(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
28 February 2019 (28.02.2019)

WIPO | PCT

(10) **International Publication Number**
WO 2019/040029 A2

(51) **International Patent Classification:**
G05D 23/00 (2006.01)

(21) **International Application Number:**
PCT/TR2018/050273

(22) **International Filing Date:**
29 May 2018 (29.05.2018)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
2017/07791 29 May 2017 (29.05.2017) TR

(71) **Applicant: KIRPART OTOMOTIV PARCALARI SANAYI VE TICARET A.S** [TR/TR]; Gedelek Mahallesi Gedelek Sokak No:470, 16800 Orhangazi/Bursa (TR).

(72) **Inventor: MERIC, Orhan**; Gedelek Mahallesi Gedelek Sokak No:470, 16800 Orhangazi/Bursa (TR).

(74) **Agent: YALINBAS, Fatih**; Altinsehir Mah. Abdi Ipekci Cad. No:20 Bulutpark Evleri A Blok Daire 13, 16120 Bursa (TR).

(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) **Title:** AN ACTUATOR WITH A PRESSURE RESISTANCE INCREASED DIAPHRAGM

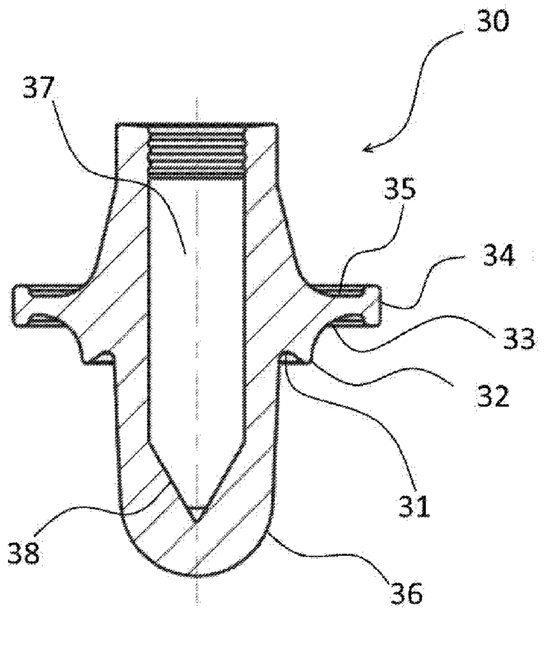


Figure 1a

(57) **Abstract:** In an actuator (10) which, comprising a reservoir (20), a piston (40), a flange (60) that is secured to the reservoir (20) and guides said piston (40), and a wax (50) that causes pressure increasement in the reservoir (20) by expanding within it in a heat sensitive manner, transforms the heat change within a thermostat into a mechanical change; the present invention is a diaphragm (30) that mechanically actuates the piston (40) by flexing with the pressure exerted from the wax (50). For enhancing the pressure resistance of the region where the sealing is provided by compressing the diaphragm (30) between the reservoir (20) and the flange (60), the present diaphragm (30) includes a lip (32) structure that is formed by recess (31) and a protrusion between the reservoir contact surface (33) and the diaphragm's (30) outer surface in contact with the wax (50).

WO 2019/040029 A2

DETAILED DESCRIPTION OF THE INVENTION

AN ACTUATOR WITH A PRESSURE RESISTANCE INCREASED DIAPHRAGM

Technical Field

The invention relates to a diaphragm with increased pressure resistance for use in actuators of thermostats used in the internal combustion engines cooling systems and an actuator formed thereby.

More particularly, the invention relates to a new diaphragm configuration with high pressure resistance developed to prevent wax leaks at high pressures depending on the raise in temperature at the rivet points between the diaphragm and the heat conductive chamber, of closed embodiment of thermo-actuator inside the key element in the engine coolers of motor vehicles and an actuator formed with this diaphragm.

Background of the Invention

In liquid-cooled systems used in internal combustion engines, the coolant liquid that takes up the heat of the engine is moved to capillary wings of radiator through the channels to be cooled by the effect of the wind and fan, and then sent to the engine channels. Until the temperature of the coolant liquid increases, circulation of the liquid in the engine channels continues. When the temperature of the coolant liquid reaches a certain height values again, the process starts from the beginning. The thermostat operates as a sensor that directs/conducts/canalizes this process depending on the temperature of the coolant liquid, sending it to the capillary channels of radiator in order to be cooled when the coolant temperature rises too much, to engine channels in order to absorb the rising temperature of engine when the coolant temperature decrease too much.

Thermostat is a control tool that keeps the system temperature in the range of desired values due to the heat and pressure sensitivity of the closed and flexible volumetric hydraulic structures located inside. Thermostats with thermo-hydraulic actuators are used in engine cooling radiators of vehicles in order to maintain the optimum working temperature of engines.

In the known state of the art, the ability to sense temperature changes in coolant and to direct this liquid coolant accordingly is due to the precise balance provided in the thermo-actuator inside the thermostats. Thermostat obtained by riveting the rubber structure with a cylindrical hollow projection in the middle and a metal container filled with a heat sensitive liquid (wax or hydraulic fluid or activation fluid) at tightness without damaging the rubber structure to prevent liquid leakage outside at high liquid pressures, has a shaft part on the outside which act forward and backward movement achieved by the operation of the internal hydraulic system of the thermo-actuator inside thermostat based on simple hydraulic principle.

The superheating coolant liquid that comes from the engine absorbed the excess heat of engine causes temperature raise and relatively pressure raise in hydraulic fluid (wax) inside metal container, so the cylindrical hollow projection in contact with the hydraulic fluid collapse in itself, causing the shaft placed tightly into inner surface of diaphragm projection to move outward. In the same way, the cooled coolant liquid that comes from radiator provides the temperature fall, therefore the pressure fall of the hydraulic liquid, allowing the cylindrical hollow projection to return to its original form so causing the shaft to be retracted. The ability of the piston portion of the thermo-actuator to continue to move back and forth is dependent on the preservation of the amount and the pressure of hydraulic fluid in the hydraulic reservoir of the inner embodiment of thermo-actuator. The hydraulic fluid in the hydraulic container, which reaches very high temperature values when the engine is extremely hot as a result of overload, leads to hydraulic fluid leaks separates the area where the flexible diaphragm and fixed metal shell are riveted each other to form the hydraulic container known in the art.

Although the internal structure of the thermostat actuators is designed to be suitable for operation at high pressures, the extreme wax pressures in the event of motor overheating result in unwanted wax leaks at joints where the metal container and flexible diaphragm structure which are firmly riveted to each other to prevent leakage outside to maintain the actuator to respond thermally responsive.

The rubber diaphragm clamped between the reservoir usually made of brass of a certain thickness and its upper lid and also the flange guiding the piston, also prevents leakage of the hydraulic fluid out of the reservoir. In present technique, an annularly surrounding sealing lip or cavity which is formed in the inner surface of the ring surface of reservoir where the diaphragm is clamped. This structure is called v-shaped sealing groove (v-shaped sealing groove).

The patent document US 5083705 mentions a vax-pellet thermostat construction. Here, a frame having a valve seat, a piston fixed to the frame, a guide member mounted on sliding shaft and a valve fixed to the guide member. An elastic ring seal is secured to the outer portion of the primary valve. A ring groove is formed on the sealing member to form an annular elastic lip on the outside of the sealing member. This elastic lip and the inner wall of frame are interlocked each other.

The patent document US 2700561 is the first document mentioning ring seal in the form of X. It has been improved as a more efficient solution then O-ring seal especially when parts move relative to one another, and where sealing of a shaft is required. Thus, the X-ring element between the shaft (or valve rod) and the bearing surface provides a sealing superiority to the other construction. Although it exhibits a minimum of friction resistance, it maintains its sealing function at the highest level.

As a result, the diaphragm structure that can prevent the leakage due to sudden and temporary extreme high pressures that may occur in the internal hydraulic system of the thermo-actuator inside the thermostat, is not offered in the known state of the art, and this leads to the invention of the diaphragm structure which guarantees waterproofness under extreme high pressure (like 400 and 500 pa).

Objectives and Short Description of the Invention

In an actuator embodiment, which consists of a heat sensitive reservoir that transform the heat change to the mechanical energy, a secured flange on the piston and reservoir as guiding the shaft, a heat sensitive hydraulic fluid that causes high pressure inside the reservoir by expanding with the rise in temperature ; an object of the invention is to put a diaphragm structure stretching with the pressure exerted by the wax and preventing leakage at high pressures and an actuator configured with this diaphragm.

Another object of the invention is put a lip structure which consists of indent and protrusion structures where the area between reservoir contact surface and diaphragm outer surface that contact hydraulic fluid, to increase the pressure resistance where diaphragm is clamped between the reservoir and flange to maintain sealing.

Description of the Figures

Figure 1a shows a sectional view depicting the diaphragm structure of the invention.

Figure 1b shows a front view of the diaphragm structure of the invention.

FIG. 2a shows a cross-sectional view of an entire thermo-actuator inner structure, including the diaphragm structure of the invention, and the lip structure in the diaphragm is indicated.

FIG. 2b shows a close-up view of the lip structure developed in the diaphragm structure of the invention.

Figure 3 shows an exploded perspective view showing parts of a thermo-actuator with the diaphragm structure of the invention.

Fig. 4 is a sectional view depicting the diaphragm structure of the prior art.

Figure 5 is a cross-sectional view of the inner structure of an actuator including a diaphragm according to the prior art.

Reference Numerals

10. Actuator
20. Reservoir
21. First twist
22. Second twist
23. Third twist
24. Flange compression extension
30. Diaphragm
31. Recess
32. Lip
33. Reservoir contact surface
34. Clamping extension
35. Flange contact surface
36. Lower outer surface
37. Piston guide hole
38. Lower inner surface
40. Piston
50. Wax
60. Flange
61. Compression edge

Detailed Description of the Invention

The present invention relates to a diaphragm (30) which generates the hydraulic system within actuators (10) of thermostats in the cooling system of the internal combustion engines, allows said actuator (10) to perform its normal function without leaking up the wax (50) located between said reservoir (20) and said diaphragm (30) by tightly riveting these structure each other, ensures the sealing of heat-sensitive fixed metal reservoir (20) also under high pressures resulted from the wax (50) in the situations where engine overheats and relates to an actuator (10) formed thereby.

The actuator (10) comprising the present diaphragm (30) is used in the thermostats within the cooling systems of the internal combustion engines. As well as said diaphragm (30) is used here in an actuator (10), it can be used in all applications where it is required heat-sensitive control and where it is expected that sealing is maintained/conserved against the high pressure within the reservoir (20).

A significant technical problem arises in the diaphragm (30) which is seen in figure 4 and has wide usage area in prior art. The hydraulic system̀s sealing structure which is formed by that the rubber is riveted with a flange (60) inserted on it as allowing the rubber within the junction locations to remain between diaphragm (30) and the metal reservoir (20) (heat permeable container) to prevent leakage and also, by clinching the flange compression extension (24) of metal reservoir (20) on them to make the sealing structure more secure, has certain restrictions too. Although it seems to be a reasonable solution to make compression operation by applying higher pressures onto the riveted portion of the rubber diaphragm (30) during assembly, material-based limitations of the rubber render these solutions insufficient. As with any material, the compressed portions of the diaphragm (30) which is produced from rubber and which is exposed to certain compression pressure values by the riveting and clinching operations, has also a pressure resistance until certain values. As well as the intensity of the pressure applied onto the material, the fact that the pressure is permanent or temporary is also the most important factor that will determine the durability of the material. Diaphragm (30) is exposed to permanent and lower pressures at the portions where it is riveted by metals while it is exposed to temporary and higher pressures at the portions where it contacts the wax. Nevertheless, since these high pressures are temporary unlike the permanent pressures in the rivet regions, they do not lead to irreversible abrasion and squeezing therefor. If the same high pressures are applied onto the rivet zones of diaphragm (30), irreversible damages occur in these regions of the diaphragm (30) and the diaphragm (30) no longer exhibits the properties of the material which it is made of. By losing their sealing properties as a result of increasing permanent pressures, the diaphragm (30) extensions compressed between the reservoir (20) and the flange (60) cause the wax (50) in the reservoir (20) to leak out and render the actuator (10) unusable.

In order to increase sealing performance of diaphragm (30) used in prior art, a solution consists of an annular groove formed on the reservoir (20) and a v-groove structure of diaphragm (30) created at this region during assembly by filling the said annular groove as a result of compression of diaphragm (30) between flange (60) and reservoir (20) is seen in figure 5. When high wax (50) pressure is applied onto the compression area where there are reservoir (20), flange (60) and the diaphragm (30) that is compressed between the reservoir (20) and the flange (60), the wax (50) leakage/progression can occur between the diaphragm (30) and the reservoir (20) wall until the v-groove region. When the wax (50) comes to the v-groove region, since the structure is forced to open with the pressure between the reservoir (20) and the diaphragm (30) while the same structure tends to close itself so, the pressure resistance can be higher in this region than other portions. However, there may be cases where a v-groove cannot be formed on the diaphragm (30) compression area of reservoir (20) because of that reservoir thickness is reduced or the reservoir is made thinner or made from another material. In this case, the wax (50) pressure resistance of the actuator (10) without v-groove structure significantly reduces if additional measures cannot be taken. The present invention also provides an alternative solution to increase the pressure resistance in these situations.

The riveting method that ensures the sealing of the hydraulic system that forms the internal structure of the thermostat which is the main element of the engine cooling systems, in another word, the compression of the diaphragm (30) between the reservoir (20) and the flange (60), can provide sealing until a certain pressure. However, leakage cannot be avoided at high pressures. The wax (50) reaching high pressures begins to leak from the rivet regions.

Adding a lip (32) protrusion in front of the rivet region of diaphragm (30) as an additional protection to the riveting method to ensure the seal performance at higher pressures generates a situation trying to close the rivet region while trying to open it on the other side as a result of that the wax (50) pressuring on the rivet region to leak out also pressurizes onto the lip (32) walls at the same high pressure. By means of the opposing forces generated by these opposing pressures, a high-quality safety wall can be formed against the wax (50) leakage at high pressures.

The actuator (10) seen in figure 2a transforms the heat change within the thermostat into a mechanical change. The actuator (10) comprises a heat conductive reservoir (20), a wax (50) which causes pressure increasement within said reservoir (20) by expanding in a heat-sensitive manner within said reservoir (20), a diaphragm (30) which stretches under the pressure exerted by said wax (50), a flange (60) which completes the sealing structure by squeezing said diaphragm (20) onto the reservoir (20) orifice, a piston (40) which settles on said diaphragm by being guided through said flange (60).

Unlike the prior art, the present novel diaphragm (30) seen in figure 1a has a ring-shaped lip (32) as centering the piston axis towards the diaphragm (30) portion which contacts with the wax (50) in the reservoir (20) and which is close to reservoir (20) wall. The lip (32) structure takes the lip-shape by a recess (31) near the reservoir contact surface (33) on the lower outer surface (36) of diaphragm (30) and a protrusion extending outwardly at a certain angle. The lip (32) is structured as close to the clamping extension (34) where sealing is provided by compressing the diaphragm (30) between reservoir (20) and flange (60). The difference from the prior art generates a structure which prevents leakages at temporary wax (50) pressures by riveting reservoir (20) and flexible rubber diaphragm (30) (which generate inner hydraulic system of actuators (10) that often have to work under the high temporary wax (50) pressures) each other by compressing the clamping extension (34) of diaphragm

(30) skirt between the reservoir (20) mouth and the flange (60) inserted on the diaphragm (30) with the permanent pressure value which is not exceed the value that causes the clamping extension (34) of the diaphragm (30) skirt to fail. So, unlike the previous technical solution in figure 4, in the present diaphragm (30) construction shown with a cross-sectional view in figure 1a and a front view in figure 1b, the pressure resistance of the diaphragm (30) consequently the pressure resistance of the construction which consists of the reservoir (20), the flange (60) and the diaphragm (30) is increased by means of the diaphragm (30) lip (32) structured in the region closed to the sealing region where the clamping extension (34) of the diaphragm (30) is compressed between the reservoir (20) and the flange (60).

In a thermostat where conventional diaphragm (30) shown in figure 4 is used, the sealing ability or the response of these forces at the not high-pressure values exerted on the rivet region where the diaphragm (30) skirt and the reservoir (20) are riveted depends on the capabilities of the rubber and sealing limits. At very high wax (50) pressure in such a diaphragm (30), the wax (50) which introduces through the rivet region and which will leak as a result of the very high wax (50) pressure exerted on the region where the reservoir (20) and the diaphragm (30) skirt are riveted, can exceed the sealing region which is limited only by the abilities of the rubber. However, with the present diaphragm (30) structure the sealing ability is not left to the capabilities of the rubber only, the resistance against high pressures is increased by removing the sealing limits to higher levels thanks to lip (32) structure of said present diaphragm (30).

The present diaphragm (30) of the invention and the front sectional view of the assembled state of the actuator (10) in which this diaphragm (30) is used are shown in figure 2a and its exploded view is shown in figure 3. The sealing abilities of the region where diaphragm (30) clamping extension (34) locates have been improved thanks to the distribution of the wax pressure forces (when simultaneously exposed to very high hydraulic fluid pressures) on the rivet regions between the reservoir (20) and diaphragm (30) skirt and on the walls of the lip (32) of diaphragm (30).

Figure 2b shows a closed cross-sectional view of the present inventive diaphragm (30) structure within an actuator (10) with the other elements of the actuator (10). The present diaphragm (30) can easily be used to increase the sealing quality in many embodiments of the same construction. The diaphragm (30) essentially comprises a piston guide hole (37) allowing movement of the piston (40) through and a lower inner surface (38) which is the initial starting region for the piston (40) to move upwardly through the piston guide groove (37). The diaphragm (30) includes a reservoir contact surface (33) located in the space formed for itself on the reservoir (20) and a flange contact surface (35) on the other side where the flange (60) settles. Said reservoir contact surface (33) and flange contact surface (35) form a clamping extension (34) on the outside of the diaphragm (30) and, a compression is applied onto said clamping extension (34) by depending on the quantity and material of diaphragm (30) used between the reservoir (20) and flange (60). Diaphragm`s (30) outer surface (36) which is in contact with the wax (50) within the reservoir (20) has a smooth surface that extends downwardly depending on the shape of the piston (40) and ends in either a full or partial hemisphere.

The circled area in figure 2b shows the region where the sealing is provided by riveting the diaphragm (30) between the reservoir (20) and the flange (60) and, also the lip (32) structure where pressure resistance is increased. The lip (32) formed in this region of the diaphragm (30) is structured by a recess (31) and a protrusion between the reservoir contact surface (33) and the diaphragm`s (30) outer surface which is in contact with the wax (50). The outer surface of the diaphragm (30) after the extreme end of the lip (32) is in contact with the inner surface of the reservoir (20), especially with the first twist (21) of the reservoir (20) mouth. This contact gets weaken at high pressures. In the prior art, with the weakening of this contact when the pressure increases, it could be causes the wax (50) to leak quickly with time or with sudden pressure increase. However, it is possible to obtain high sealing performance in present invention since the contact is still maintained strongly between the diaphragm (30) reservoir contact surface (33) and the reservoir (20) thanks to that the pressure is also applied onto concave space structured by the recess (31) and the lip (32).

The reservoir (20) has an outwardly expanding volume in its mouth portion for allowing the diaphragm (30) to be locked by compressed between the reservoir (20) and the flange (60) and for allowing sealing therefor. The reservoir (20) mouth extends outward after first twist (21) until the second twist (22), then extends upwardly up with a certain height where the flange (60) can be tightly settles therefor, and lastly a flange compression extension (24) is formed with an inward third bend (23). Said flange (60) spreads outwardly with a hole guiding the piston (40) in the middle of said flange (60) and a compression edge (61) to compress the diaphragm (30) onto the reservoir (20). It is allowed that the diaphragm (30) is compressed between the reservoir (20) and the flange (60) by riveting it as a result of bending of flange (60) compression edge (61) onto flange compression extension (24).

CLAIMS

1. The present invention is an actuator (10) which, comprising a heat-sensitive reservoir (20), a wax (50) that causes a pressure increase in said reservoir (20) by expanding within said reservoir (20) in a heat sensitive manner, a diaphragm (30) that stretches with the pressure applied by the wax (50), a flange (60) that completes the sealing structure by compressing said diaphragm (30) onto the reservoir (20) mouth and a piston (40) that locates on the diaphragm (30) by guided through the flange (60), transforms the heat change within a thermostat into a mechanical change and characterized by;

   comprising a lip (32) that is structured with a recess (31) and a protrusion between the reservoir contact surface (33) and diaphragm`s (30) outer surface in contact with wax (50) to increase the pressure resistance of the area where the diaphragm (30) is compressed between the reservoir (20) and the flange (60) to provide sealing thereof.

2. An actuator (10) according to claim 1 and characterized in that; said diaphragm (30) basically comprises;
   a piston guide hole (37) that permits the movement of the piston (40) through, a lower inner surface (38) that is the initial starting region of the upward movement of the piston (40) through said piston guide hole (37),

   a reservoir contact surface (33) that settles on the region formed on the reservoir (20) for diaphragm (30), a flange contact surface (35) where, on the other side of said reservoir contact surface (33), the flange (60) locates,

   a lip (32) that is constructed by a recess (31) and a protrusion between the said reservoir contact surface (33) and the outer surface of the diaphragm (30) in contact with the wax (50);

   and the sealing is strengthened by maintaining said contact between diaphragm (30) reservoir contact surface (33) and the reservoir (20) still in a strong way due to both of that diaphragm`s (30) outer surface after the extreme point of the recess (31) contacts with the reservoir (20) inner surface and the pressure is also exerted on the concave region structured by the recess (31) and the lip (32) together.

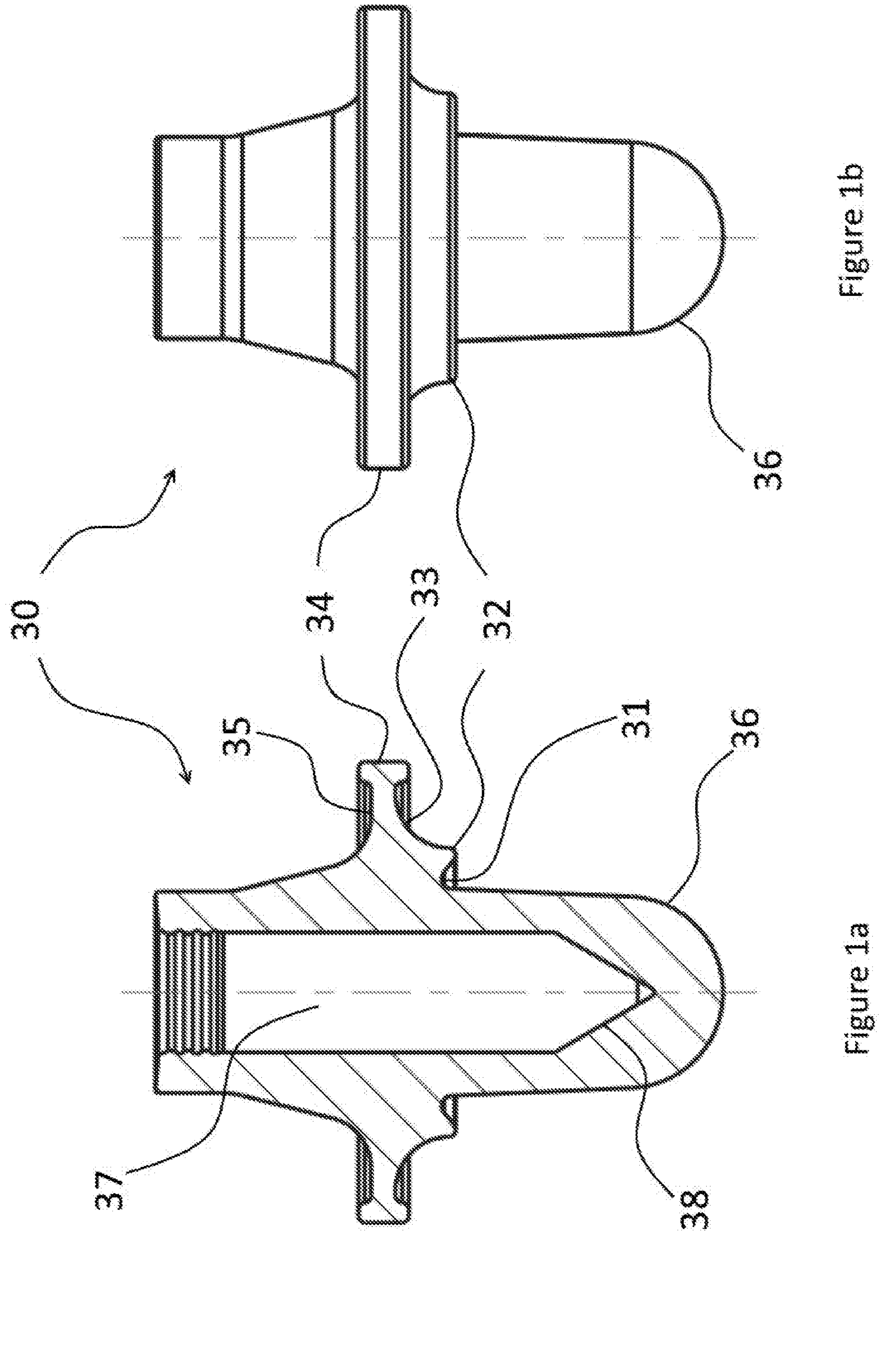


Figure 1a

Figure 1b

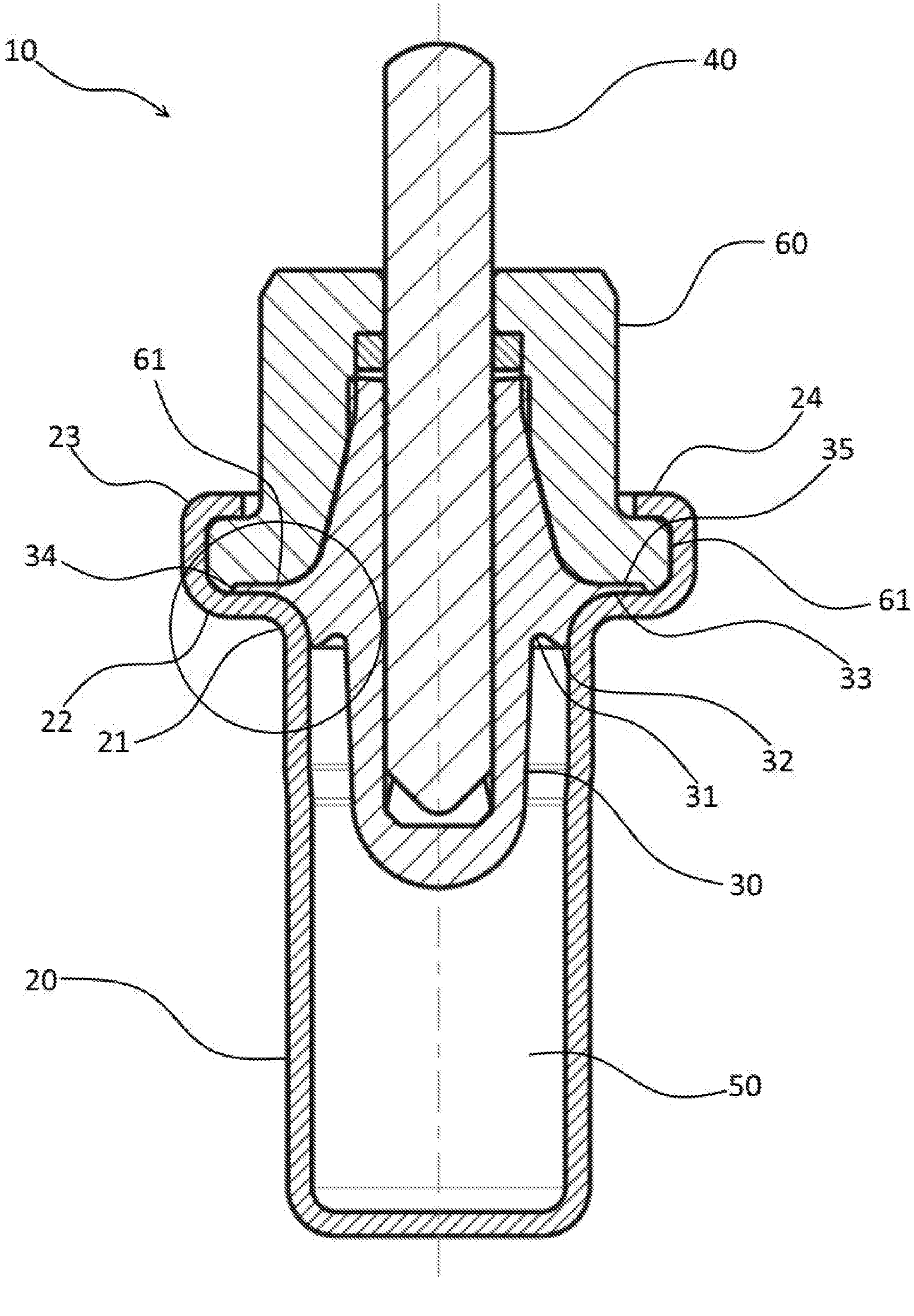


Figure 2a

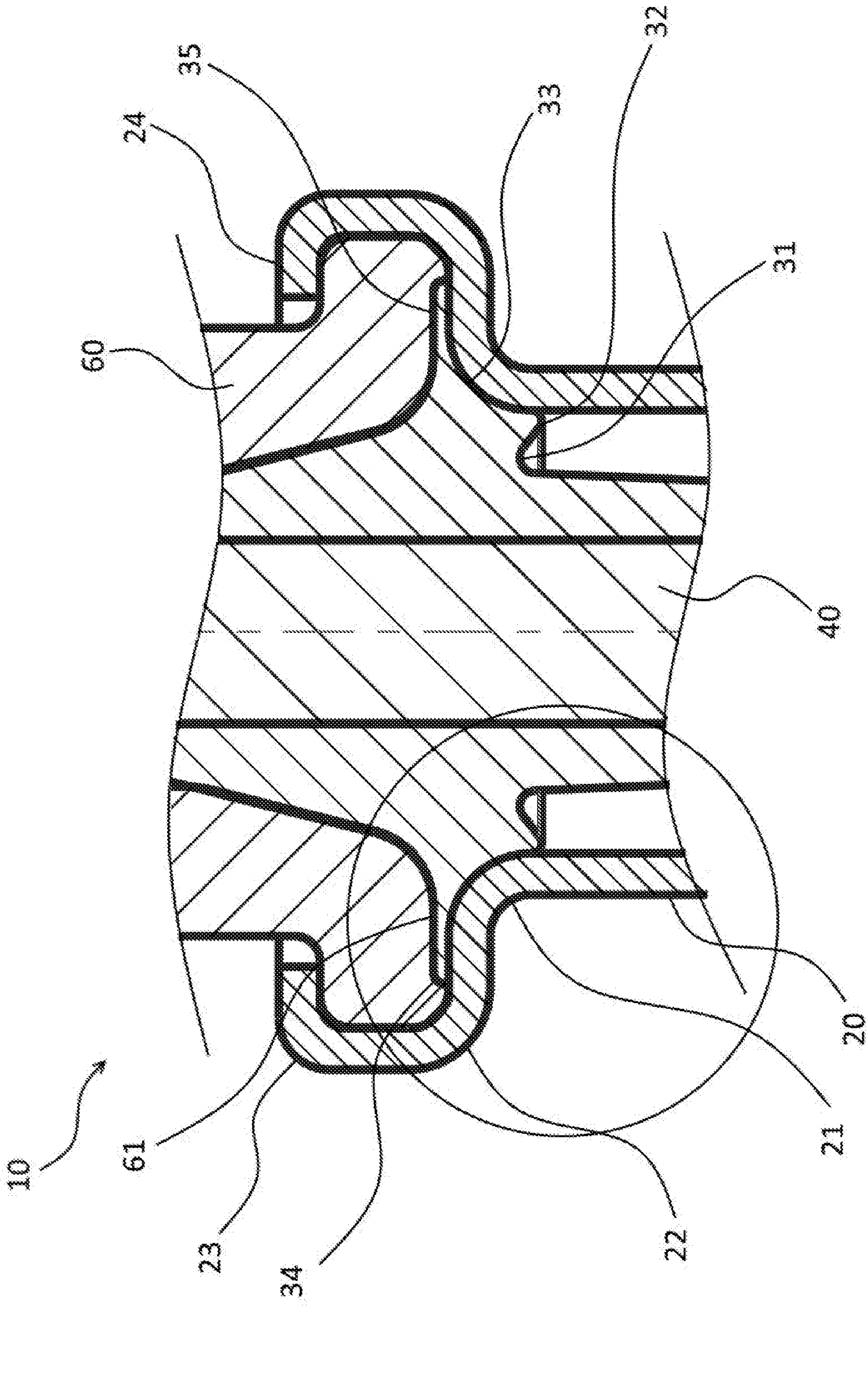


Figure 2b

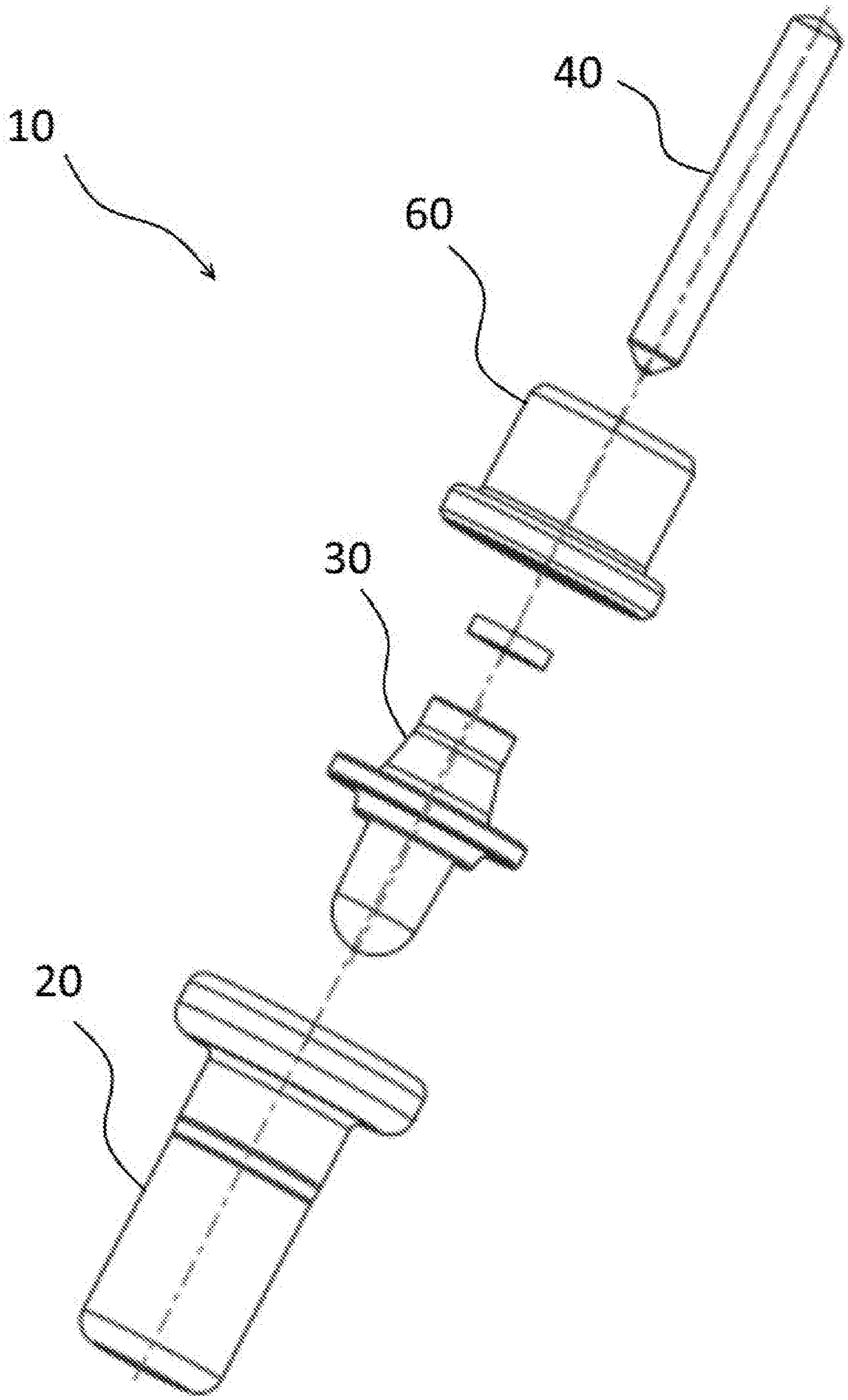
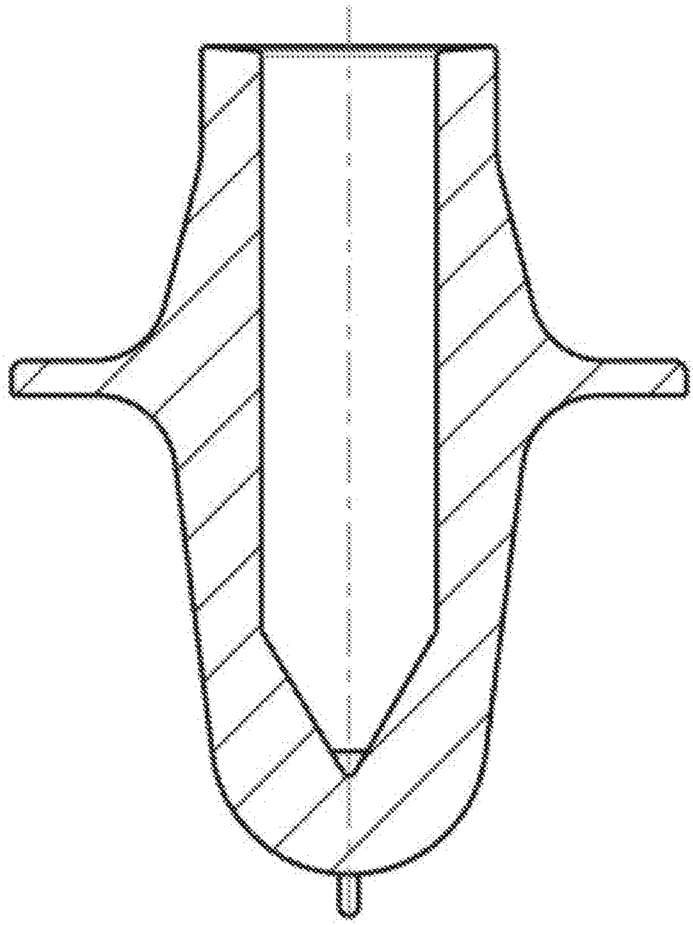
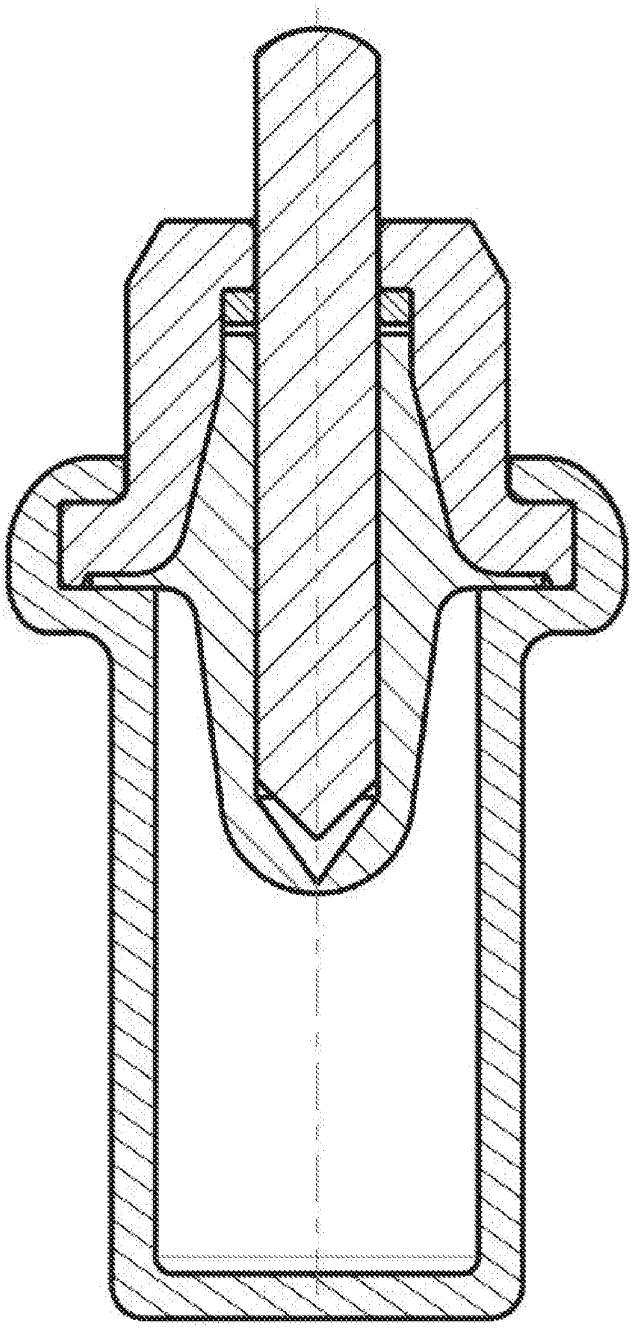


Figure 3



PRIOR ART

Figure 4



PRIOR ART

Figure 5