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(54) **LOW-TORQUE VALVE**

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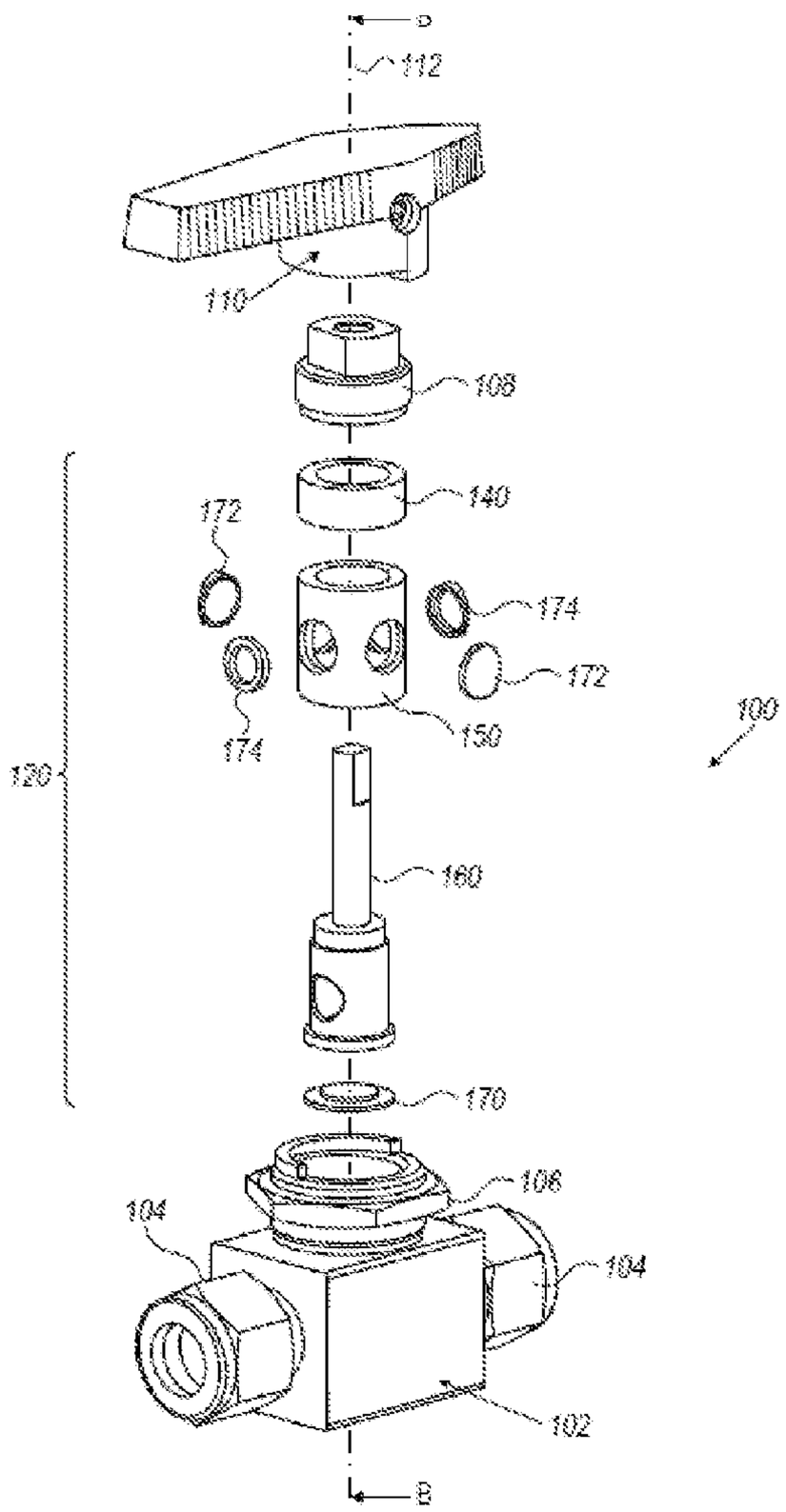
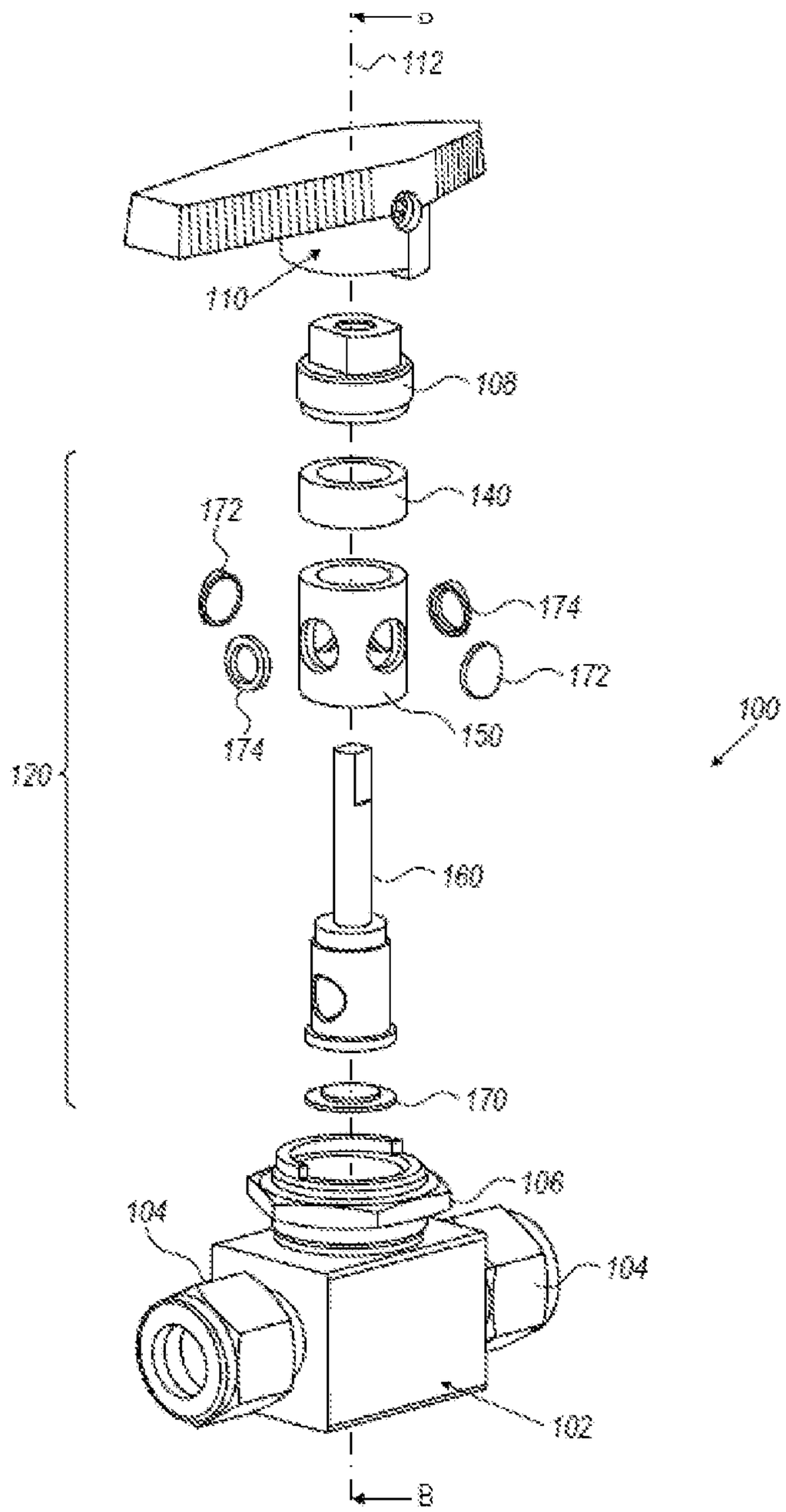
(57) **ABSTRACT**

A valve for controlling a fluid flow including (a) a valve body; (b) a valve stem securable within the valve body; the valve stem having a control portion configured for blocking the fluid flow and a tail portion configured to transfer a rotating torque; and (c) a deformable valve seat carried thereon in a coaxial and rotating manner; the valve stem and valve seat having inner and outer surfaces, respectively, conformal to each other. The outer surface of the valve stem has a circumferentially-arranged stepped area; the deformable valve seat when secured within the valve is deformed such that a space between the circumferentially-arranged stepped area of the outer surface and the inner surface of the valve seat is filled by the valve seat.




D
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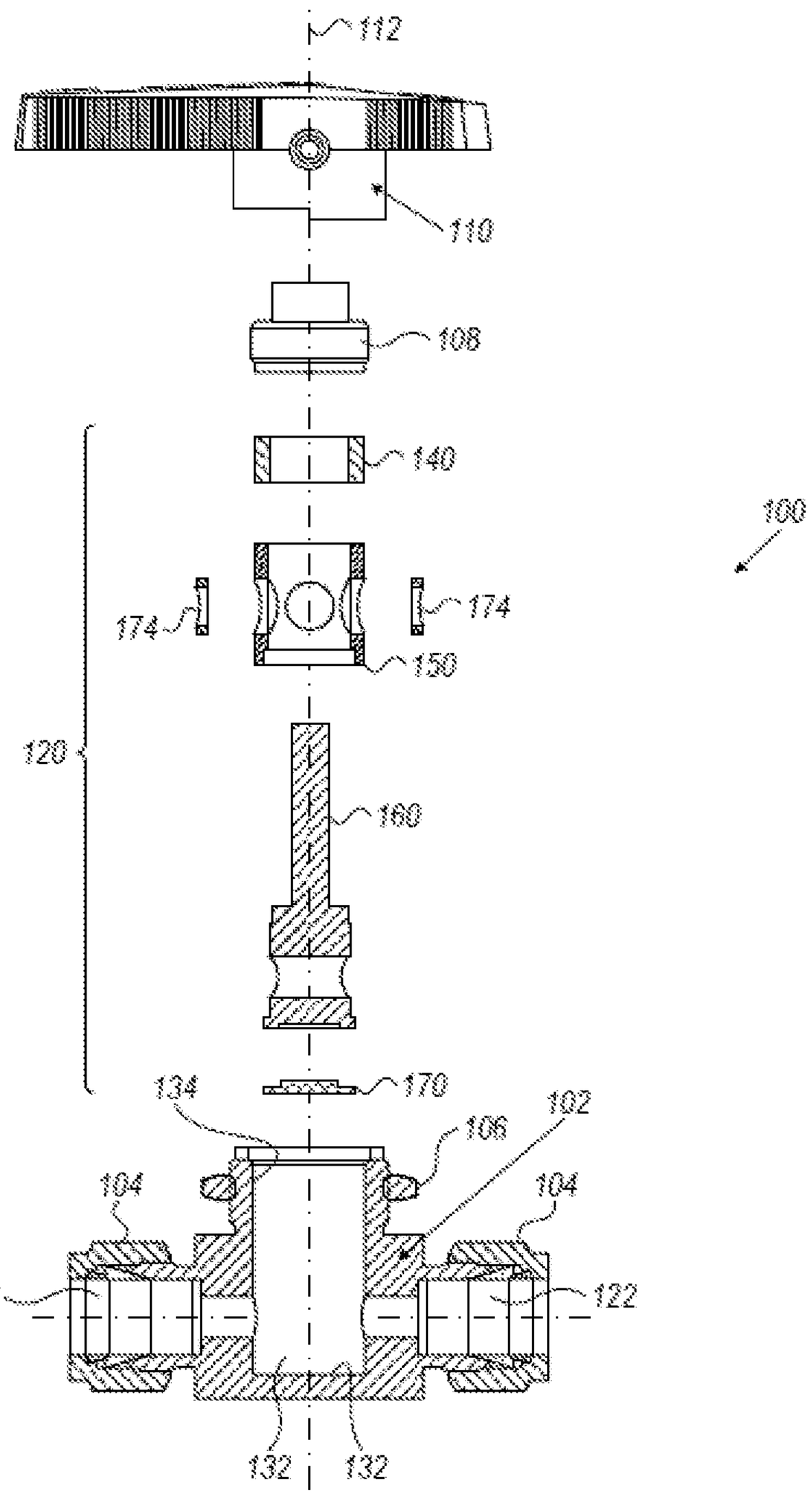
B

Fig. 1A


112
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132
132
100

Fig. 1B

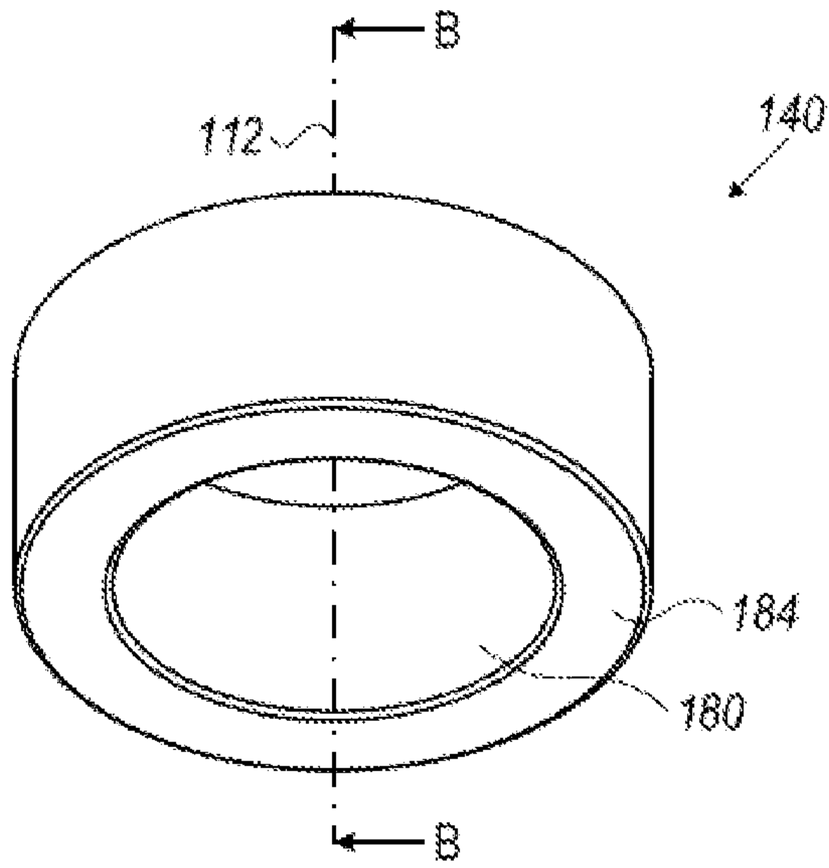


Fig. 2A

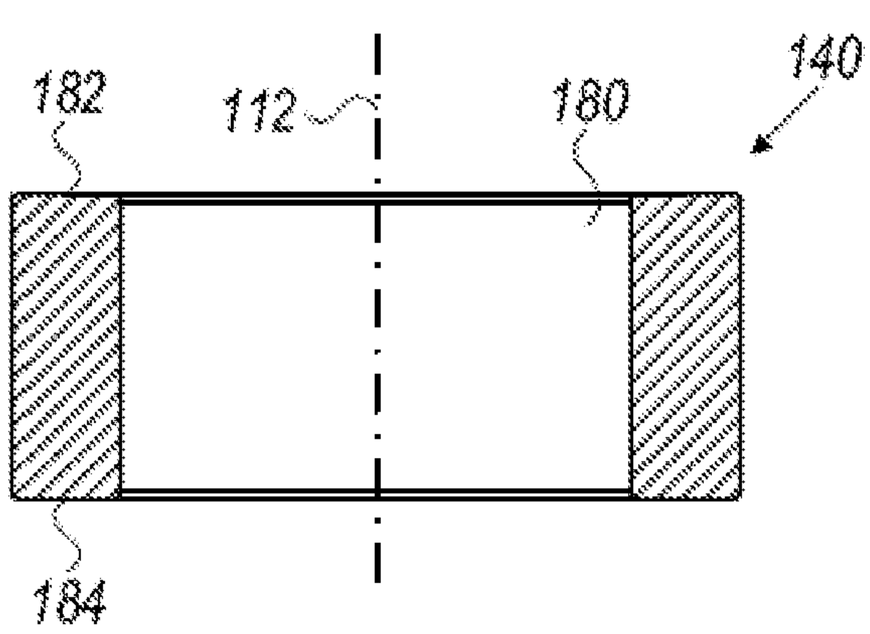


Fig. 2B

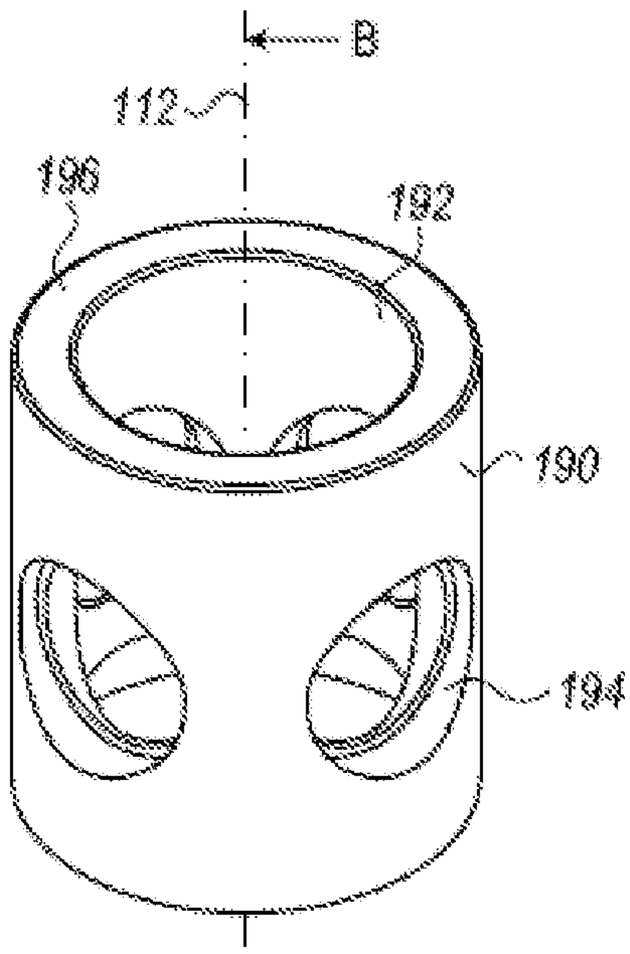


Fig. 3A

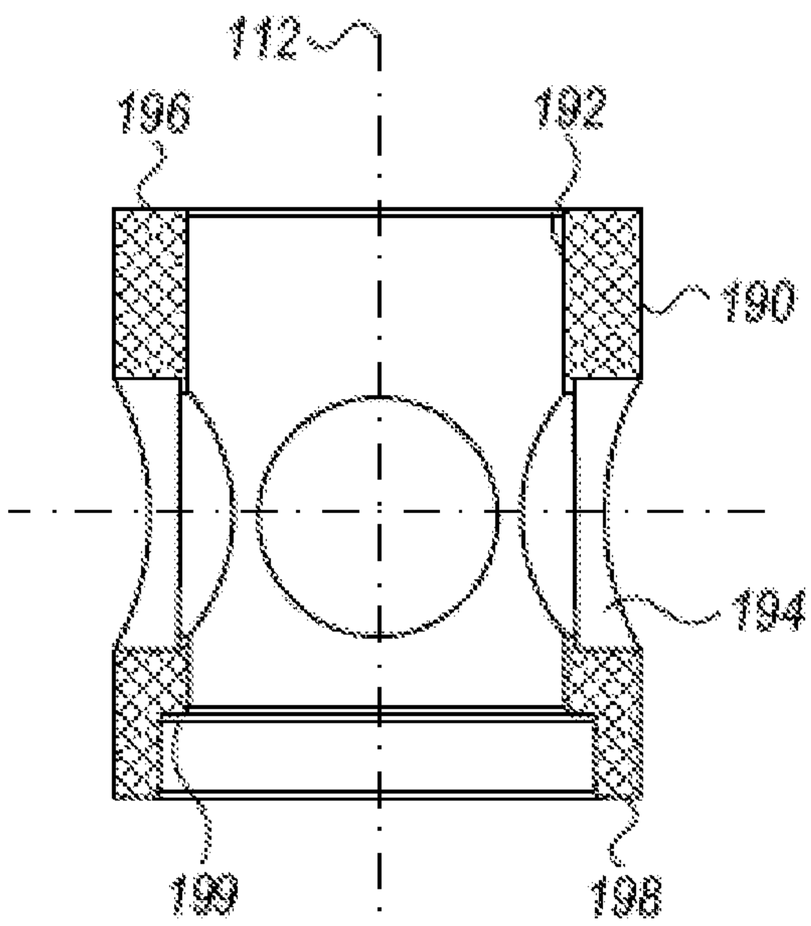
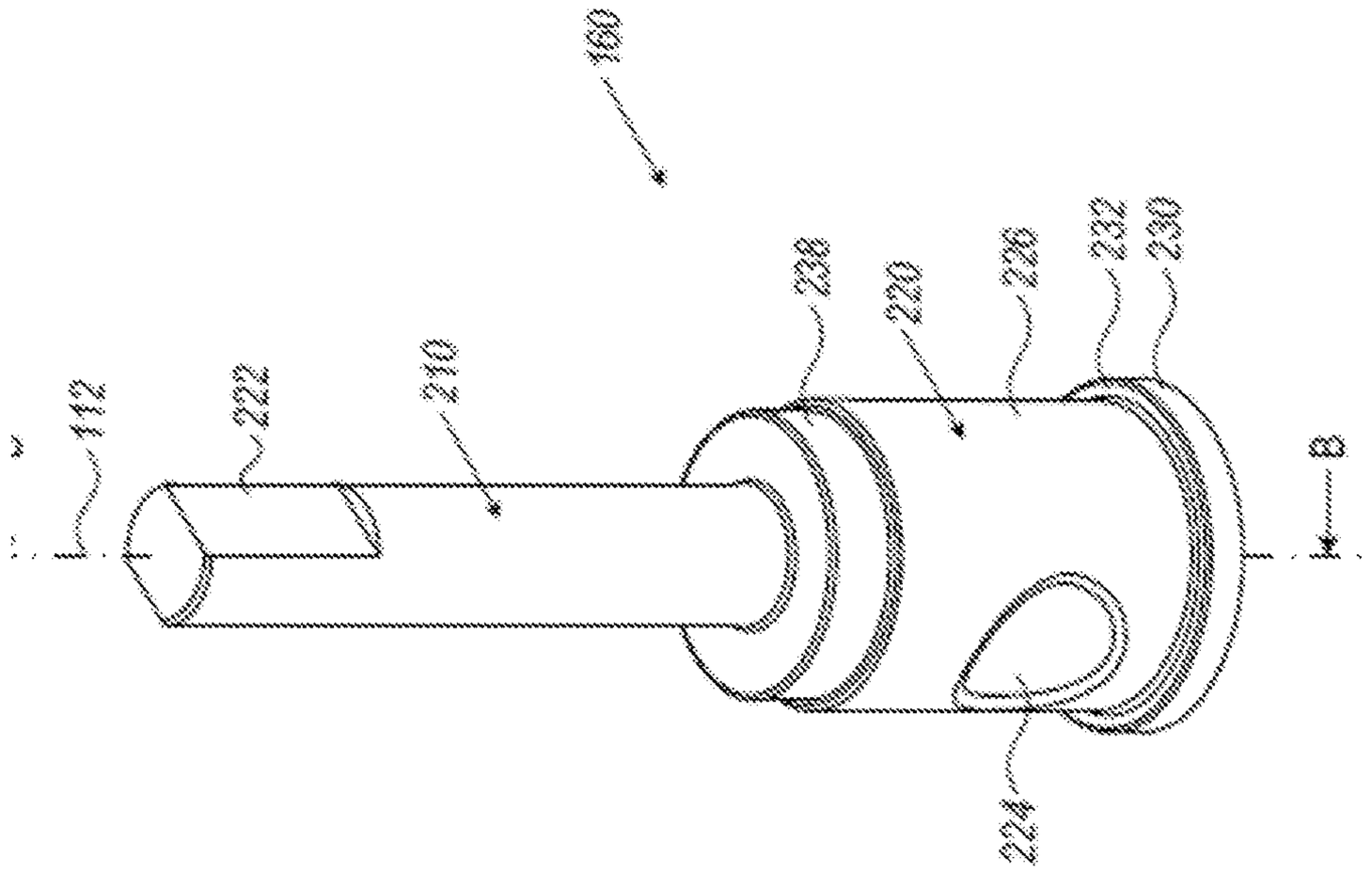


Fig. 3B


160
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238
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226
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224
a

Fig. 4A

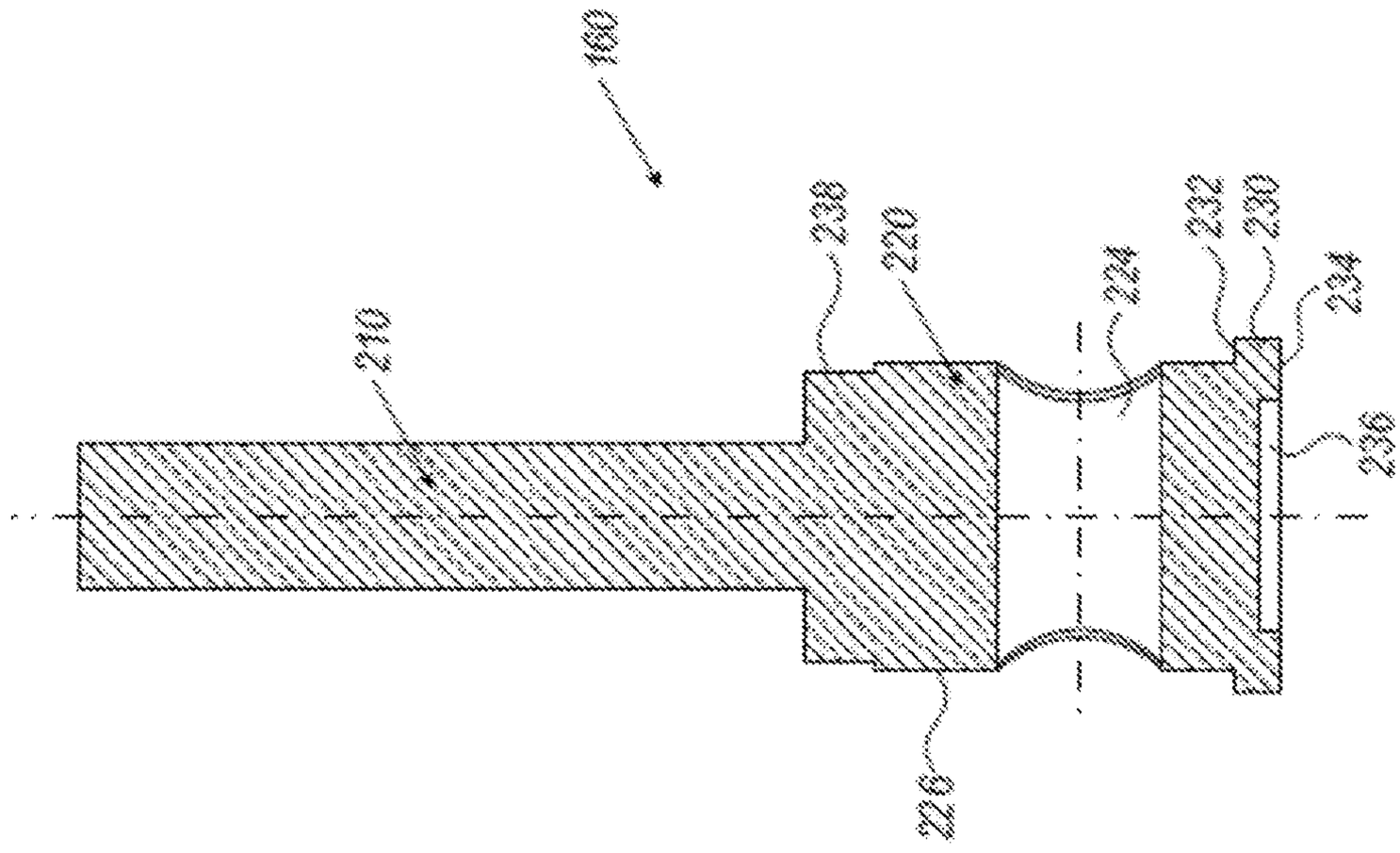
160
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Fig. 4B

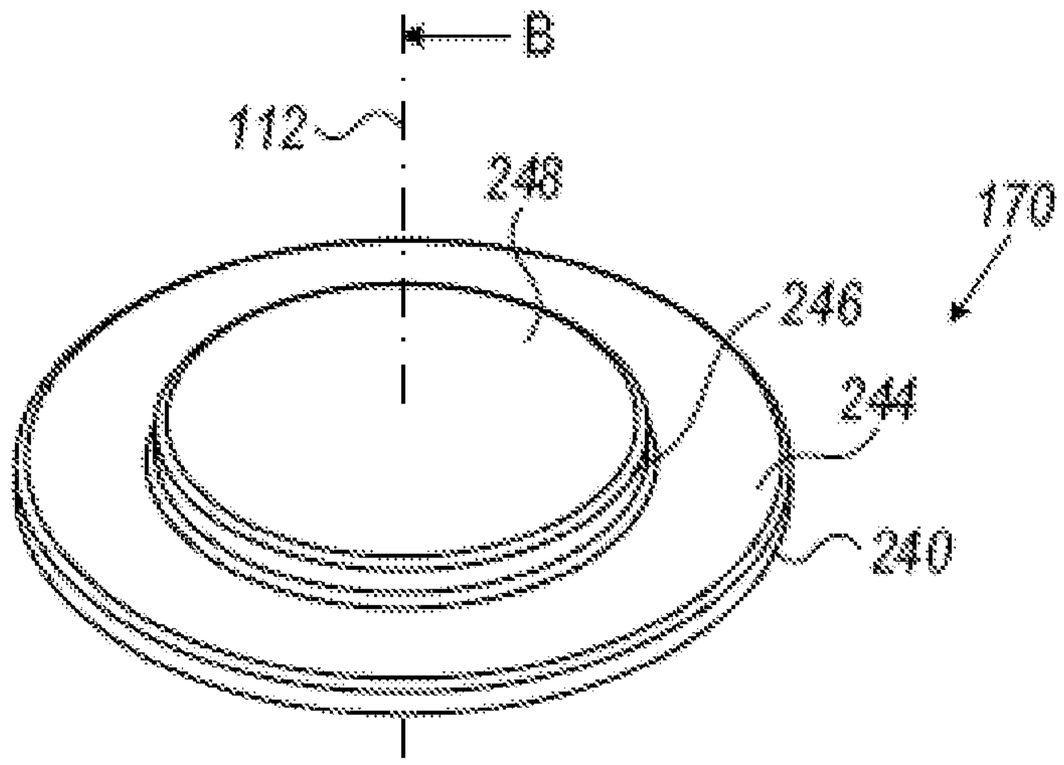

Fig. 5A

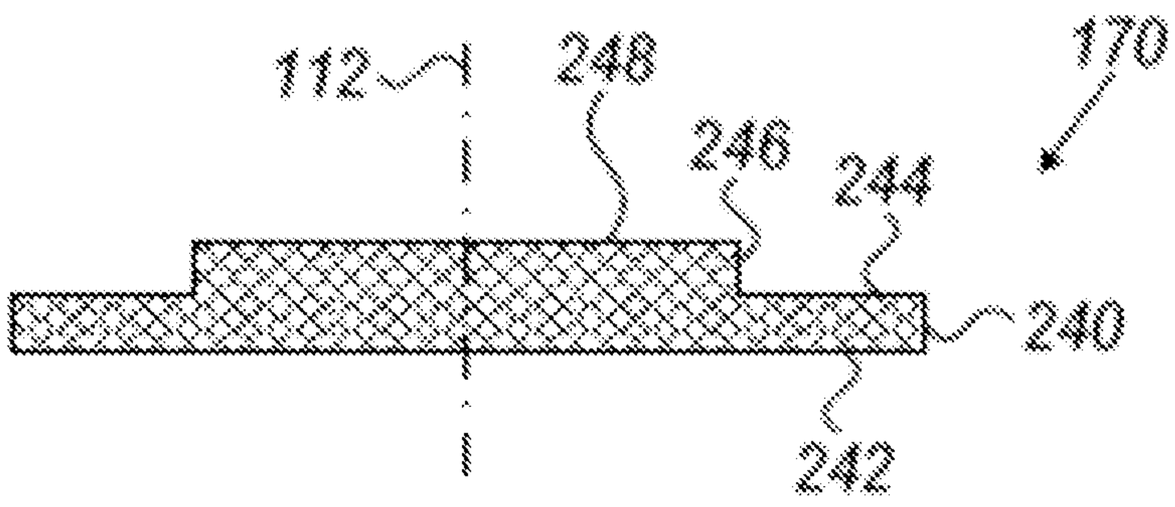

Fig. 5B

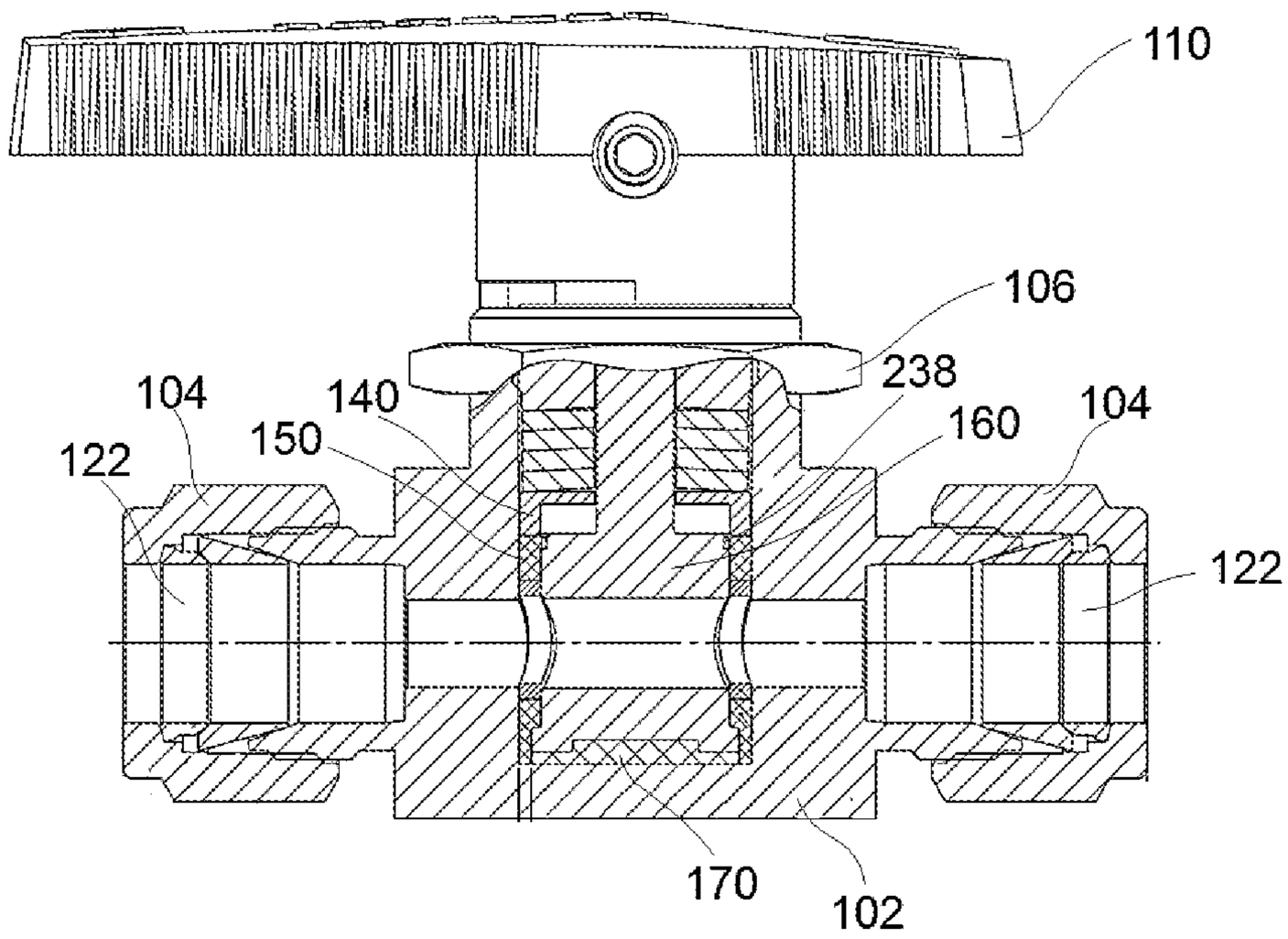

Fig. 6

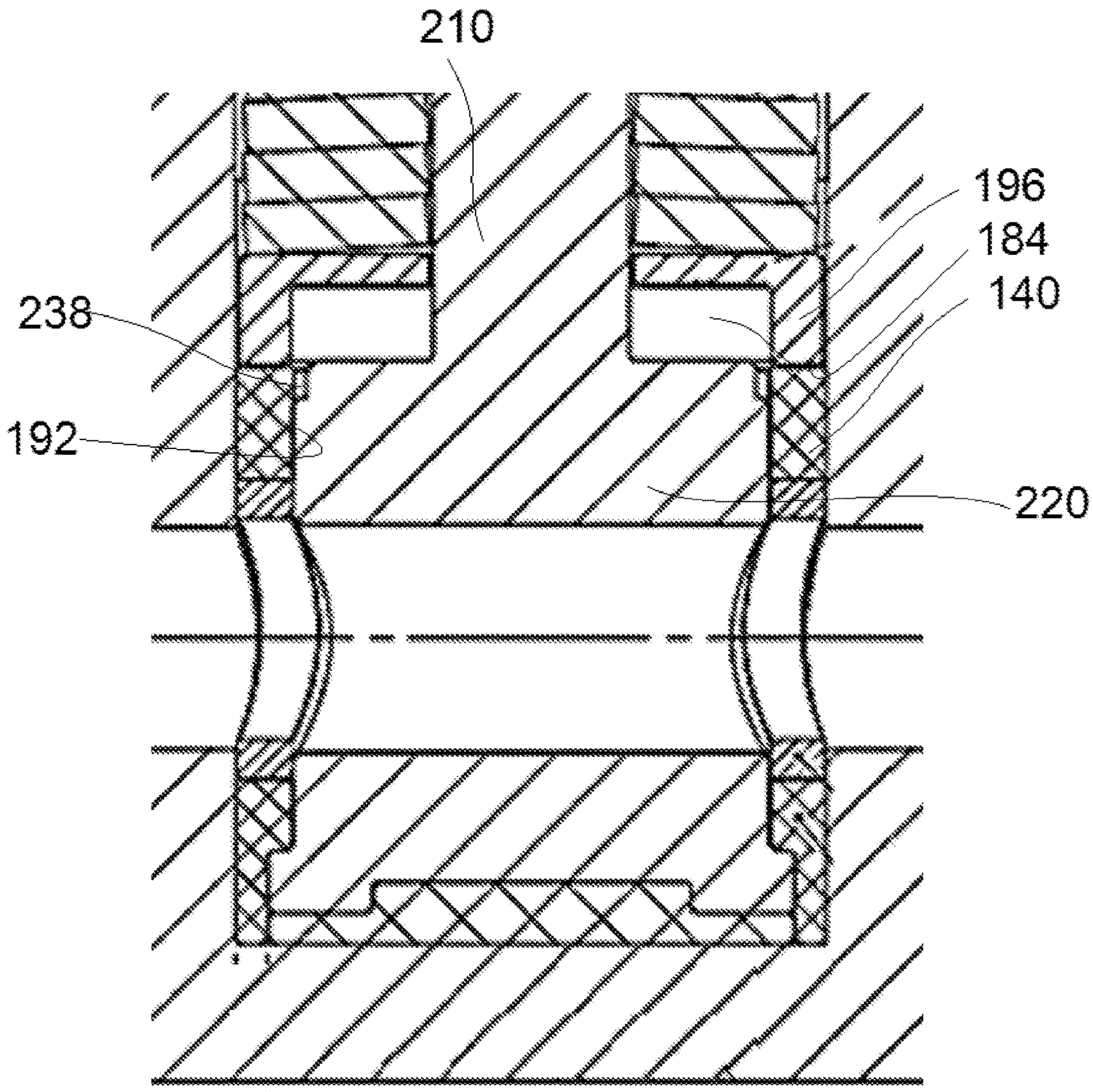

FIG. 7

LOW-TORQUE VALVE

RELATED APPLICATIONS

[0001] This application is a Continuation-in-Part of PCT Patent Application No. PCT/IL2017/051399 having International filing date of Dec. 28, 2017, which claims the benefit of priority of U.S. Provisional Application No. 62/440,470 filed on Dec. 30, 2016. The contents of the above applications are all incorporated by reference as if fully set forth herein in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to valves, and more particularly to low-torque valves.

BACKGROUND OF THE INVENTION

[0003] A plurality of devices for controlling of fluid flow are known, such as valves and in particular ball-type valves, which are adapted to selectively open and close a fluid flow passage. It is particularly known that large-diameter ball-type valves are typically operated using high-torque.

[0004] U.S. Pat. No. 5,947,443 discloses a gas distribution valve including a body defining an inlet and an outlet passage, a central well containing a cylindrical plug disposed for arcuate displacement therein and including a transverse thru-bore that can be rotated into and out of axial alignment with the flow passages of said body for opening and closing the valve respectively. Overmolded elastomeric seat seals are provided for superior sealing that are urged against the well walls by an arcuate leaf spring intervening between the seals and the plug and extending in a direction concentric with the plug.

[0005] US20160208936 discloses a high-pressure trunnion ball valve having an upper stem and a lower stem having the same diameter are provided on an upper side and a lower side of the ball in an extending manner secured by slider bearings coated by a PTFC resin. There is a long-felt and unmet need for providing valves demonstrating reliable and no-leaks behavior by means of an integral valve seat embracing a flow regulation portion.

SUMMARY OF THE INVENTION

[0006] The present invention seeks to provide an improved low-torque valve.

[0007] There is thus provided in accordance with an embodiment of the present invention a valve for controlling fluid flow passage, including a valve body; a valve stem securable within the valve body; the valve stem having a control portion configured for blocking the fluid flow and a tail portion configured to transfer a rotating torque; and a deformable valve seat carried thereon in a coaxial and rotating manner; said valve stem and valve seat having an inner and outer surfaces.

[0008] The outer surface of the valve stem has a circumferentially-arranged stepped area. The deformable valve seat when secured within the valve body is deformed such that a space between the circumferentially-arranged stepped area of the outer surface and the inner surface of said the seat is filled by deforming the latter.

[0009] Preferably, the outer surface of the valve stem is cylindrical and the inner surface of the valve seat is cylindrical.

[0010] Further preferably, contact surface between the valve stem and the valve seat is minimal in the direction in which forces are exerted on the valve stem along the longitudinal axis, thereby minimizing the torque created between the valve body and the handle.

[0011] Still preferably, the valve seat is formed by machining. Yet preferably, the valve seat is made of a polymeric material, selected from the group consisting of PEEK, PCTFE, PTFE, Reinforced PTFE, Modified PTFE and PFA.

[0012] Preferably, the outer surface of the valve stem defines a step surface operative to engage the valve seat and prevent disassembly of the valve stem and the valve seat. Further preferably, the outer surface of the valve stem defines a circumferential step recess, which is operative to enhance sealing between the valve stem and the valve body. Yet further preferably, the valve includes a disc adapted to be seated between the valve stem and the valve body and thereby preventing contact therebetween.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

[0014] FIGS. **1**A and **1**B are respective simplified pictorial exploded illustration and sectional exploded illustration of a low-torque valve constructed and operative in accordance with an embodiment of the present invention, section being taken along lines B-B in FIG. **1**A;

[0015] FIGS. **2**A and **2**B are respective simplified pictorial and sectional illustrations of a ring forming part of the low-torque valve of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **2**A;

[0016] FIGS. **3**A and **3**B are respective simplified pictorial and sectional illustrations of a valve seat forming part of the low-torque valve of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **3**A;

[0017] FIGS. **4**A and **4**B are respective simplified pictorial and sectional illustrations of a valve stem forming part of the low-torque valve of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **4**A;

[0018] FIGS. **5**A and **5**B are respective simplified pictorial and sectional illustrations of a disc forming part of the low-torque valve of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **5**A;

[0019] FIG. **6** is a simplified cut-out illustration of the assembled low-torque valve of FIGS. **1**A and **1**B; and

[0020] FIG. **7** is an enlarged cut-out illustration of the assembled low-torque valve of FIGS. **1**A and **1**B.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] In accordance with an embodiment of the present invention, a valve is provided for controlling and adjusting passage of fluid within a flow system. Fluid is defined hereby as liquid, gas, vapor, gel or any other material or state thereof that can flow via one or more directing elements such as tubes, pipes, conduits and the like.

[0022] The flow system can be any system requiring control and adjustment of flow of fluids such as an engine gas transport system, a water piping system, flow—control components for the semiconductor industry, gas and oil (energy) industry, or any other system or industry that requires valve control for fluid flow control.

[0023] In accordance with some embodiments of the present invention, the valve is configured and located such as to control fluid flow between one or more outlets of at least one fluid directing means such as a tube, conduit, pipeline and the like into one or more inlets of at least one other directing means to one or more inlets of directing means. The valve can control a throughput of the fluid flow or prevent passage thereof by being located between a conduit outlet and another conduit inlet.

[0024] It is appreciated that usually all components of ball-type valves are made of stainless steel, other than the valve seat, which is made of a polymeric, relatively resilient material.

[0025] Reference is now made to FIGS. **1**A and **1**B, which are respective simplified pictorial exploded illustration and sectional exploded illustration of a low-torque valve constructed and operative in accordance with an embodiment of the present invention, section being taken along lines B-B in FIG. **1**A.

[0026] A low-torque valve **100** is seen in FIGS. **1**A and **1**B, including a valve body **102** having a plurality of valve ports **104**, generally extending in different radial directions and a connector portion **106** adapted for attachment with a nut **108**. A handle **110** adapted to be selectably rotatably attached to the nut **108** and connector portion **106** of valve body **102**.

[0027] It is noted that valve body **102** can have any number of valve ports **104**.

[0028] A valve assembly **120** is arranged along a longitudinal axis **112** and is configured to be disposed between valve body **102** and handle **110**.

[0029] It is seen in FIG. **1**B that fluid flow passage is defined by bores **122** formed through ports **104** of the valve body **102**. Bores **122** fluidly communicate with a valve assembly receiving cavity **130**. Valve assembly receiving cavity **130** defines an upwardly facing surface **132** and a circumferential surface **134**.

[0030] It is a particular feature of an embodiment of the present invention that as seen in FIGS. **1**A and **1**B, valve assembly **120** preferably includes a ring **140**, adapted to be mounted onto a valve seat **150**, which is adapted to be seated around a portion of a valve stem **160**, which in turn is adapted to be seated onto a disc **170**. It is additionally seen that typically two seat discs **172** and two seat rings **174** are adapted to be mounted onto valve seat **150** to prevent it from buckling when the valve seat **150** is assembled into the low-torque valve **100**.

[0031] Reference is now made to FIGS. **2**A and **2**B, which are respective simplified pictorial and sectional illustrations of ring **140** forming part of the low-torque valve **100** of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **2**A.

[0032] Ring **140** is preferably an integrally formed element made of stainless steel and arranged along longitudinal axis **112**. The ring **140** forms part of the valve assembly **120**.

[0033] Ring **140** defines a through-going bore **180**, an upwardly facing annular surface **182** and a downwardly facing annular surface **184**.

[0034] Reference is now made to FIGS. **3**A and **3**B, which are respective simplified pictorial and sectional illustrations of valve seat **150** forming part of the low-torque valve **100** of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **3**A.

[0035] Valve seat **150** is preferably an integrally formed element made of a polymeric material and arranged along longitudinal axis **112**. The valve seat **150** forms part of the valve assembly **120**.

[0036] It is a particular feature of an embodiment of the present invention that valve seat **150** is a hollow cylindrical element defining an outwardly facing cylindrical surface **190** and an inwardly facing cylindrical surface **192**, adapted to fit to the cylindrical outer surface of valve stem **160**.

[0037] It is noted that the inner surface of valve seat **150** can be of any non-spherical shape.

[0038] A plurality of bores **194** are formed in valve seat **150** and extend along axes which are perpendicular to longitudinal axis **112**. It is appreciated that at least two of bores **194** are adapted to selectably communicate with bores **122** of valve body **102**, when the low-torque valve **100** is disposed in an open operative orientation.

[0039] Valve seat **150** defines an upwardly facing surface **196** and a downwardly facing surface **198** and a circumferential downwardly facing step **199** formed adjacent the downwardly facing surface **198**.

[0040] It is a particular feature of an embodiment of the present invention that the cylindrical valve seat **150** is formed by machining, thus allowing manufacturing of the valve seat **150** using the following materials: PEEK (polyetheretherketone); PCTFE (polychlorotrifluoroethylene); PTFE (polytetrafluoroethylene); RPTFE (Reinforced PTFE) in addition to TFM (modified PTFE) and PFA (Perfluoroalkoxy alkane), which are typically used while manufacturing valve seats by means of injection molding. It is noted that the valve seat **150** can additionally be manufactured using any other suitable polymeric material that provides the desired sealing characteristics between the valve stem **160** and the valve body **102**.

[0041] Reference is now made to FIGS. **4**A and **4**B, which are respective simplified pictorial and sectional illustrations of valve stem **160** forming part of the low-torque valve **100** of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **4**A.

[0042] Valve stem **160** is preferably an integrally formed element made of stainless steel and arranged along longitudinal axis **112**. The valve stem **160** forms part of the valve assembly **120**.

[0043] Valve stem **160** preferably includes an elongate connection portion **210** and a flow regulation portion **220**.

[0044] Connection portion **210** has a non-rotational engagement surface **222**, adapted for non-rotatably fixating the valve stem **160** relative to valve handle **110**.

[0045] It is a particular feature of an embodiment of the present invention that flow regulation portion **220** of valve stem **160** has a cylindrical cross-section having a through-going bore **224** extending along an axis which is generally perpendicular to longitudinal axis **112**. It is appreciated that bore **224** is adapted to selectably communicate with bores **122** of valve body **102**, when the valve handle **110** is rotatebly suitably positioned, such as to position the low-torque valve **100** in an open operative orientation.

[0046] The flow regulation portion **220** of valve stem **160** defines an outwardly facing cylindrical surface **226**. It is noted that alternatively, the flow regulation portion **220** of valve stem **160** can be of any other non-spherical shape.

[0047] A slightly outwardly extending circumferential flange **230** is formed at the bottom end of flow regulation portion **220** of valve stem **160**. The flange **230** defines an

upwardly facing step surface **232** and a downwardly facing surface **234**. A recess **236** is formed in downwardly facing surface **234**.

[0048] It is noted that a circumferential step recess **238** is formed at the top end of the flow regulation portion **220**, which is operative for engaging the inner surface of ring **140**, and thereby enhancing sealing between the valve stem **160** and the ring **140**.

[0049] It is further noted that valve stem **160** may be integrally formed or alternatively, it may be formed of several separate parts coupled to each other.

[0050] Reference is now made to FIGS. **5**A and **5**B, which are respective simplified pictorial and sectional illustrations of disc **170** forming part of the low-torque valve **100** of FIGS. **1**A and **1**B, section being taken along lines B-B in FIG. **5**A.

[0051] Disc **170** is preferably an integrally formed element made of PCTFE and arranged along longitudinal axis **112**. The disc **170** forms part of the valve assembly **120**.

[0052] Disc **170** includes a circular portion **240** defining a downwardly facing surface **242** and an upwardly facing surface **244** and an upwardly extending circular protrusion **246** defining an upwardly facing surface **248**. The protrusion **246** is adapted to be received within recess **236** of valve stem **160**.

[0053] Reference is now made to FIGS. **6** and **7**, which is a simplified cut-out illustration of the assembled low-torque valve **100** of FIGS. **1**A and **1**B.

[0054] It is further seen in FIG. **6** that the valve seat **150** is press-fit assembled between the valve stem **160** and the valve body **102**. Valve stem **160** is retained between valve seat **150** and disc

[0055] It is appreciated that disc **170**, which is made of a relatively resilient material, is operative to prevent contact between two metal parts, namely between the valve stem **160** and the valve body **102**.

[0056] It is a particular feature of an embodiment of the present invention that when valve assembly **120** is inserted into valve body **102**, and valve handle **110** is rotated relative to valve body **102**, ring **140** exerts force on valve seat **150**, such that valve seat **150** is deformed and pressurized between valve stem **160** and valve body **102** in order to create a seal therebetween.

[0057] It is appreciated that when the handle **110** and the valve stem **160** are rotatably suitably positioned with respect to valve body **102**. It is seen in FIG. **6** that an interference-fit engagement is formed between the valve seat **150**, valve body **102** and valve stem **160**. It is particularly seen that outwardly facing cylindrical surface **226** of valve stem **160** engages inwardly facing cylindrical surface **192** of valve seat **150** and outwardly facing cylindrical surface **190** of valve seat **150** engages circumferential surface **134** of valve body **102**.

[0058] The valve seat **150** is carried on the valve stem **160** in a coaxial and rotating manner. The outer surface **226** of said valve stem has a circumferentially-arranged stepped area **238**. The deformable valve seat **150** when secured within the valve body **102** is deformed such that a space between the circumferentially-arranged stepped area **238** of the outer surface **226** and the inner surface of the valve seat **150** is filled by deforming the latter.

[0059] It is a particular feature of an embodiment of the present invention that minimal contact surface exists between valve seat **150** and valve stem **160** on which axial forces along longitudinal axis **112** are exerted, thus providing for low torque forces between valve stem **160** and valve seat **150** and thus in turn between handle **110** and valve body **102**. It is particularly seen that upon rotation of handle **110**, valve seat **150** is pressurized between ring **140** and valve stem **160** due to the following engagements: engagement between annular surface **184** of ring **140** and upwardly facing surface **196** of valve seat **150** and engagement of upwardly facing step surface **232** of valve stem **160** and downwardly facing step **199** of valve seat **150**.

[0060] It is a particular feature of an embodiment of the present invention that due to the fact that both the flow regulation portion **220** of valve stem **160** and valve seat **150** are of a cylindrical cross-section, the engagement surface between the valve stem **160** and the valve seat **150** on which forces are exerted in the direction of longitudinal axis is minimal, thus torque forces therebetween are minimized.

[0061] It is a further particular feature of an embodiment of the present invention that due to the fact that the valve seat **150** is machined and both valve seat **150** and valve stem **160** have cylindrical cross-section, these two components can be easily separated at any given time.

[0062] It is a yet further particular feature of an embodiment of the present invention that the operating torque of the low-torque valve **100**, required for selectably positioning the valve **100** in the open operative orientation or the closed operative orientation, is at least 40% lower than the operating torque of typical commercially available ball valves having the same valve seat outer diameter and valve seat material as the low-torque valve **100** constructed in accordance with an embodiment of the present invention.

[0063] It is additionally noted that valve assembly **120** is replaceable following a pre-determined amount of operation cycles of low-torque valve **100**.

[0064] It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of various features described hereinabove as well as variations and modifications thereof which are not in the prior art.

1. A valve for controlling a fluid flow, comprising:

a. a valve body;

b. a valve stem securable within said valve body; said valve stem having a control portion configured for blocking said fluid flow and a tail portion configured to transfer a rotating torque;

c. a deformable valve seat carried thereon in a coaxial and rotating manner; said valve stem and valve seat having inner and outer surfaces, respectively, conformal to each other;

wherein said outer surface of said valve stem has a circumferentially-arranged stepped area; said deformable valve seat when secured within said valve is deformed such that a space between said circumferentially-arranged stepped area of said outer surface and said inner surface of said valve seat is filled by said valve seat.

2. The valve according to claim **1**, wherein said outer surface of said valve stem is cylindrical and said inner surface of said valve seat is cylindrical.

3. The valve according to claim **1**, wherein contact surface between said valve stem and said valve seat is minimal in the direction in which forces are exerted on said valve stem

along said longitudinal axis, thereby minimizing torque forces created between said valve body and said handle.

4. The valve according to claim **1**, wherein said valve seat is formed by machining.

5. The valve according to claim **4**, wherein said valve seat is made of a polymeric material, selected from the group consisting of PEEK, PCTFE, PTFE, Reinforced PTFE, Modified PTFE and PFA.

6. The valve according to claim **1** comprising a disc adapted to be seated between said valve stem and said valve body and thereby preventing contact therebetween.

* * * * *