one or more hammers 620. The hammer housing 610 includes openings 611 for receiving the hammers 620. The hammer housing 610 also includes a passage 612 for allowing the output shaft 630 to extend through the openings 611. The hammer housing 610 also includes pins 613 for positioning the hammers 620 within the openings 611, and set screws 614 for securing the pins 613 in the housing 610. In another embodiment, the pins 613 may be secured within the housing 610 by welding, brazing, or other faster device.

As can be seen in FIG. 7, the housing 610 has a first end surface 615 having openings 616 for receiving the pins 613 (not shown) and set screws 614. The first end surface 615 also has a through passage 617 extending into the openings 611. The through passage 617 has splines 618 configured to mate and engage with protrusions 215 of motor shaft 211 such that rotation of the motor shaft 211 rotates the drive section 14.

Referring again to FIGS. 6-8, the output shaft 630 includes a hammer engagement portion 631 and a shaft portion 632. The hammer engagement portion 631 includes protrusions or tabs 633 extending radially therefrom for engaging hammers 620. The number of tabs 633 corresponds to the number of hammers 620. The hammer engagement portion 631 of the output shaft 630 extends through the through the hammer housing passage 612, through passages 623 of the hammers 620, and into through passage 617. The output shaft 630 has a through passage 633 extending through the axial length of the output shaft 630 for receiving fluid from the through passage 617.

FIGS. 9 and 10 show perspective views of a hammer 620. As can be seen in FIGS. 9 and 10, a hammer 620 includes an outer perimeter surface 921, and an inner perimeter surface 922 defining a through passage 923. The outer surface 921 includes a recess or slot 924 for engaging a pin 613a (see FIG. 8) in such a manner that the pin 613a can rotate in the slot 924. The outer surface 921 further includes a trough 925 that allows another pin 613b (see FIG. 8) to move within in a confined manner. The movement of pin 613b is limited to the width W of trough 925 defined by a first ridge 926 and a second ridge 927.

As can be further seen in FIGS. 9 and 10, the inner perimeter surface 922 includes a first protrusion 928 and a

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second protrusion 929. The first protrusion 928 includes an engagement surface 930. The second protrusion 929 includes a sliding surface 931.

The rotation of the output shaft 630 by the vane motor 12 will now be described by referring to FIGS. 11-19 discussed in the following paragraphs.

FIG. 11 shows a cross-sectional view of FIG. 7 taken along line A-A showing a hammer 620 engaging the output shaft 630 at a first, initial position. As can be seen in FIG. 11, the hammer 610 has been rotated in a direction R by the vane motor 12 (FIGS. 1 and 2) such that the engagement surface 930 of the first protrusion 928 is in contact and engaging tab 633 of output shaft 630. Also, first pin 613a is in rotational contact within slot 924 and the second pin 613b is in the trough 925 and in contact with first ridge 926. At this time, the hammer 610 has enough rotational energy to provide sufficient torque to rotate the output shaft 630 to the position shown in FIG. 12. It should be noted that the first pin 613a is in the trough (not shown) of the second hammer, positioned behind the shown hammer in this figure, and that the second pin 613b is in the slot of the second hammer.

An analysis of the energy transfer during rotation is as follows. The rotational hammer is used to generate rotation in the output shaft through the transfer of angular momentum. The rotating hammer is driven to a specified angular velocity before impacting the output shaft. Upon impact, energy is transferred from the rotating hammer to the output shaft, resulting in rotational advancement.

Analysis of the rotating hammer system begins with the vane motor. Given an input pressure  $P_1$  and outlet pressure  $P_2$ , the moment delivered by the motor is given by Equation (1). In the equation,  $C_M$  is a geometric parameter,  $L_v$  is the length of the motor,  $Z_v$  is the number of vanes.

$$M_M = \frac{C_M \cdot R_R^2 \cdot L_v \cdot Z_v}{2\pi} (P_1 - P_2) \quad (1)$$

The geometric parameter  $C_M$  is given by

$$C_M = \frac{1}{a_m} \left[ \varphi_v \left( a_m + \frac{1}{2} \right) - 2(a_m + 1) \cos \left( \varphi_1 + \frac{\varphi_v}{2} \right) \sin \left( \frac{\varphi_v}{2} \right) + \frac{1}{2} \cos \left( 2\varphi_1 + \frac{\varphi_v}{2} \right) \sin(\beta_m) \right] \quad (2)$$

where  $a_m = R_R / H_v$ ,  $\varphi_v$  is the angle between vanes, and  $\omega_1$  is the angle at the end of the charging process.

If the moment is known, then the equation of motion for the rotational hammer is given by Equation (3). In the equation,  $I_1$  is the mass moment of inertia of the body, and  $M_{impact}$  is the torque rebound due to impact. The equation shows that the applied moment from the vane motor is resisted by the impact between the rotational hammer and the output shaft.

$$I_1 \ddot{\theta}_1 = M_M - M_{impact}(t) \quad (3)$$

The impact moment  $M_{impact}$  is estimated from the angular impulse imparted to the output shaft. Treating the rotating hammer and the output shaft as a system, the conservation of momentum for the system is given by Equation (4).

$$I_1 \omega_1 + I_2 \omega_2 = I_1 \omega_1' + I_2 \omega_2' \quad (4)$$

The relationship between the rotational speeds before and after impact is given by the coefficient of restitution  $e$ .



$$e = \frac{\omega'_2 - \omega'_1}{\omega_1 - \omega_2} \quad (5)$$

Looking at the components individually, the moment impulse imparted on the output shaft to cause rotation is given by

$$I_2\omega_2 + M_{\text{impact}}\Delta t = I_2\omega'_2 \quad (6)$$

The equation of motion for the output shaft takes a similar form. Assuming the impact moment accelerates the output shaft from rest, then the equation of motion is given by

$$I_2\ddot{\theta}_2 = M_{\text{impact}}(t) - M_{\text{WOB}} \quad (7)$$

The estimated torque load from the weight on output shaft is given by

$$M_{\text{WOB}} = \frac{\mu \cdot d \cdot \text{WOB}}{3 \cdot C_{\text{area}}} \quad (8)$$

where  $\mu$  is the coefficient of friction,  $d$  is the output shaft diameter,  $\text{WOB}$  is the weight on the output shaft, and  $C_{\text{area}}$  is the ratio of the button area (the button area being the surface area of the cutting inserts contacting the cutting surface) to the output shaft face.

FIG. 13 shows a point in time when the hammer 620 and output shaft 630 has continued to rotate in direction R from the position shown in FIG. 12 with the engagement surface 930 of the first protrusion 928 in contact and engaging tab 633 of output shaft 630. Also, first pin 613A is in rotational contact within slot 924 and the second pin 613B is in the trough 925 and in contact with first ridge 925. At this time, the hammer 610 does not have enough rotational energy to provide sufficient torque to rotate the output shaft 630. For example, the output shaft 630 may be coupled to a drill bit (not shown) that has engaged a surface that requires more torque to rotate the drill bit than is being provided by the hammer 610.

An analysis of the applied force between the hammer and output shaft at the position shown in FIG. 13 is as follows. A force vector due to the torque applied by the vane motor exists between the driving pin 613A and the impact face 930. The force vector has a component normal  $\phi$  to the impact face and parallel  $\theta$  to the impact face. The normal force creates a friction force between the lobe or protrusion 928 of the hammer 620 and the protrusion or tab 633 of the output shaft 630. If the friction force exceeds the force component parallel to the impact face, the hammer 620 will not release from the output shaft 630. The hammer protrusion 928 will begin to release from the tab 633 when the parallel force component exceeds the normal force. This releasing force can be designed into the system by adjusting the contact angle between the hammer protrusion 928 and drive shaft tab 633.

FIG. 14 shows a point in time when the first protrusion 928 is about to disengage from the tab 633. As can be seen in FIG. 13, the second pin 613b has begun to move across the trough 925 towards the second ridge 927. As can be further seen in FIG. 14, the hammer 610 has begun to reposition in the housing 610.

FIG. 15 shows a point in time when the first protrusion 928 has moved past the tab 633 and the hammer 610 has continued to rotate R as the output shaft 630 remains stationary. As can be seen in FIG. 15, the first protrusion 928 is no longer engaged with the tab 928, but is in sliding

contact with the tab 633, allowing the hammer 610 to rotate. The second pin 613b continues to move across the trough 925 towards the second ridge 927. As can be further seen in FIG. 15, the hammer 610 has continued to reposition in the housing 610.

FIG. 16 shows a point in time when the hammer 610 has continued to rotate R as the output shaft 630 remains stationary. As can be seen in FIG. 16, the second pin 613b has moved across the trough 925 and is in contact with second ridge 927. As can be further seen in FIG. 16, the hammer 610 has repositioned in the housing 610.

FIG. 17 shows a point in time when the hammer 610 has continued to rotate R as the output shaft 630 remains stationary. As can be seen in FIG. 17, the hammer 610 is in contact with the tab 928 and the second pin 613b has started to move back towards the first ledge 926.

FIG. 18 shows a point in time when the hammer 610 has continued to rotate R as the output shaft 630 remains stationary. As can be seen in FIG. 18, the hammer 610 is not in contact the tab 633 or any part of the output shaft 630 and the second pin 613B has moved back into contact with the first ledge 926.

FIG. 19 shows a point in time when the hammer 610 has continued to rotate R as the output shaft 630 remains stationary. As can be seen in FIG. 19, the hammer 610 is free to rotate until striking and contacting the tab 633 in the position shown in FIG. 11. At that time, energy is transferred from the hammer 610 to the tab 633, and ultimately to the output shaft 630, to rotate the output shaft 630 if enough torque can be transferred from the hammer 610 to the tab 633. If sufficient torque exists, the hammer 610 will continue to rotate the output shaft 630. When insufficient torque exists to rotate the output shaft 630, such as for example when the output shaft 630 is connected to a drill bit that has engaged a restrictive surface, the tab 633 begins to slip from the tab 633 as described above. The impulsive force generated between the hammer lobe and the drive shaft protrusion produces the output torque. This action repeats as long as the vane motor continues to receive input from the external fluid supply. The repeated impulsive force transfer creates the characteristic indexing action of the tool. The amount of rotation seen at the bit for each impulse depends on the reacting torque from the external load.

Referring again to FIGS. 1 and 2, the output shaft 630 is supported in the bearing/shaft section 16 of the casing 18 by bearings 16A. In this exemplary embodiment, the motor assembly 10 includes 10 bearings 16A, however, in another embodiment, none, one, or more bearings may be used. Bearings 16A may be roller bearings, angular contact or any type of bearing used to support shaft rotation.

The bearing/shaft section 16 is held in place in the casing 18 by output end cap 22. Output end cap 22 is assembled to the casing 18 by threads 22A. In another embodiment, the output end cap 22 may be welded, brazed or fastened to the casing 18.

The coupler 24 is attached to the output shaft 30 by threads 25. In another embodiment, the coupler 24 may be welded, brazed or fastened to the output shaft 30. The coupler 24 includes an internal fluid passage 26 having an inlet 26A and an outlet 26B. The inlet 26A is in fluid connectivity with the passage 633 of the outlet shaft 630 so as to receive fluid therefrom and discharge fluid via the outlet 26B. The coupler 24 may be attached to a shaft, drill bit, or other extension for providing rotation to a tool or device.

FIG. 20 shows the motor assembly 10 shown in FIG. 1 attached to a drilling shaft 990 and bit 992 to form a drilling



assembly 995. As will be appreciated by one of ordinary skill in the art, this configuration is exemplary, and other shaft and bit configurations, including, but not limited to flexible shaft and rotary hammer assemblies, may be used.

While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. A motor assembly, comprising:

a casing;

a vane motor disposed within the casing;

wherein the vane motor comprises:

a shaft having a shaft passage therethrough;

a motor assembly comprising a plurality of vanes defining a plurality of chambers, the motor assembly disposed around the shaft;

an orifice component disposed in the shaft passage and in fluid connectivity with the shaft passage that regulates fluid distribution between the shaft passage and the plurality of chambers;

a drive section coupled to the vane motor; and

an output shaft coupled to the drive section;

wherein the drive section comprises:

a drive hammer coupled to the vane motor that engages the output shaft to provide rotation thereto; and

wherein the drive hammer comprises two lobes that strike two corresponding tabs on the output shaft sequentially per revolution to provide two impulses per revolution to generate the provided rotation thereto;

wherein the output shaft comprises an output shaft passage therethrough in fluid connectivity with the shaft passage; and

wherein the orifice component comprises a body comprising a passage within the orifice component that regulates fluid distribution between the shaft passage and the plurality of chambers.

2. The motor assembly of claim 1, wherein the drive section further comprises:

a housing; and

pins attached to the housing that contact the drive hammer such that the drive hammer can pivot about one pin of the pins to change position within the housing.

3. The motor assembly of claim 2, wherein the change of position of the drive hammer causes the drive hammer to disengage from the drive section.

4. The motor assembly of claim 2, wherein the drive hammer includes a slot that allows for rotational contact with a pin of the pins attached to the housing, and wherein the drive hammer further includes a trough that allows for sliding contact with a second pin of the pins attached to the housing.

5. The motor assembly of claim 4, wherein the output shaft comprises:

a tab for releasably engaging the drive hammer.

6. The motor assembly of claim 5, wherein the corresponding tabs are released from the drive section when a predetermined amount of torque is applied from the hammer to the drive section.

7. The motor assembly of claim 4, wherein the two lobes strike the two corresponding tabs in a releasable manner.

8. The motor assembly of claim 1, wherein the two corresponding tabs releasably engage the drive hammer.

9. The motor assembly of claim 1, wherein the two lobes strike the two corresponding tabs in a releasable manner.

10. The motor assembly of claim 9, wherein the corresponding tabs are released from the drive section when a predetermined amount of torque is applied from the hammer to the drive section.

11. The drill assembly of claim 1, wherein the drive section further comprises:

a housing; and

pins attached to the housing that contact the drive hammer

such that the drive hammer can pivot about one pin of the pins to change position within the housing.

12. The motor assembly of claim 11, wherein the drive hammer includes a slot that allows for rotational contact with a pin of the pins attached to the housing, and wherein the drive hammer further includes a trough that allows for sliding contact with a second pin of the pins attached to the housing.

13. A drill assembly, comprising:

a motor assembly comprising:

a casing;

a vane motor disposed within the casing;

wherein the vane motor comprises:

a shaft having a shaft passage therethrough;

a motor assembly comprising a plurality of vanes defining a plurality of chambers, the motor assembly disposed around the shaft;

an orifice component disposed in the shaft passage and in fluid connectivity with the shaft passage that regulates fluid distribution between the shaft passage and the plurality of chambers;

a drive section coupled to the vane motor;

an output shaft coupled to the drive section; and

a drill bit assembly coupled to the output shaft of the motor assembly;

wherein the drive section comprises:

a drive hammer coupled to the vane motor that engages the output shaft to provide rotation thereto; and

wherein the drive hammer comprises two lobes that strike two corresponding tabs on the output shaft sequentially per revolution to provide two impulses per revolution to generate the provided rotation thereto;

wherein the output shaft comprises an output shaft passage therethrough in fluid connectivity with the shaft passage; and

wherein the orifice component comprises a body comprising a passage within the orifice component that regulates fluid distribution between the shaft passage and the chambers.

14. The motor assembly of claim 13, wherein the change of position of the drive hammer causes the drive hammer to disengage from the drive section.