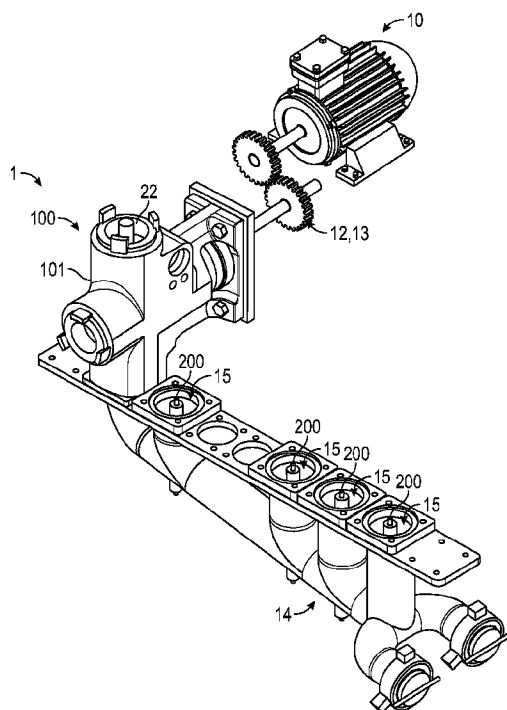




(86) Date de dépôt PCT/PCT Filing Date: 2017/12/15
(87) Date publication PCT/PCT Publication Date: 2019/06/20
(45) Date de délivrance/Issue Date: 2022/01/04
(85) Entrée phase nationale/National Entry: 2020/02/28
(86) N° demande PCT/PCT Application No.: US 2017/066720
(87) N° publication PCT/PCT Publication No.: 2019/117947

(51) Cl.Int./Int.Cl. *F04B 17/03* (2006.01),
E21B 43/12 (2006.01), *F04B 53/10* (2006.01),
F04B 53/14 (2006.01)
(72) Inventeurs/Inventors:
HUNTER, TIMOTHY HOLIMAN, US;
STEPHENSON, STANLEY VERNON, US
(73) Propriétaire/Owner:
HALLIBURTON ENERGY SERVICES, INC., US
(74) Agent: NORTON ROSE FULBRIGHT CANADA
LLP/S.E.N.C.R.L., S.R.L.

(54) Titre : SYSTEME DE POMPAGE AVEC ACTIONNEUR
(54) Title: PUMPING SYSTEM WITH ACTUATOR



(57) Abrégé/Abstract:

A pumping system is provided which includes a motor coupled with a transmission and a pump. The pump includes a housing with a chamber, a plunger coupled with the motor and the transmission and translatable into and out of the chamber creating pressure changes in the chamber, an entry valve at an inlet in the housing to the chamber, an exit valve at an outlet in the housing to the chamber, and an actuator coupled with the entry valve. The actuator is operable to hold the entry valve in an open configuration independent of pressure changes created by the translation of the plunger.

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

(19) World Intellectual Property

Organization

International Bureau

(43) International Publication Date

20 June 2019 (20.06.2019)



(10) International Publication Number

WO 2019/117947 A1

(51) International Patent Classification:

F04B 17/03 (2006.01) **F04B 53/14** (2006.01)**F04B 53/10** (2006.01) **E21B 43/12** (2006.01)

(21) International Application Number:

PCT/US2017/066720

(22) International Filing Date:

15 December 2017 (15.12.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(71) Applicant: **HALLIBURTON ENERGY SERVICES, INC.** [US/US]; 3000 N. Sam Houston Parkway E., Houston, Texas 77032 (US).

(72) Inventors: **HUNTER, Timothy Holiman**; 275919 E. 1740 Rd., Duncan, Oklahoma 73533 (US). **STEPHENSON, Stanley Vernon**; 920 E. Osage Rd., Duncan, Oklahoma 73533 (US).

(74) Agent: **BRYAN, Jason W.** et al.; 1000 Louisiana Street, Fifty-Third Floor, Houston, Texas 77002 (US).

(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:

— with international search report (Art. 21(3))

(54) Title: PUMPING SYSTEM WITH ACTUATOR

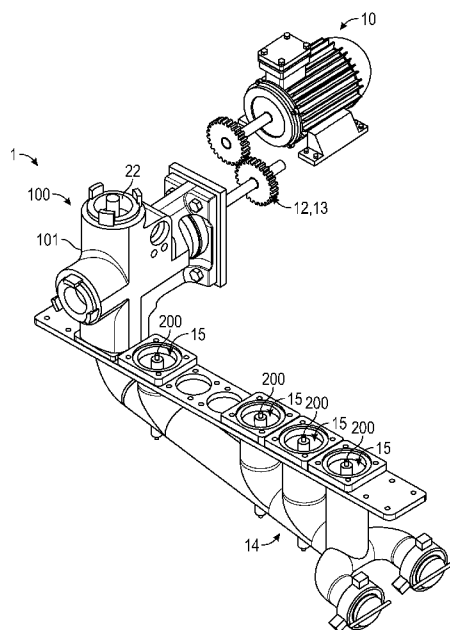


FIG. 1A

(57) Abstract: A pumping system is provided which includes a motor coupled with a transmission and a pump. The pump includes a housing with a chamber, a plunger coupled with the motor and the transmission and translatable into and out of the chamber creating pressure changes in the chamber, an entry valve at an inlet in the housing to the chamber, an exit valve at an outlet in the housing to the chamber, and an actuator coupled with the entry valve. The actuator is operable to hold the entry valve in an open configuration independent of pressure changes created by the translation of the plunger.



WO 2019/117947 A1

PUMPING SYSTEM WITH ACTUATOR

FIELD

[0001] The present disclosure relates generally to pumping systems. In particular, the present disclosure relates to pumping systems with an actuator to reduce a resistive torque load while a transmission shifts gears.

BACKGROUND

[0002] Motors can be used to provide power to pumps. To control or increase the speed of the pump, transmissions can be used to shift gears. When pumping fluid, the fluid flows through an entry valve into a recess which includes a plunger. The entry valve then closes, the plunger compresses the fluid, and the fluid flows through an exit valve under pressure. During such a procedure, the fluid imparts a resistive torque load on the transmission. As such, when increasing power and shifting gears under load, heat may be generated in the transmission converter and clutches, and the life of the transmission may be shortened.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Implementations of the present technology will now be described, by way of example only, with reference to the attached figures, wherein:

[0004] FIG. 1A is a diagram illustrating a perspective view of an exemplary pumping system according to the present disclosure;

[0005] FIG. 1B is a diagram illustrating a partial cross-sectional view of the pumping system of FIG. 1A according to the present disclosure;

[0006] FIG. 2A is a diagram illustrating an exemplary pump with an entry valve in an open configuration according to the present disclosure;

[0007] FIG. 2B is a diagram illustrating an exemplary pump with an entry valve in a closed configuration according to the present disclosure;

[0008] FIG. 3A is a diagram illustrating an exemplary pump with an actuator actuated such that an entry valve is transitioned to an open configuration;

[0009] FIG. 3B is a diagram illustrating an enlarged view of the entry valve and the actuator of FIG. 3A; and

[0010] FIG. 4 is a flow chart of a method for utilizing an exemplary pumping system.

DETAILED DESCRIPTION

[0011] It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the examples described herein. However, it will be understood by those of ordinary skill in the art that the examples described herein can be practiced without these specific details. In other instances, methods, procedures and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

[0012] The term "coupled" is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The connection can be such that the objects are permanently connected or releasably connected.

[0013] Disclosed herein is a pumping system. The pumping system includes a motor coupled with a transmission having a plurality of gears to provide power to a pump. The pump includes a housing with a chamber. A plunger is coupled with the motor and is translatable into and out of the chamber. The pump also includes an entry valve at an inlet to the chamber and an exit valve at an outlet to the chamber. The entry valve is transitionable between an open configuration where fluid can pass through the inlet into and out of the chamber and a closed configuration where fluid cannot pass through the inlet. The pump also includes an actuator which can transition the entry valve to the open configuration and/or hold the entry valve in the open configuration until released, independent of the pressure changes caused by the movement of the plunger. When the actuator is not actuated, the pump operates as normal. For example, as the plunger retracts from the chamber, a vacuum in the chamber is created, and the entry valve transitions to the open configuration. Fluid then flows through the inlet into the chamber. As the plunger extends into the chamber, the fluid is compressed, the entry valve closes, and at a predetermined pressure, the fluid flows through the outlet and the exit valve.

[0014] When the actuator is actuated, the entry valve is transitioned to the open configuration and/or held in the open configuration until the actuator is released, independent of

the pressure changes caused by the movement of the plunger. As such, the fluid can flow into and out of the chamber through the inlet such that a resistive torque load created by the compression of the fluid is reduced. As such, the transmission can shift gears without experiencing as high, or none, of the resistive torque load. The transmission life can thus be extended.

[0015] The system can be employed in an exemplary pumping system 1 shown, for example, in FIGS. 1A and 1B. FIGS. 1A and 1B illustrate a pumping system 1 which includes a fluidic channel 14. The fluidic channel 14 can be a pipe, a wellbore, a hose, or any other suitable channel through which fluid can be transported. The fluidic channel 14 as illustrated in FIGS. 1A and 1B has a substantially circular cross-sectional shape, but can be any suitable shape such as rectangular, triangular, ovoid, or irregular shape. The fluidic channel 14 can be made of metal, plastic, or any suitable material such that the material does not burst from the pressure of the fluid. The fluidic channel 14 has one or more openings 15 through which fluid can flow. The openings 15 as illustrated in FIGS. 1A and 1B are substantially circular, but can be any suitable shape such as rectangular, triangular, or ovoid. While FIGS. 1A and 1B show 5 openings 15, the fluidic channel 14 can have one, two, or more openings 15 as desired. The openings 15 of the fluidic channel 14 permit fluidic communication from the fluidic channel to the pump 100. As illustrated in FIGS. 1A and 1B, the fluidic channel 14 provides fluid to the pump 100, and the pump 100 pumps the fluid to another avenue (not shown) through an outlet 22.

[0016] A motor 10 (shown in FIG. 1A) is provided to impart power to the pump 100. The motor 10 can be, for example, a diesel engine. In other examples, the motor 10 can be other suitable motors, for example, electric motors, natural gas or gasoline engines or motors 10 with less torque characteristics than diesel engines. For example, the motor 10 can be diesel engine. The motor 10 is coupled with a transmission 12 which has a plurality of gears 13. The transmission 12 provides controlled application of the power from the motor 10. The transmission 12 uses the gears 13 to convert the output from the motor 10 to varying speed and torque to the pump 100. FIG. 1A illustrates a simple motor 10 and transmission 12 system, however any suitable motor 10 and transmission 12 system can be utilized. The transmission 12 provides different gears 13 with different gear ratios such that varying speed and torque can be provided to the pump 100. Switching to the desired gears 13 can be controlled automatically or

manually. Switching gears 13 includes connecting gears 13 with different gear ratios to the motor 10. In doing so, different gears 13 will engage one another.

[0017] The motor 10 is coupled with a plunger 104 (shown in FIGS. 1B-3B) in the pump 100 which is translatable along a longitudinal axis by the motor 10 into and out of a chamber 102. The translation of the plunger 104 into and out of the chamber 102 creates pressure changes within the chamber 102. For example, when the plunger 104 retracts from the chamber 102, the pressure within the chamber is decreased, and when the plunger 104 translates into the chamber 102, the pressure within the chamber 102 is increased due to compression of fluid within the chamber 102.

[0018] As shown in FIG. 1B, the pump 100 has a housing 101. The housing 101 of the pump 100 can be made of metal, plastic, or any other suitable material or combination of materials. Fluid flows from the fluidic channel 14 and through the opening 15 of the fluidic channel 14 to the pump 100. The pump 100 includes an entry valve 106 at an inlet 20 in the housing 101 to the chamber 102. The entry valve 106 can be transitionable between an open configuration permitting fluidic communication through the inlet 20 to the chamber 102 and a closed configuration preventing fluidic flow through the inlet 20 to the chamber 102. The entry valve 106 can be a passive pressure valve that transitions to the open configuration when the pressure outside of the chamber 102 is greater than the pressure inside of the chamber 102. When the pressure outside of the chamber 102 is less than the pressure inside the chamber, the entry valve 106 can transition to the closed configuration. Other suitable entry valves 106 can also be utilized, so long as the entry valve 106 is operable to transition between an open configuration and a closed configuration.

[0019] The pumping system 1 also includes an actuator 200. The actuator 200 is coupled with the entry valve 106. The actuator 200 is operable to hold or maintain the entry valve in the open configuration independent of the pressure changes between inside and outside the chamber 102. The actuator 200 can be positioned within the pump 100 or, as illustrated in FIGS. 1A and 1B, outside of the pump 100, so long as the actuator 200 is coupled with the entry valve 106.

[0020] FIGS. 2A and 2B illustrate the pump 100 operating as normal, for example when the actuator 200 is not actuated such that the actuator 200 is not holding the entry valve 106 in the open configuration.

[0021] In FIG. 2A, the plunger 104 is retracted from the chamber 102. The plunger 104 is opposite an abutment 1040 across the chamber 102. As the plunger 104 is retracting, the pressure inside the chamber 102 decreases. As such, the pressure inside the chamber 102 becomes less than the pressure outside of the chamber 102, for example at the opening 15 which has fluid 500 from the fluidic channel 14. The pressure differential causes the entry valve 106 to transition to the open configuration 1000 such that the fluid 500 can pass through the inlet 20 into chamber 102. The entry valve 106 abuts an entry bias 1060 which is operable to bias the entry valve 106 to the closed configuration. As such, to transition the entry valve 106 to the open configuration, the force from the pressure opposite the entry valve 106 in relation to the chamber 102 overcomes the biasing force enacted on the entry valve 106 by the entry bias 1060. The entry bias 1060 can be, for example, a spring.

[0022] Also due to the pressure differential created by the retraction of the plunger 104, an exit valve 108 at an outlet 22 in the housing 101 to the chamber 102 transitions to a closed configuration to prohibit fluid flow through the outlet 22 from the chamber 102. The exit valve 108, as illustrated in FIG. 2A, abuts an exit bias 1080. The exit bias 1080 biases the exit valve 108 to a closed configuration. The exit bias 1080 can be, for example, a spring.

[0023] While a pump 100 with a passive valve system with the entry valve 106 and the exit valve 108 being suction valves is described herein, other valve systems can be utilized so long as the entry valve and the exit valve are operable to transition between an open configuration and a closed configuration to permit fluid flow through the inlet and outlet, respectively. For example, the entry valve 106 and exit valve 108 can be mechanically linked to the plunger 104 such that when the plunger 104 retract, the entry valve 106 transitions to an open configuration and the exit valve transitions to a closed configuration. An exemplary pump 100 may be a Halliburton HT-400.

[0024] In FIG. 2B, the plunger 104 extends into the chamber 102 by the motor 10. When the plunger 104 extends, the fluid 500 within the chamber 102 is compressed. As such, the pressure within the chamber 102 increases. At a predetermined pressure, the entry valve 106 transitions to the closed configuration 2000 to prevent fluid flow through the inlet 20. Also, at the predetermined pressure, the exit valve 108 transitions to an open configuration to permit fluid flow through the outlet 22. In other words, the fluid 500 is pumped out of the chamber 102 through the outlet 22 at a predetermined pressure within the chamber 102. The plunger 104 can

extend at least partially into the chamber 102. In at least one example, the plunger 104 can extend into the chamber 102 such that the plunger becomes proximate the cylinder cover 1040.

[0025] The compression of the fluid 500 when the plunger 104 extends into the chamber 102 and before the exit valve 108 opens creates a resistive force against the extension of the plunger 104 into the chamber 102. As such, a resistive torque load is imparted on the transmission 12 and motor 13. When the transmission 12 shifts gears 13, the resistive torque load can cause heat to be generated as the transmission clutches and torque converter disengage and re-engage during the shift sequence. Accordingly, the life of the transmission 12 may be reduced, leading to increased transmission failures.

[0026] To reduce pressure within the chamber 102 and subsequently the resistive torque load, the actuator 200 can be actuated at least when the plunger 104 is extending into the chamber 102, as illustrated in FIGS. 3A and 3B.

[0027] The actuator 200 includes an actuation cylinder 206, and a protrusion 204. The protrusion 204 is coupled with the entry valve 106. The actuation cylinder 206 can be a pneumatic cylinder, a hydraulic cylinder, or any other suitable mechanism to enact a force to trigger the protrusion 204 to transition and/or hold the entry valve 106 in the open configuration 1000. For the actuation cylinder 206 to push the protrusion 204 to extend from the actuator 200, the actuation cylinder 206 must enact a force on the protrusion 204 that is greater than the force of the entry bias 1060 and valve drag in the fluid stream. As such, when the actuator 200 is actuated, the actuation cylinder 206 imparts a force on the protrusion 204 against the entry valve 106, and the protrusion transitions and/or holds the entry valve 106 in the open configuration 1000. In the illustrated example of FIGS. 3A and 3B, the protrusion 204, when the actuator 200 is actuated, pushes the entry valve 106 to the open configuration 1000 such that fluid can flow through the inlet 20, independent of the pressure changes created by the translation of the plunger 104. As such, the plunger 104 translating in and out of the chamber 102 may still compress the fluid to an extent but at a reduced amount, and the actuator 200 is operable to hold the entry valve 106 in the open configuration 1000 and withstand the reduced pressure changes within the chamber 102.

[0028] The pressure changes within the chamber 102 are reduced when the actuator 200 is actuated and the entry valve 106 is in the open configuration 1000 because the fluid is able to flow through the inlet 20. In such a state, when the plunger 104 extends into the chamber 102,

the compression of the fluid and the pressure within the chamber 102 can be reduced for the fluid to exit the chamber 102. The fluid is able to substantially freely flow through the inlet 20 into and out of the chamber 102. To flow out of the chamber 102 through the inlet 20, some forces may still need to be overcome such that it is not a purely free flow; however, the pressure created within the chamber 102 for the fluid to exit through the inlet 20 is reduced.

[0029] When the actuator 200 is actuated and the entry valve 106 is in the open configuration 1000, the transmission 12 can shift gears 13 under the reduced resistive torque load. Shifting gears 13 under the reduced resistive torque load can reduce heat generation in transmission converter and clutches, simplify and reduce equipment risks of bringing pumps on-line, shift transmission ranges and return to lock-up without a resistive torque load, improve transmission life, enable use of motors with narrower torque bands, among other aspects.

[0030] Referring to FIG. 4, a flowchart is presented in accordance with an example embodiment. The method 400 is provided by way of example, as there are a variety of ways to carry out the method. The method 400 described below can be carried out using the configurations illustrated in FIGS. 1A-3B, for example, and various elements of these figures are referenced in explaining example method 400. Each block shown in FIG. 4 represents one or more processes, methods or subroutines, carried out in the example method 400. Furthermore, the illustrated order of blocks is illustrative only and the order of the blocks can change according to the present disclosure. Additional blocks may be added or fewer blocks may be utilized, without departing from this disclosure. The example method 400 can begin at block 402.

[0031] At block 402, a motor is provided. The motor is coupled with a transmission and a pump. The transmission includes a plurality of gears such that the transmission can switch gears to provide different power to the pump. The pump includes a housing with a chamber and a plunger coupled with the motor. The plunger is translatable along a longitudinal axis into and out of the chamber by the motor. As the plunger translates, the pressure inside the chamber changes. For example, as the plunger retracts out of the chamber, the pressure in the chamber decreases. As the plunger extends into the chamber, the compression of fluid causes the pressure in the chamber to increase. The pump also includes an entry valve at an inlet in the housing to the chamber and an exit valve at an outlet in the housing to the chamber. The entry valve is transitionable between an open configuration permitting fluid flow through the inlet to the

chamber and a closed configuration preventing fluid flow through the inlet. The exit valve is operable to permit fluid flow through the outlet from the chamber at a predetermined pressure. When the pressure within the chamber is at or above a predetermined pressure, the exit valve can open to permit fluid flow through the outlet.

[0032] The pump further includes an actuator which is coupled with the entry valve. The actuator is operable to hold the entry valve in the open configuration independent of the pressure changes created by the translation of the plunger. The actuator includes an actuation cylinder and a protrusion. The protrusion can be coupled with the entry valve. The actuation cylinder can be, for example, a pneumatic cylinder or a hydraulic cylinder to trigger the protrusion to hold the entry valve in the open configuration.

[0033] When the plunger retracts out of the chamber and the pressure in the chamber decreases, the entry valve transitions to the open configuration and the exit valve transitions to the closed configuration such that fluid can flow through the inlet.

[0034] When the plunger extends into the chamber, the fluid within the chamber is compressed, increasing the pressure within the chamber. The entry valve transitions to the closed position to inhibit fluid flow through the inlet to the chamber. The pressure in the chamber continues to increase until a predetermined pressure is reached, and the exit valve transitions to the open configuration such that the fluid flows through the outlet. As the fluid within the chamber is compressed, the fluid resists the movement of the plunger, leading to a resistive torque load to be enacted on the transmission and motor. If the transmission switches gears while the resistive torque load is increased, then excessive slipping may occur, causing heat generation, and decreasing the life of the transmission.

[0035] To reduce the resistive torque load and increase transmission life, at block 404, the actuator is actuated to hold the entry valve in the open configuration. The actuation cylinder, when the actuator is actuated, imparts a force on the protrusion against the entry valve and the entry bias, and the protrusion holds the entry valve in the open configuration. In at least one example, the protrusion can hold the entry valve in the open configuration by physically pushing the entry valve open. In other examples, the protrusion can trigger a mechanism such that the entry valve is held open. As such, when the plunger extends into the chamber, the fluid can flow through the inlet and reduces the resistive torque load.

[0036] At block 406, the transmission switches gears while the actuator is actuated. In at least one example, the actuator can be actuated automatically when the transmission is going to switch gears. Also, the actuator can be actuated manually.

[0037] At block 408, the actuator is released. The actuator can be released when the gear switch is complete. In other examples, the actuator can be released for a predetermined or desired amount of time. For example, if the actuator can be actuated such that the entry valve is held in the open configuration for the duration of the pumping system to reach the desired gear.

[0038] Numerous examples are provided herein to enhance understanding of the present disclosure. A specific set of statements are provided as follows.

[0039] Statement 1: A pumping system is disclosed comprising: a motor coupled with a transmission, the transmission having a plurality of gear ranges; a pump including: a housing with a chamber; a plunger coupled with the motor and the transmission, the translation of the plunger creating pressure changes in the chamber; an entry valve at an inlet in the housing to the chamber, the entry valve transitionable between an open configuration permitting fluid flow through the inlet to the chamber and a closed configuration preventing fluid flow through the inlet to the chamber; an exit valve at an outlet in the housing to the chamber, the exit valve permitting fluid flow through the outlet from the chamber at a predetermined pressure; and an actuator coupled with the entry valve, the actuator operable to hold the entry valve in the open configuration independent of the pressure changes created by the translation of the plunger.

[0040] Statement 2: A pumping system is disclosed according to Statement 1, wherein the actuator includes an actuation cylinder and a protrusion, wherein the protrusion is coupled with the entry valve.

[0041] Statement 3: A pumping system is disclosed according to Statement 2, wherein the actuation cylinder is one of a pneumatic cylinder or a hydraulic cylinder.

[0042] Statement 4: A pumping system is disclosed according to Statements 2 or 3, wherein the actuation cylinder, when the actuator is actuated, imparts a force on the protrusion against the entry valve, and the protrusion holds the entry valve in the open configuration.

[0043] Statement 5: A pumping system is disclosed according to any of preceding Statements 1-4, wherein the entry valve is coupled with an entry bias which biases the entry valve to the closed configuration.

[0044] Statement 6: A pumping system is disclosed according to Statement 5, wherein the plunger, when retracting, transitions the entry valve to the open configuration such that a fluid passes through the inlet into the chamber, wherein when the actuator is not actuated and as the plunger extends, the entry valve transitions to the closed configuration, and the fluid passes through the outlet when at the predetermined pressure.

[0045] Statement 7: A pumping system is disclosed according to claim 6, wherein when the actuator is actuated, the entry valve is held in the open configuration independent of the translation of the plunger such that the fluid passes through the inlet, reducing a resistive torque load, wherein the transmission, when the entry valve is in the open configuration, shifts gears under the reduced resistive torque load.

[0046] Statement 8: A pump is disclosed comprising: a housing with a chamber; a plunger coupled with a motor and a transmission and translatable along a longitudinal axis into and out of the chamber by the motor; an entry valve at an inlet in the housing to the chamber, the entry valve transitionable between an open configuration permitting fluid flow through the inlet to the chamber and a closed configuration preventing fluid flow through the inlet to the chamber; an exit valve at an outlet in the housing to the chamber, the exit valve permitting fluid flow through the outlet from the chamber at a predetermined pressure; and an actuator coupled with the entry valve, the actuator operable to hold the entry valve in the open configuration independent of the pressure changes created by the translation of the plunger.

[0047] Statement 9: A pump is disclosed according to Statement 8, wherein the actuator includes an actuation cylinder and a protrusion, wherein the protrusion is coupled with the entry valve.

[0048] Statement 10: A pump is disclosed according to Statement 9, wherein the actuation cylinder is one of a pneumatic cylinder or a hydraulic cylinder.

[0049] Statement 11: A pump is disclosed according to Statements 9 or 10, wherein the actuation cylinder, when the actuator is actuated, imparts a force on the protrusion against the entry valve, and the protrusion holds the entry valve in the open configuration.

[0050] Statement 12: A pump is disclosed according to any of preceding Statements 8-11, wherein the entry valve is coupled with an entry bias which biases the entry valve to the closed configuration.

[0051] Statement 13: A pump is disclosed according to any of preceding Statements 8-12, wherein the plunger, when retracting from the chamber, transitions the entry valve the open configuration such that a fluid passes through the inlet into the chamber, wherein, when the actuator is not actuated and as the plunger extends into the chamber, the entry valve transitions to the closed configuration, and the fluid passes through the outlet at the predetermined pressure.

[0052] Statement 14: A pump is disclosed according to Statement 13, wherein when the actuator is actuated, the entry valve is held in the open configuration independent of the translation of the plunger such that the fluid passes through the entry valve, reducing a resistive torque load.

[0053] Statement 15: A method is disclosed comprising: providing a motor coupled with a transmission, the transmission having a plurality of gear ranges, and a pump, the pump includes: a housing with a chamber; a plunger coupled with the motor and the transmission, the plunger translatable along a longitudinal axis into and out of the chamber by the motor and transmission; an entry valve at an inlet in the housing to the chamber, the entry valve transitionable between an open configuration permitting fluid flow through the inlet to the chamber and a closed configuration preventing fluid flow through the inlet to the chamber; an exit valve at an outlet in the housing, the exit valve permitting fluid flow through the outlet from the chamber at a predetermined pressure; and an actuator coupled with the entry valve, the actuator operable to hold the entry valve in the open configuration independent of the pressure changes created by the translation of the plunger; actuating the actuator to hold the entry valve in the open configuration and permit fluid flow through the inlet such that a resistive torque load is reduced; shifting gears in the transmission under the reduced resistive torque load; and releasing the actuator.

[0054] Statement 16: A method is disclosed according to Statement 15, wherein the actuator includes an actuation cylinder and a protrusion, wherein the protrusion is coupled with the entry valve.

[0055] Statement 17: A method is disclosed according to Statement 16, wherein the actuation cylinder is one of a pneumatic cylinder or a hydraulic cylinder.

[0056] Statement 18: A method is disclosed according to Statements 16 or 17, further comprising, when the actuator is actuated, imparting a force on the protrusion against the entry valve, and holding the entry valve in the open configuration.

[0057] Statement 19: A method is disclosed according to any of preceding Statements 15-18, wherein the entry valve is coupled with an entry bias which biases the entry valve to the closed configuration.

[0058] Statement 20: A method is disclosed according to any of preceding Statements 15-19, further comprising: retracting the plunger from the chamber which transitions the entry valve, when the actuator is not actuated, to the open configuration such that a fluid passes through the inlet into the chamber, extending the plunger such that the entry valve, when the actuator is not actuated, transitions to the closed configuration, and the fluid passes through the outlet at the predetermined pressure.

[0059] The disclosures shown and described above are only examples. Even though numerous characteristics and advantages of the present technology have been set forth in the foregoing description, together with details of the structure and function of the present disclosure, the disclosure is illustrative only, and changes may be made in the detail, especially in matters of shape, size and arrangement of the parts within the principles of the present disclosure to the full extent indicated by the broad general meaning of the terms used in the attached claims. It will therefore be appreciated that the examples described above may be modified within the scope of the appended claims.

CLAIMS

What is claimed is:

1. A pumping system comprising:
 - a motor coupled with a transmission, the transmission having a plurality of gear ranges;
 - a pump including:
 - a housing with a chamber;
 - a plunger coupled with the motor and the transmission and translatable along a longitudinal axis into and out of the chamber by the motor and transmission, the translation of the plunger creating pressure changes in the chamber;
 - an entry valve at an inlet in the housing to the chamber, the entry valve transitionable between an open configuration permitting fluid flow through the inlet to the chamber and a closed configuration preventing fluid flow through the inlet to the chamber;
 - an exit valve at an outlet in the housing to the chamber, the exit valve permitting fluid flow through the outlet from the chamber at a predetermined pressure; and
 - an actuator coupled with the entry valve, the actuator operable to hold the entry valve in the open configuration independent of the pressure changes created by the translation of the plunger wherein the actuator is automatically activated upon the transmission initiating a switch gear, wherein the actuator is activated in response to the transmission shifting gears.
2. The pumping system of claim 1, wherein the actuator includes an actuation cylinder and a protrusion, wherein the protrusion is coupled with the entry valve.
3. The pumping system of claim 2, wherein the actuation cylinder is one of a pneumatic cylinder or a hydraulic cylinder.
4. The pumping system of claim 2, wherein the actuation cylinder, when the actuator is actuated, imparts a force on the protrusion against the entry valve, and the protrusion holds the entry valve in the open configuration.

5. The pumping system of claim 1, wherein the entry valve is coupled with an entry bias which biases the entry valve to the closed configuration.
6. The pumping system of claim 5, wherein the plunger, when retracting, transitions the entry valve to the open configuration such that a fluid passes through the inlet into the chamber, wherein when the actuator is not actuated and as the plunger extends, the entry valve transitions to the closed configuration, and the fluid passes through the outlet when at the predetermined pressure.
7. The pumping system of claim 6, wherein when the actuator is actuated, the entry valve is held in the open configuration independent of the translation of the plunger such that the fluid passes through the inlet, reducing a resistive torque load, wherein the transmission, when the entry valve is in the open configuration, shifts gears under the reduced resistive torque load.
8. A pump comprising:
a housing with a chamber;
a plunger coupled with a motor and a transmission and translatable along a longitudinal axis into and out of the chamber by the motor;
an entry valve at an inlet in the housing to the chamber, the entry valve transitionable between an open configuration permitting fluid flow through the inlet to the chamber and a closed configuration preventing fluid flow through the inlet to the chamber;
an exit valve at an outlet in the housing to the chamber, the exit valve permitting fluid flow through the outlet from the chamber at a predetermined pressure; and
an actuator coupled with the entry valve, the actuator operable to hold the entry valve in the open configuration independent of the pressure changes created by the translation of the plunger, wherein the actuator is activated in response to the transmission switching gears.
9. The pump of claim 8, wherein the actuator includes an actuation cylinder and a protrusion, wherein the protrusion is coupled with the entry valve.

10. The pump of claim 9, wherein the actuation cylinder is one of a pneumatic cylinder or a hydraulic cylinder.
11. The pump of claim 9, wherein the actuation cylinder, when the actuator is actuated, imparts a force on the protrusion against the entry valve, and the protrusion holds the entry valve in the open configuration.
12. The pump of claim 8, wherein the entry valve is coupled with an entry bias which biases the entry valve to the closed configuration.
13. The pump of claim 8, wherein the plunger, when retracting from the chamber, transitions the entry valve the open configuration such that a fluid passes through the inlet into the chamber, wherein, when the actuator is not actuated and as the plunger extends into the chamber, the entry valve transitions to the closed configuration, and the fluid passes through the outlet at the predetermined pressure.
14. The pump of claim 13, wherein when the actuator is actuated, the entry valve is held in the open configuration independent of the translation of the plunger such that the fluid passes through the entry valve, reducing a resistive torque load.
15. A method comprising:
providing a motor coupled with a transmission, the transmission having a plurality of gear ranges, and a pump, the pump includes:
a housing with a chamber;
a plunger coupled with the motor and the transmission, the plunger translatable along a longitudinal axis into and out of the chamber by the motor and transmission;
an entry valve at an inlet in the housing to the chamber, the entry valve transitionable between an open configuration permitting fluid flow through the inlet to the chamber and a closed configuration preventing fluid flow through the inlet to the chamber;
an exit valve at an outlet in the housing, the exit valve permitting fluid flow through the outlet from the chamber at a predetermined pressure; and

an actuator coupled with the entry valve, the actuator operable to hold the entry valve in the open configuration independent of the pressure changes created by the translation of the plunger;

actuating the actuator to hold the entry valve in the open configuration and permit fluid flow through the inlet such that a resistive torque load is reduced;

shifting gears in the transmission under the reduced resistive torque load; and

releasing the actuator, wherein the actuator is activated in response to the transmission shifting gears.

16. The method of claim 15, wherein the actuator includes an actuation cylinder and a protrusion, wherein the protrusion is coupled with the entry valve.

17. The method of claim 16, wherein the actuation cylinder is one of a pneumatic cylinder or a hydraulic cylinder.

18. The method of claim 16, further comprising, when the actuator is actuated, imparting a force on the protrusion against the entry valve, and holding the entry valve in the open configuration.

19. The method of claim 15, wherein the entry valve is coupled with an entry bias which biases the entry valve to the closed configuration.

20. The method of claim 15, further comprising:

retracting the plunger from the chamber which transitions the entry valve, when the actuator is not actuated, to the open configuration such that a fluid passes through the inlet into the chamber,

extending the plunger such that the entry valve, when the actuator is not actuated, transitions to the closed configuration, and the fluid passes through the outlet at the predetermined pressure.

1/6

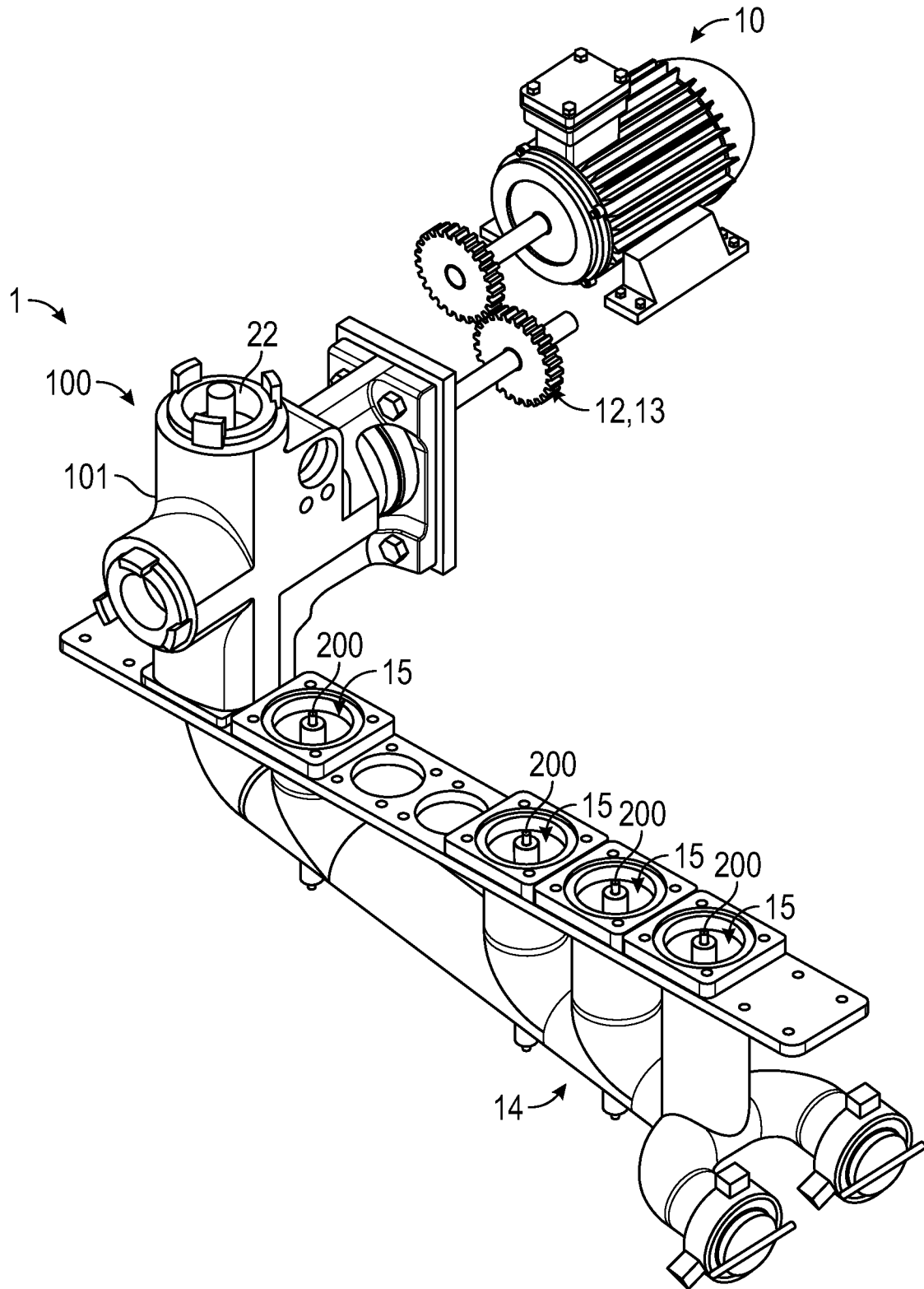
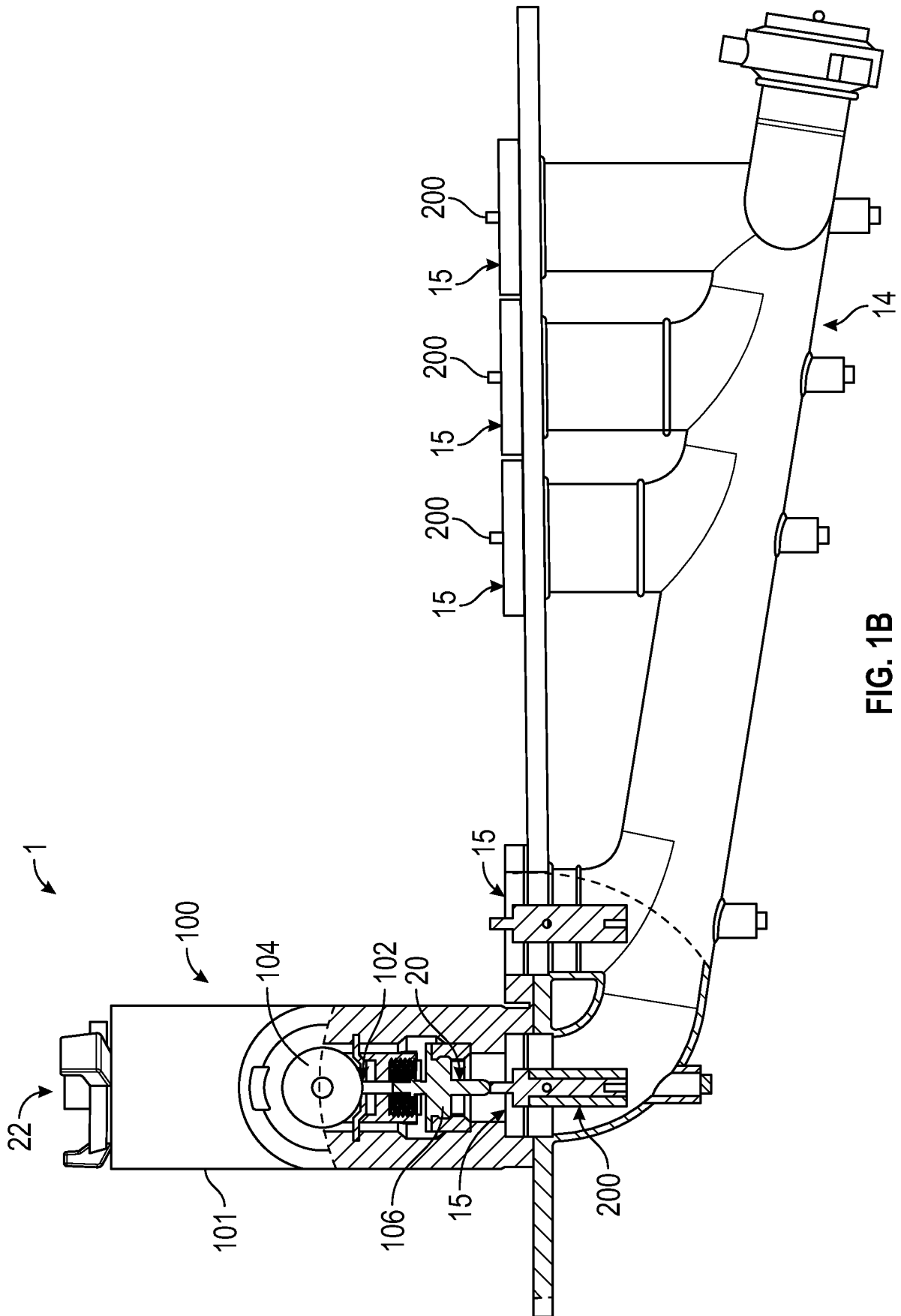


FIG. 1A

2/6



3/6

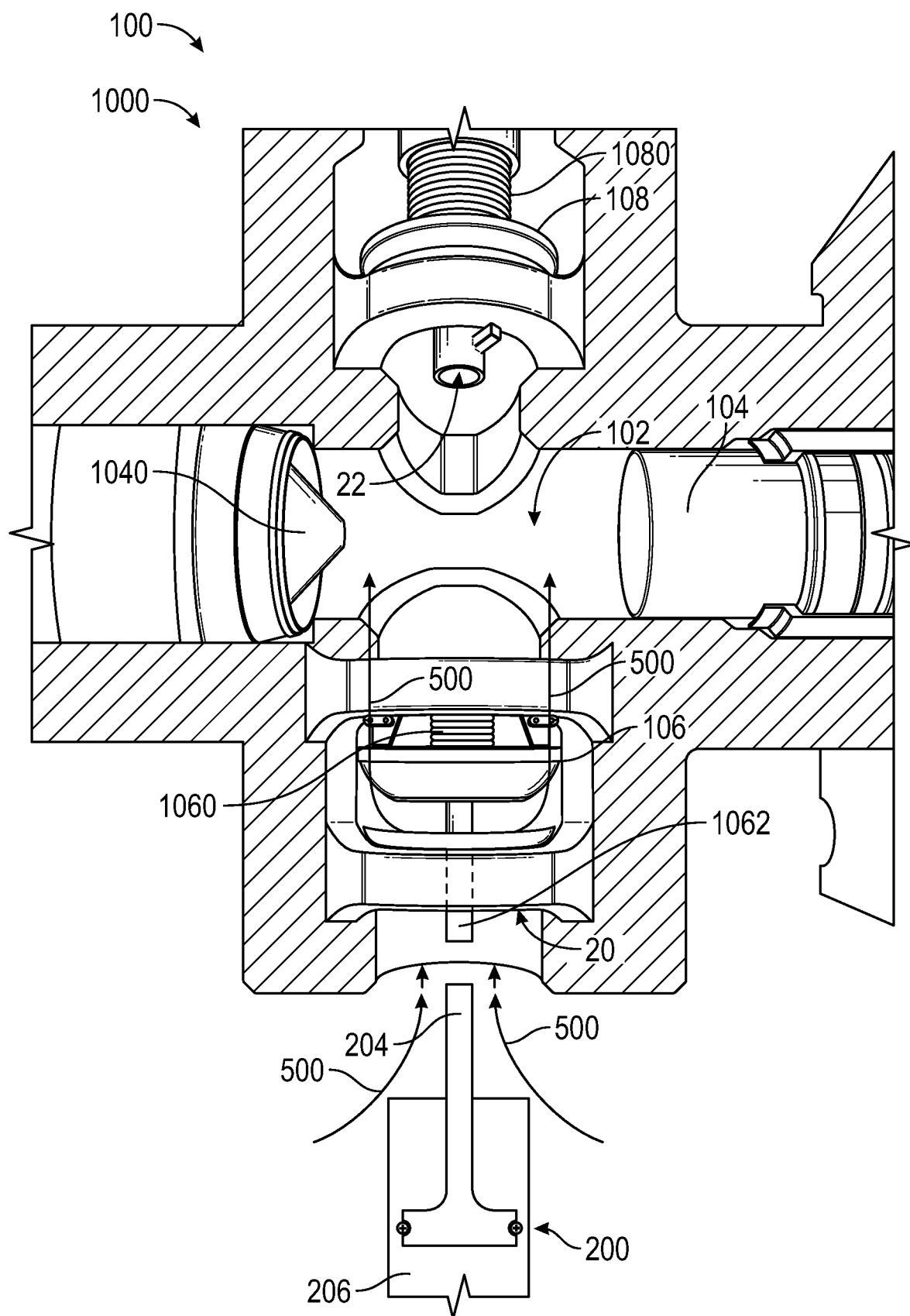


FIG. 2A

4/6

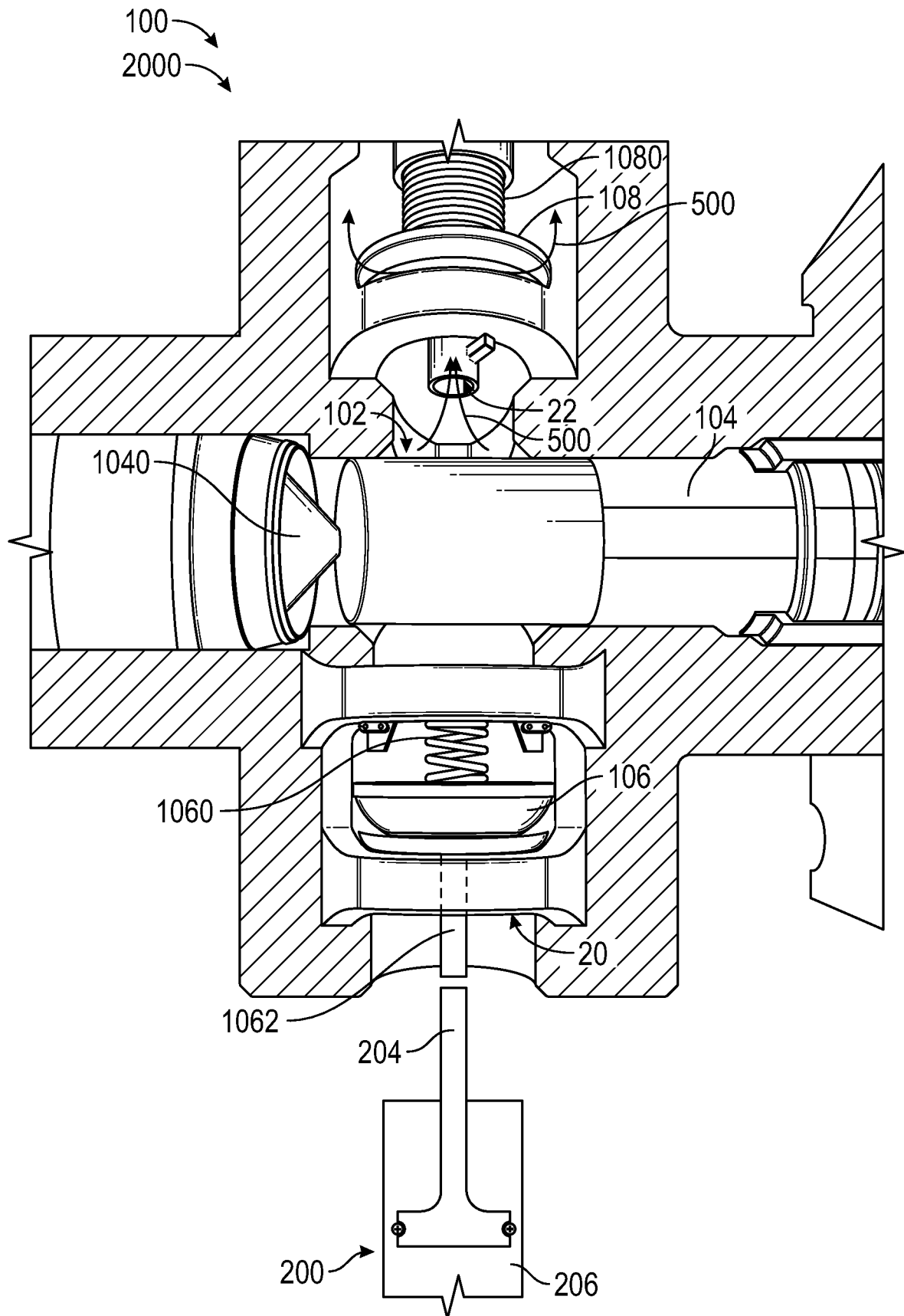


FIG. 2B

5/6

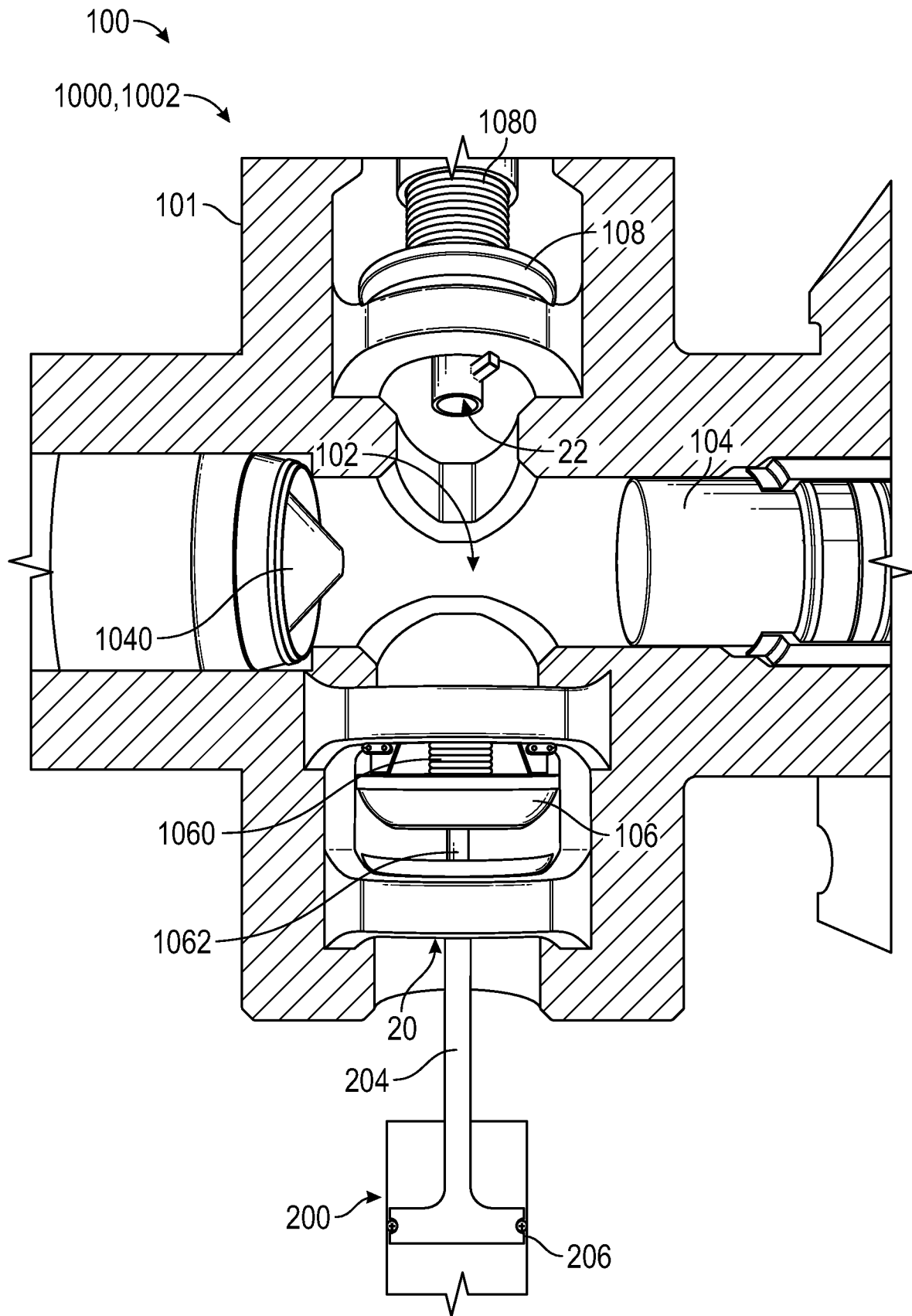


FIG. 3A

6/6

1000,1002

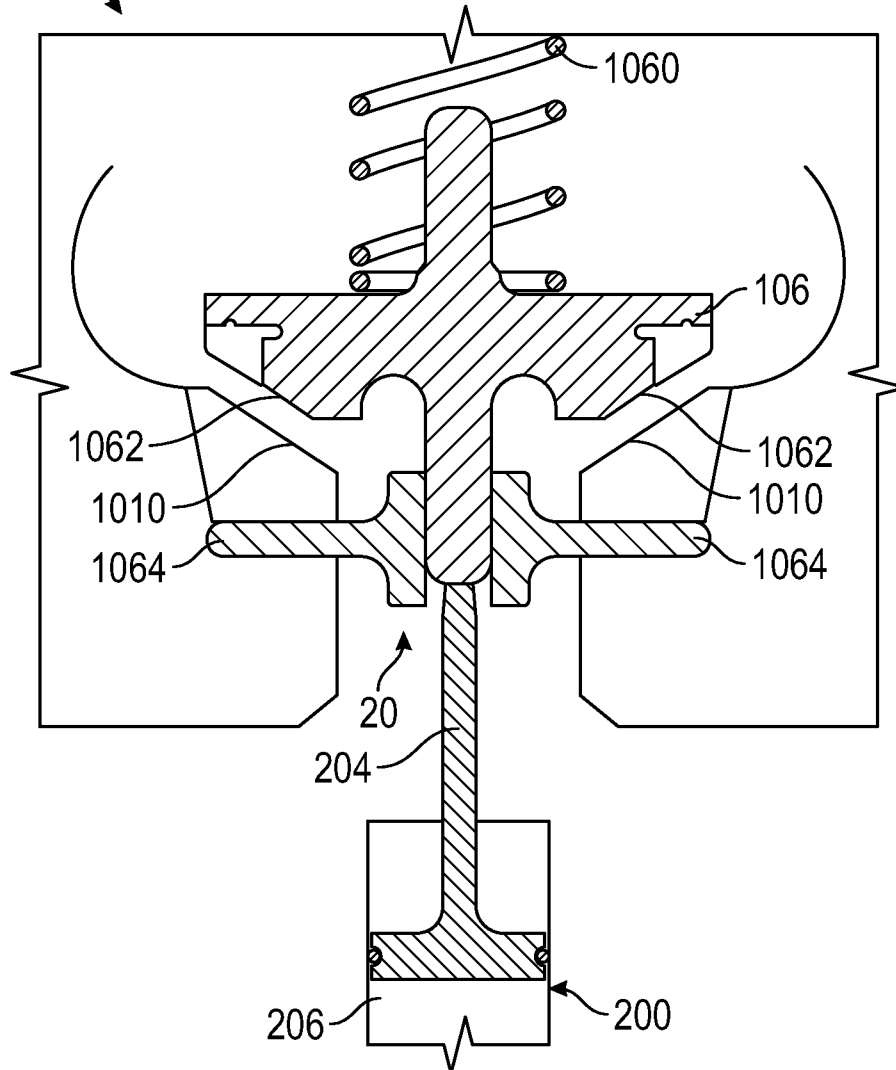


FIG. 3B

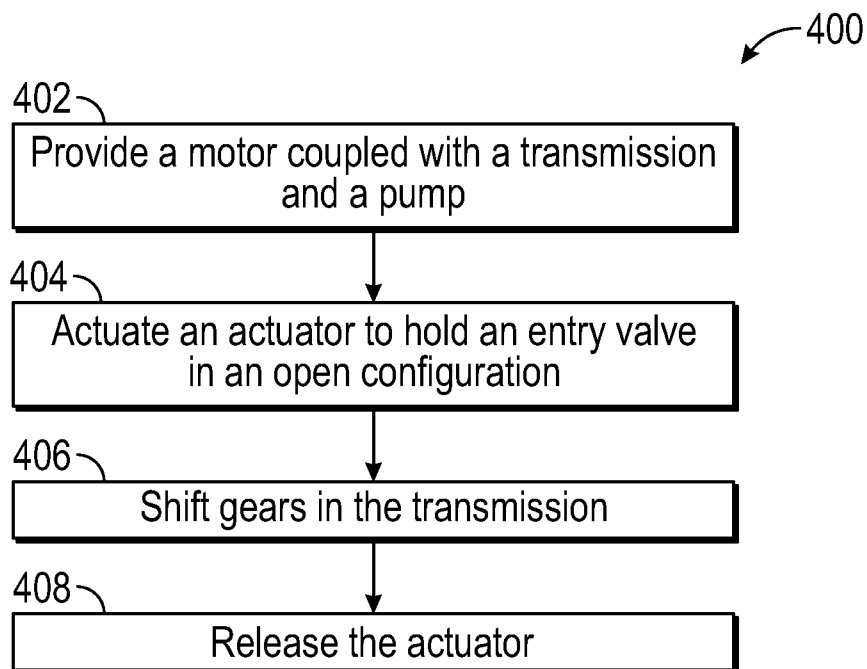


FIG. 4

