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(54) **Title:** JOURNAL HOUSING ASSEMBLY AND BALANCED TORQUE ARM FOR HIGH-PRESSURE ROTARY VALVE
SYSTEM AND METHOD

(57) **Abstract:** Steam cutting, chatter, journal vibration, welding, and milling within a high-pressure rotary valve system may be mit-
igated by the use an adjustable journal housing assembly disengaged from the high-pressure rotary valve housing and configured to
move laterally with respect to the journal to accommodate changes in journal eccentricity and attitude angle. A torque arm with at
least two equidistant turnbuckles may be fitted on at least one end of a journal such that the at least two turnbuckles are fixedly en-
gaged to a housing of the rotary valve system.



JOURNAL HOUSING ASSEMBLY AND BALANCED TORQUE ARM FOR HIGH-PRESSURE ROTARY VALVE SYSTEM AND METHOD

CROSS-RELATED APPLICATION

[0001] This application is a Non-Provisional Application claiming the benefits of U.S. Provisional Patent Application Serial No. 61/978,463 filed April 11, 2014, the entirety of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. TECHNICAL FIELD

[0002] The present disclosure relates generally to rotary drive systems and specifically to high-pressure rotary valve systems frequently used in the pulp and paper and other cellulosic bio-product industries.

2. RELATED ART

[0003] High-pressure rotary valves generally transfer particulate lignocellulosic biomass, or other particulate material, to an environment at a raised temperature and pressure from an environment at lowered temperature and pressure and *vice versa*. For example, a high-pressure rotary valve commonly known as a “high-pressure feeder” may be used to transfer raw lignocellulosic biomass from a storage bin at near-atmospheric temperature and pressure to a chemical digester operating at substantially higher temperatures and pressures. A high-pressure feeder can permit transfer of large volumes of lignocellulosic material across temperature and pressure gradients efficiently.

[0004] High-pressure feeders generally have a pocketed rotor horizontally oriented within a housing. The pocketed rotor may generally resemble a truncated cone and a clearance exists between the pocketed rotor and the interior housing wall. A motor, located outside of the housing, rotates a shaft extending into the housing and through the pocket rotor’s axis of rotation. The shaft may continue to extend out of the housing opposite the direction of motor. The motor has historically been supported by a ground-based frame. More recently, operators have elected to suspend the motor above the ground and use a single torque arm connecting the

motor to the ground or to a building structure external to the high-pressure rotary valve system. The lignocellulosic biomass or other particulate material acting on the pocketed rotor and the weight of the rotor typically offers significant rotational resistance. By grounding the motor to a structure capable of exerting a force larger than the rotational resistance forces of the lignocellulosic biomass and the pocketed rotor, the torque arm typically prevents the motor from spinning in a direction opposite the direction of shaft rotation.

[0005] Lignocellulosic biomass, or other particulate material, generally enters the top of the high-pressure feeder housing at near-atmospheric pressure and temperature through an inlet. The particulate material then falls into an exposed pocket on the pocketed rotor. As the rotor rotates, the pocket moves past the inlet and into a section of the housing that is not generally exposed to atmospheric temperature and pressure. Operators may inject steam and other fluid (*e.g.* cooking liquor) into the housing to pressurize and pretreat the lignocellulosic biomass as the lignocellulosic biomass rotates downwardly toward an outlet. This outlet generally communicates with the digester's high-pressure and high temperature environment, such that when the pocket rotates and becomes exposed to the outlet, the lignocellulosic biomass falls through the outlet and into the digester.

[0006] As the high-pressure feeder example illustrates, high-pressure rotary valves generally have a rotor (*e.g.* a drum, screw, rake, pocketed rotor, tap, or other rotary body) disposed within a pressurized housing. A motor disposed outside the housing likewise rotates a shaft extending to the rotor inside the housing. To facilitate rotation, journal bearings may also be placed at various locations along the shaft to reduce rotational friction. The journal bearings may be located in journal housings integrally engaged to the high-pressure rotary valve housing and disposed around the shaft. The "journal" generally refers to the portion of the shaft that is outside of the high-pressure rotary valve housing. A clearance also exists between the shaft and integral journal housing. The integral journal housing may be a pack box generally located at positions along the shaft where the shaft enters or exits the high-pressure rotary valve housing. A pack box generally contains a stack of packing rings disposed around the shaft. When the packing rings form tight seals between the shaft and the pack box interior wall, the packing rings generally isolate the environment in the high-pressure rotary valve from the external environment.

[0007] In applications that use high-pressure rotary valves, it is generally desirable to minimize pressure loss from within the high-pressure rotary valve. In high-pressure feeders, it is also generally desirable to convey large volumes of lignocellulosic material into a continuous digester to maintain production. To do this, designers may be cognizant of the size of the final high-pressure rotary valve as well as the physical properties of the material from which the rotor and housing are manufactured. The size, shape, and material of the high-pressure rotary valve may affect how individual components within the valve (*e.g.* the rotor and the housing) expand and change shape as the temperature and pressure changes.

[0008] For example, in a high-pressure feeder, the rotor and housing are generally made of steel or a steel alloy. Once manufactured, the components are generally assembled at near ambient atmospheric temperature and pressure. When operators activate a dormant high-pressure rotary valve and begin to inject steam and other fluids to pressurize the high-pressure rotary valve, the internal temperature rises and the rotor, housing, and shaft expand. As disclosed in U.S. Pat. No. 8,052,065, pressure differentials within the high-pressure rotary valve create elastic deflection and thermal profile variations.

[0009] Thermal expansion may be particularly pronounced in areas that frequently interact with larger concentrations of hot gasses or hot processes as compared with other areas in the high-pressure rotary valve system. Environmental factors, such as ambient atmospheric pressure, humidity, and the high-pressure rotary valve's proximity to other environment-affecting sources such as machinery or ventilation systems may also impact the temperature and pressure distribution within a high-pressure rotary valve system.

[0010] As a result of thermal expansion, operators typically calibrate a new high-pressure rotary valve over a period of hours or weeks to condition the high-pressure rotary valve for operation under production-level temperatures and pressures. Operators generally desire the rotor and the housing to expand congruently such that the clearance between the rotor and the housing interior remains narrow. A narrow clearance typically minimizes pressure loss from the high-pressure rotary valve and allows for efficient energy input.

[0011] When the clearance is large, or when the rotor, housing, or shaft expand incongruently, the steam and other pressurized fluids within the high-pressure rotary valve leaks into the clearance and can corrode and wear away the shaft, rotor, housing, journal bearings, integral journal housings, and other high-pressure rotary valve components. This corrosion is commonly

known as “steam cutting.” By way of example, in high-pressure systems subject to consistent use, steam cutting can be so corrosive that common wear parts, such as elbow joints made from quarter inch steel pipes, may be in condition for replacement at least twice yearly. Component replacement often requires the high-pressure rotary valve be deactivated to allow operators to replace parts safely. Deactivation results in production loss.

[0012] As noted in U.S. Pat. No. 8,052,065, the rotor and housing generally do not expand congruently when the high-pressure rotary valve is placed over a single heat source. Portions of the stationary housing closer to the heat source generally have a higher temperature than portions of the stationary housing distally located from the heat source and therefore tend to expand to a greater degree than the portions of the housing distally located from the heat source. Areas of the rotor with more mass similarly expand to a greater degree than areas of the rotor with less mass. Therefore, when the housing and rotor reach thermal equilibrium, the clearance between the rotor and the housing and between the shaft and fixed rotor housing generally do not have uniform measurement dimensions.

[0013] Incongruent rotor and housing thermal expansion and the resulting non-uniform clearance permits uneven steam cutting on the high-pressure rotary valve housing, including the integral journal housings. Further, non-uniform housing expansion results in non-uniform integral journal housing expansion such that steam and other pressurizing fluid generally leak out of the integral journal housing even after the high-pressure rotary valve has obtained thermal equilibrium at production-level temperatures and pressures. These leaks reduce pressure within the high-pressure rotary valve, expose operators to safety risks, unbalance the rotor, increase chatter and energy input, generally disrupt the processes for which the rotary valve system was designed, and shorten the useful life of the high-pressure rotary valve system. The addition of large volumes of particulate matter to the top of a horizontally disposed high-pressure rotary valve and the asymmetric distribution of the mass of the particulate matter within the high-pressure rotary valve may compound these problems.

[0014] To compensate for rotor instability and to reduce steam cutting, conventional high-pressure rotary valve systems offset the center axis of rotation at near-ambient temperatures and pressures. That is, the integral journal housing, which may be a pack box or other integral journal housing configured to support the shaft, have a greater diameter than the shaft at near-ambient temperatures and pressures. Such integral journal housings are static and are

incorporated into the rotary valve system during the design and manufacturing stage of development. At near-ambient temperatures and pressures, the shaft's axis of rotation is vertically offset from the center of the hole in the integral journal housing, such that a gap may exist between the apex of the shaft and the oppositely disposed interior wall of the integral journal housing. This offset is known as "eccentricity." An angle formed by the eccentricity and horizontal offset of the shaft's central rotational axis from the integral journal housing's center is generally known as the "attitude angle".

[0015] It was believed that as the shaft began to warm and expand radially, the eccentricity would reduce, such that the shaft's axis of rotation would eventually align with the center of the hole in the integral journal housing and thereby plug integral journal housing leaks while increasing shaft and rotor stability. The eccentricity generally decreases and shaft stability generally increases as the load on the rotor and shaft decreases, the rotational speed of the shaft increases, or both the shaft load decreases and the shaft rotational speed increases.

[0016] However, introducing eccentricity still results in loss of pressure and higher energy input when activating a dormant high-pressure rotary valve. Steam and other pressurized fluid tend to leak from the non-uniform clearance in the integral journal housing. Moreover, non-uniform heating of the high-pressure rotary valve housing relative to the rotor may allow for a downwardly adjusted shaft to become flush with the bottom section of the integral journal housing, but may prevent the shaft from becoming flush with the upper section of the integral journal housing due to the non-uniform change in shape of integral journal housing. That is, steam or other fluid can continue to leak from the high-pressure rotary valve through the integral journal housing after the high-pressure rotary valve arrives at production-level temperatures and pressures.

[0017] Therefore, eccentricity offset estimations in integral journal housings are still insufficient to address the problems of welding, milling, and chatter caused by shaft vibrations and instability. Moreover, the integral journal housings are often ill-equipped to accommodate the dynamic and frequently changing system and environmental factors that contribute instability. For example, if a load at the top of the rotor is particularly large, the load's downward force and the weight of the rotor itself tends to bend the shaft ends upward slightly, such that the shaft may become slightly parabolic. The upward angle of the shaft ends generally raises the center of the shaft end above the center of the hole in the integral journal housings. As the shaft spins, the

shaft ends can shear the edges of the integral journal housings and thereby create vibrations and instability that can contribute to undesirable welding, milling, and chatter within the high-pressure rotary valve.

[0018] Additionally, prolonged instability and shaft vibration may provide uneven wear to less durable components of the rotary valve system, such as the packing rings. Even with slow-spinning shafts, constant wear of the packing rings at a high eccentricity or attitude angle can contribute to uneven clearances. This in turn may also contribute to increased shaft vibrations and uneven rotary valve system wear. Such wear may decrease the useful life of rotary valve systems and contribute to loss of production.

SUMMARY OF THE INVENTION

[0019] By way of example, high-pressure rotary valves may describe high-pressure rotary feeders, inverted top separators, rotary outlet devices for digesters, metering screws, journal incline drains, steam mixing conveyors, and other rotary valves configured to transfer particulate lignocellulosic matter to environments of raised pressure or temperature, in environments of raised pressure or temperature, or from environments of raised pressure and temperature.

[0020] To address the problems of steam cutting, shaft vibration, instability and resultant welding, milling, and chatter in a high-pressure rotary valve, the present disclosure describes a system comprising: a high-pressure rotary valve housing having an area defining an opening in a valve housing, an inner journal housing partially disposed within the opening in the valve housing and an exterior wall of the inner journal housing defining an outer clearance between the area defining an opening in the valve housing and the inner journal housing, a flange extending from a portion of the exterior wall of the inner journal housing not disposed within the opening in the valve housing, an outer journal housing having feet disposed on the flange, wherein the feet of the outer journal housing engage the flange of the inner journal housing by an adjustment mechanism configured to move the inner journal housing laterally with respect to the outer journal housing.

[0021] It is an object of the present disclosure to adjust the journal housings in response to changes in journal eccentricity.

[0022] It is a further object of the present disclosure to adjust the journal housings in response to changes in journal attitude angle.

[0023] It is an object of the present disclosure to adjust the journal housings in response to angular journal movement.

[0024] It is a further object of the present disclosure to adjust the journal housing assembly in response to axial thermal expansion of the journal housings.

[0025] An additional object of the present disclosure is to disengage the journal housings from the high-pressure rotary valve housings to allow the journal housings to be adjusted to accommodate changes in shaft position relative to the high-pressure rotary housing automatically.

[0026] It is a further object of this disclosure to reduce production and energy losses due to leakage and compensatory energy input.

[0027] It is an object of the present disclosure to describe a system for high-pressure rotary valves that permits the high-pressure rotary valve to operate effectively in response to dynamic operating conditions and ancillary conditions.

[0028] By way of example, dynamic operating conditions may include changes in pressure and temperature within the high-pressure rotary valve and incongruent changes in shape or size of components comprising the high-pressure rotary valve. Ancillary conditions affecting high-pressure rotary valve performance may include the properties of the lignocellulosic feed material and environmental factors, such as humidity, ambient atmospheric pressure, and the high-pressure rotary valve's proximity to other environment-affecting sources such as machinery or ventilation systems.

[0029] An embodiment in accordance with the present disclosure may have sensors and an automated adjustment mechanism for the journal housings configured to detect changes in journal shape, attitude angle, size, and eccentricity and to adjust the position of the journal housings in response to these changes.

[0030] The assembly of journal housings may further comprise a shaft extending through the inner journal housing and outer journal housing. In other exemplary embodiments, the assembly of journal housings may further comprise a support arm having a first end and a second end, wherein the first end engages the high-pressure rotary valve housing and the second end engages the assembly of journal housings. In another exemplary embodiment, the adjustment mechanism may be configured to permit axial movement of the inner journal housing relative to the outer journal housing. In still another exemplary embodiment, the adjustment mechanism may be

configured to permit axial movement of the inner journal housing relative to the outer journal housing in addition to permitting lateral movement of the inner journal housing with respect to the outer journal housing.

In still another exemplary embodiment of the present disclosure, the inner journal housing may be angularly displaced from the outer journal housing to define an offset angle such that the offset angle may be used to counteract the eccentricity of a shaft. In an exemplary embodiment, the offset angle of the outer journal housing from the inner journal housing may be in a range of 0 degrees to 20 degrees. Pressure may vary depending on the type of high-pressure rotary valve and the intended purpose of the high-pressure rotary valve. In exemplary embodiments where the high-pressure rotary valve is a high-pressure feeder, pressure may range about 5 bar gauge to about 15 bar gauge, and may desirably be about 7 bar gauge to about 10 bar gauge.

[0031] An outer journal housing may also be used in connection with the pack box. Apertures located next to each wing on the pack box allow for the outer journal housing to be connected to the pack box. The outer journal housing may be allowed to move relative to the pack box to reduce chatter. The outer journal housing may further comprise an oil seal, bearing adapter, seal retainer, bearing. The bearing may be made of PET plastic and the oil seal may be made of copper alloy, each of the other parts in the outer journal may be made using steel.

[0032] The inner journal housing may be a pack box having a set of packing rings, one or more bearings, and a packing gland follower. The inner journal housing can be partially disposed within an opening in the high-pressure rotary valve housing such that a clearance exists between the exterior the inner journal housing and the area of the high-pressure rotary valve housing defining the opening. To prevent steam and other fluid leaks from this exterior clearance, packing rings, or a sleeve may be fitted between the inner journal housing's exterior and the area defining the opening in the high-pressure rotary valve housing.

[0033] The inner journal housing may further comprise an adjustment mechanism comprising flange extending from an exterior wall of the inner journal housing. It may be desirable to have inner and outer journal housings move with the shaft. Wings may extend from the flange on the inner journal housing, such as for example at the corners of the flange. Each wing may have one or more fastener holes. Each flange and wing may be manufactured from forged steel. The pack box may be made of steel.

[0034] An outer journal housing is desirably used in connection with the inner journal housing. Legs extending from the outer journal housing may allow for the outer journal housing's position to be adjusted relative to flanges on the inner journal housing. Each leg may have a foot with areas defining fastener holes corresponding to fastener holes on the flange and wings of the inner journal housing. By adjusting inner fasteners, (*e.g.* bolts, screws, washers, nuts, and other fasteners) the inner journal housing may be adjusted laterally with respect to the outer journal housing. This lateral adjustment may reduce eccentricity of the journal within the inner journal housing and outer journal housing to reduce chatter, welding, steam cutting, and similar problems caused by an unbalanced shaft. In other exemplary embodiments, fastener holes with fasteners may extend through the top of the feet on the legs and through the top and bottom of the flange. Adjusting these fasteners may allow for axial adjustment of the inner journal housing relative to the outer journal housing. This adjustment mechanism may be used to accommodate axial journal housing expansion.

[0035] In other exemplary embodiments, the feet on the legs of the outer housing may comprise the wings and the inner journal housing may have arms extending from a portion of the inner journal housing not disposed within an opening in the high-pressure rotary valve housing. The arms may have fastener holes with fasteners that align with fastener holes on the wings extending from the feet on the legs of the outer journal housing. These fastener holes and fasteners may likewise permit the lateral and axial adjustment of the inner journal housing's position relative to the outer journal housing. Other adjustment mechanisms configured to permit lateral movement of the inner journal housing relative to the journal housing are within the scope of this disclosure.

[0036] In still other exemplary embodiments, multiple journal housing assemblies having adjustable inner journal housings and outer journal housings may be disposed around the shaft.

[0037] In an exemplary method, the outer journal housing may be adjusted independently of the inner journal housing relative to the journal.

[0038] A bearing may be placed in the outer and inner journal housing. In other exemplary embodiments, a bearing may be placed in only the outer journal housing, or only the inner journal housing. In still other exemplary embodiments, more than one bearing may be placed in a journal housing. The bearing in the outer and inner journal housing may be a plain journal bearing configured to accommodate the weight of the journal and the internal pressure and

temperature of the high-pressure rotary valve system. Pin bearings may be used in the journal housings as well. In an exemplary embodiment, the bearing may be a shoulder bushing and pack box housing as described in PCT App. No. PCT/US14/66099, the entirety of which is herein incorporated by reference.

[0039] An exemplary system according to the present disclosure may further comprise a rotor, high-pressure rotary valve housing for the rotor, shaft, inlet, outlet, and piping to introduce steam and other fluid. The high-pressure rotary valve housing can be constructed using cast steel. The shaft can be constructed of quenched and tempered 4340 steel. The system may include a configured gear box that has been adapted to work with the adjustments that can be made by the moving parts within the system. The gear box can be coved using a gear box cover. The gear box cover can be made using AS TM A36 Steel. The gear box may also use a gear box adapter specially configured for use with the gear box. The gear box adapter may be made using steel.

[0040] In a further exemplary embodiment, a torque arm assembly comprising a motor plate, turnbuckles, and two or more braces may be symmetrically disposed around the shaft. The motor plate may circumscribe the motor. At least two turnbuckles may engage the motor plate, wherein each turnbuckle is flexibly engaged to a corresponding brace symmetrically distributed around the shaft and fixedly engaged to a grounding point such as the high-pressure rotary valve housing, building steel, ground, or other structure adapted to withstand the motor's torque. At least one of the torque arms is preloaded with torque in a direction opposite the direction of the torque exerted by the motor. By preloading the symmetrically disposed torque arm assembly, an exemplary torque arm assembly may counteract and balance the motor's torque.

[0041] An exemplary system may use a hydraulic motor with a torque arm assembly having a motor plate with four extensions, wherein each extension is disposed 90 degrees from an adjacent extension. In other exemplary embodiments, the motor plate may have at least two extensions radially symmetrically disposed around the motor. Turnbuckles may connect each extension on the motor plate to separate braces. The braces are desirably disposed radially symmetrically around the shaft or motor. The braces may be substantially linear, 7-shaped, V shaped, concave, convex, or a combination thereof. Connecting the motor plate to each separate brace with turnbuckles may allow for the torque arm assembly to be preloaded and keep the torque within the motor and torque arm system. Preloading may be desirable to prevent motor movement as well as rotor movement within the housing. Movement within the housing can be

destructive to the system and cause problems such as internal welding, milling, and chatter. The turnbuckles may be re-tightened or loosened to accommodate shaft axial, lateral, and angular movement. In certain exemplary embodiments, the braces may run generally parallel to the shaft and may provide axial support to the shaft. The motor plate and braces in the torque arm assembly may be made using milled steel or any other type of milled metal sufficiently durable to withstand the torque of the high-pressure rotary valve system.

[0042] In an exemplary rotary valve system, a hydraulic motor may rotate a shaft in a range from 0 rotations per minute (rpm) to 30 rpm. In another exemplary rotary valve system, a motor may rotate a shaft in a range of 5 rpm to 20 rpm.

[0043] A torque arm assembly symmetrically distributed around a motor may balance the rotational forces of the shaft and motor thereby substantially reduce or eliminate shaft bending stress from the drive end of the high-pressure rotary valve system. The braces in the torque arm assembly may be fixedly engaged to building steel or the high-pressure rotary valve housing. In other exemplary embodiments, at least one brace may be fixedly engaged to the rotary valve housing while at least one other brace is fixedly engaged to an external structure such as building steel or the ground. In yet another exemplary embodiment, the torque arm assembly may be configured to withstand the constant torque of a motor, such as a hydraulic motor.

[0044] In still another exemplary embodiment, the torque arm assembly may have at least three motor plate extensions evenly distributed around the circumference of the motor and a corresponding turnbuckle connecting each extension to a separate brace disposed around the shaft. In this exemplary embodiment, extensions may be disposed 120 degrees from either adjacent extension.

[0045] In another exemplary embodiment, four or more braces may be distributed around the circumference of a shaft motor such that the torque from the motor is substantially evenly distributed throughout the torque arm assembly. In embodiments employing four motor plate extensions and braces, the motor plate extensions may each be located at 90 degrees around the circumference of the journal. In still another exemplary embodiment with four motor plate extensions and braces, the motor plate extensions and braces may be distributed around the circumference of the journal at 120 degrees, 60 degrees, 120 degrees, and 60 degrees respectively. An exemplary torque arm assembly in accordance with the present disclosure may be a combination of two or more braces connected to a first end of a turnbuckle or other flexible

means adapted to be preloaded with torque, flexible, and configured to withstand the torque of the high-pressure rotary valve system wherein the turnbuckles or other flexible means has a second end connected to a motor or motor plate at radially symmetrical intervals.

[0046] An exemplary method for pre-loading the motor plate with torque has been conceived comprising flexibly engaging a separate turnbuckle to three of at least four extensions of a motor plate, wherein the at least four extensions are distributed around the motor plate such that each extension is equidistant from either adjacent extension, and wherein each turnbuckle comprises a first end engaged to a first ball rod end, a turnbuckle rod, and a second ball rod end engaged to a second end, wherein each extension of the motor plate is engaged to the first end of the turnbuckle and each second end of each turnbuckle is engaged to a separate brace, engaging the first end of a fourth turnbuckle to a fourth extension of the motor plate and the second end of the fourth turnbuckle to a fourth brace, and rotating the turnbuckle rod of the fourth turnbuckle to tighten the first ball end and second ball end.

[0047] In another exemplary method, at least one turnbuckle rod may be rotated such that the motor plate, turnbuckles, and braces retain about 100 foot pounds of torque. The flexibility conferred by the turnbuckles may allow the motor plate, motor, and shaft to accommodate eccentricity adjustments to the shaft made with the inner and outer journal housings.

[0048] The torque arms may be pre-loaded with torque to substantially reduce or eliminate shaft motor backlash. Backlash or play in the turnbuckles may accommodate vibrations from the shaft motor, thereby reducing the efficiency with which the motor spins the shaft and mitigating shaft and motor vibrations and instability.

[0049] In another exemplary high-pressure rotary valve system, the system may comprise a high-pressure rotary valve housing having an area defining an opening in the high-pressure rotary valve housing, an inner journal housing partially disposed within the area defining an opening in the high-pressure rotary valve housing, wherein an exterior wall of the inner journal housing defines an outer clearance between the area defining an opening in the high-pressure rotary valve housing and the inner journal housing, a flange extending from a portion of the exterior wall of the inner journal housing not disposed within the opening in the high-pressure rotary valve housing, an outer journal housing having feet disposed on the flange, a journal extending through the outer journal housing and inner journal housing, an adjustment mechanism comprising the feet of the outer journal housing, wherein the adjustment mechanism adjustably

engages the feet to the flange of the inner journal housing, and wherein the adjustment mechanism is configured to move the inner journal housing laterally with respect to the outer journal housing, a motor engaged to a journal end, a torque arm assembly comprising a motor plate, at least two turnbuckles, and at least two braces, wherein the turnbuckles have a first end and a second end, wherein the second end of each turnbuckle is engaged to a separate brace, wherein the first end of each turnbuckle is engaged to the motor plate such that each first end is equally distant from an adjacent first end of an adjacent turnbuckle, and wherein the end or ends of the brace not engaged to the second end of the turnbuckle is engaged to a stationary structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] The foregoing will be apparent from the following more particular description of exemplary embodiments of the disclosure, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views unless otherwise stated. The drawings are not necessarily to scale, with emphasis instead being placed upon illustrating the disclosed embodiments.

[0051] FIG. 1 is a perspective view of a conventional high-pressure feeder assembly, the high-pressure feeder being a conventional type of high-pressure rotary valve.

[0052] FIG. 2 is a detailed perspective view of a high-pressure feeder with a cut-a-way depicting a pocketed rotor.

[0053] FIG. 3A is a perspective view of an exemplary outer journal housing with legs.

[0054] FIG. 3B is front view of an exemplary outer journal housing further depicting the journal and a clearance between the journal and interior components of the outer journal housing.

[0055] FIG. 3C is a side-view of an exemplary outer journal housing with journal

[0056] FIG. 3D is a cross sectional view of FIG. 1C bisected along line A — A.

[0057] FIG. 4A front view of an exemplary inner journal housing disposed around a journal with flanges and wings.

[0058] FIG. 4B cross-sectional view of an exemplary inner journal housing bisected along line B — B in FIG. 4A.

[0059] FIG. 5 depicts a portion of an exemplary rotary valve system in which the outer journal housing and the inner journal housing are engaged to each other via fasteners around a journal.

[0060] FIG. 6A is a front view of an exemplary journal housing assembly disposed around a journal.

[0061] FIG. 6B is a cross sectional view of the exemplary journal housing assembly of FIG. 6A bisected along line C—C.

[0062] FIG. 7 is a front view of an exemplary motor plate.

[0063] FIG. 8 is a perspective view of an exemplary system using both an exemplary journal housing assembly and an exemplary torque arm assembly.

DETAILED DESCRIPTION OF THE INVENTION

[0064] The following detailed description of the preferred embodiments is presented only for illustrative and descriptive purposes and is not intended to be exhaustive or to limit the scope and spirit of the invention. The embodiments were selected and described to best explain the principles of the invention and its practical application. A person of ordinary skill in the art will recognize many variations can be made to the invention disclosed in this specification without departing from the scope and spirit of the invention.

[0065] FIG. 1 is a schematic diagram of a conventional feed system **10** for providing particulate lignocellulosic material (e.g. wood chips, corn stover, sawdust, recycled fiber, bagasse, and related biomass), to a continuous digester **17**. The high-pressure feeder **12** is a type of conventional high-pressure rotary valve. Particulate lignocellulosic material is stored in a chip bin **22** at near-atmospheric temperatures and pressures. When the system is active, the particulate lignocellulosic material flows past a measurement meter **20**, down a chute **18**, and through an inlet **40** into the high-pressure feeder **12**. Additional liquor may be added to the chip chute **18** through conduit **23**.

[0066] A hydraulic pump **32** may pressurize cooking liquor, steam, or other fluid and transfers the liquor, steam, or other fluid to a high-pressure inlet **33** via conduit **30**. The cooking liquor, steam, or other fluid pressurizes the particulate lignocellulosic material in the high-pressure feeder **12**. The particulate lignocellulosic material enters the high-pressure feeder **12** and may fall into a packet **36** (FIG. 2) of a rotor **35** (FIG. 2). As the rotor **35** rotates, the liquor, steam, or other fluid introduced to the high-pressure feeder **12** through high-pressure inlet **33** pressurizes the particulate lignocellulosic material. The pockets **36** may be configured to communicate with an opening in the center shaft when oppositely disposed pockets align with the high-pressure

inlet **33** and the high-pressure outlet **38** such that the pressurized fluid from the high-pressure inlet **33** displaces the particulate lignocellulosic material in the opposing pocket and pushes the lignocellulosic material through the high-pressure outlet **38**. Once outside of the high-pressure feeder **12**, the particulate lignocellulosic material may flow through conduit **14** past a flow meter **15**, through an inlet **16** of a continuous digester **17**, chip steaming vessel, inverted top separator, and other high-pressure chip processing system.

[0067] In FIG. 1, the high-pressure feeder **12** has a low-pressure outlet **24** for liquor that is not conveyed through high-pressure outlet **38**. The liquor from the low-pressure outlet **24** flows through conduit **26** to a liquor recovery system **28**, which may circulate the liquor to the hydraulic motor **32** to be re-pressurized.

[0068] FIG. 2 shows a conventional high-pressure feeder **12** comprising a housing **34** with a rotor **35** mounted for rotation within a chamber defined by housing interior wall **48** defined by the housing **34**. Housing **34** includes four ports: a high-pressure inlet **33** (in rear of housing **34** and shown in FIG. 1); a high-pressure outlet **38**; a low-pressure inlet **40** and a low-pressure outlet **24** (at the bottom of housing **34** and shown in FIG. 1).

[0069] A variable speed motor and gear reducer **37** coupled to a drive shaft **42** may rotate the rotor **35** is rotated by. The rotor **35** rotates such that the pockets **36** sequentially communicate with the four ports of the housing **34**.

[0070] A controller and motor assembly **62** and a shaft **58** adjust the axial position of the rotor **35**. While the controller, gear motor and gear box may be separate, they are depicted in FIG. 2 as the controller and motor assembly **62**. The shaft extends through an end bell **56** defined by supports **72** having a first end integrally engaged to an end bell flange **75** and a second side integrally engaged to a bearing housing **73**.

[0071] An annular clearance **51** is formed between the rotor **35** and the housing interior wall **48**, when the pocketed cylindrical rotor **35** is inserted into the chamber defined by the housing interior wall **48**. A conduit **57** may be included for the addition of steam, or liquid such as white liquor or other suitable fluid. This conduit **57** is connected to end bells **56** at opposite ends of the housing **34**. The steam or other fluid is provided under pressure from conduit **57** to pressurize the liquid in the end bells **56** and to prevent a flow of liquor and fines from the rotor **35** into the end bells **56**.

[0072] The clearance **51** generally becomes less congruent as production continues. When the rotor **35** is substantially conical, and where the chamber is tapered to correspond to the substantially conical rotor shape, and if the housing interior wall **48** forms a congruent clearance **51**, the annular clearance **51** may be narrowed or expanded by moving the rotor **35** axially towards the small diameter end of the chamber defined by housing interior wall **48**. Similarly, the annular clearance **51** may be expanded by moving the rotor **35** axially towards the large diameter end of the chamber defined by the housing interior wall **48**. During axial movement, the rotor **35** remains within the housing **34**.

[0073] Asymmetric thermal expansion may cause parts of a rotor **35** to expand into the housing interior wall **48** and grind away at the housing interior wall **48**. Shavings from this grinding, may contaminate the particulate lignocellulosic material, disrupt processes in downstream systems, scrape the housing interior wall **48** and rotor **35**, unbalance the rotor **35** and cause chatter, welding, increase energy input to the high-pressure feeder **12** to compensate for increased frictional resistance, and generally shorten the operational life of the high-pressure rotary valve.

[0074] Steam or other fluid such as liquor, lubricant, or cooling fluid can flow through the annular clearance **51**. Steam or fluid escape may be especially prevalent at inlets and outlets to the high-pressure feeder and in areas of the end bell **56** that engage the shaft **58**, **42** such as a pack box **71** integral with the end bell **56** or housing **34** or a bearing housing **73** internally engaged to supports **72** of the end bell **56**. The fluid in the end bells **56** is preferably maintained under pressure to prevent additional flow, which may include fines, into the end bells **56**.

Additionally, if a gap between the shaft and the end bell **56** becomes too large, excess fluid and small particles may enter a clearance (see **125** FIG. 3B) between the shaft and the end bell **56**. If small particles such as fines and debris collect in interior end bell **56** in the gap between the shaft and the end bell **56** the small particles may resist shaft rotation, wear down the interior of the integral pack box **71** and integral bearing housing **73**, and thereby unbalance the shaft and rotor to cause chatter, welding, increased power consumption, and reduced operational life.

[0075] FIG. 3A is a perspective view of an exemplary outer journal housing **100** having legs **120**. The legs **120** may terminate in a foot **192** having fastener holes **105**.

[0076] FIG. 3A further depicts an exemplary bearing **160** resting within the outer journal housing **100**. Seals **140**, such as packing rings **240** (FIG. 3B), may rest on top of the bearing

160. In an exemplary high-pressure rotary valve system **500, 800** (FIG. 5, FIG. 8, and see FIG. 6B), these seals **140** separate the pressurized interior of the journal housing from the pressure outside of the high-pressure rotary valve system **500, 800**. The seals **140** generally prevent fluid **155** (FIG. 3B) such as steam or lubricants (*e.g.* oil) from exiting the outer journal housing **100**. In other exemplary embodiments, these seals **140** may be omitted. The pressure outside of the high-pressure rotary valve system may be atmospheric pressure. Fastener holes **105** may be distributed around a circumference of the outer journal housing **100** and extend through the top of the outer journal housing **100**. A seal retainer **130** may rest on a furthest seal from the bearing **160**. The seal retainer **130** may be a packing gland follower, oil seal, or other seal retainer configured to prevent leakage from the outer bearing housing **100**. Operators may tighten fasteners in fastener holes **105** to move the seal retainer **130** closer to the bearing **160**. A tightened seal retainer **130** presses down on the seals **140** such that the seals **140** laterally expand to narrow the clearance **125** between the seals **140** and the journal **150** (FIG. 3B) and thereby prevent leaks. The seals **140** may be packing rings **240** or other sealing means commonly used in the industry.

[0077] The outer bearing **100** may further have an fluid inlet **112** configured to receive fluid **155** such as a coolant, lubricant, or similar fluid for introduction into the clearance **125** through bearing holes **110**.

[0078] FIG. 3B is a front view of an exemplary outer journal housing **100** with legs **120** terminating in feet **192**. Fasteners **115** (FIG. 6A) extending through fastener holes **105** in the feet **192** of the legs **120** adjustably engage the outer journal housing **100** to the inner journal housing **200** (FIG. 4A and see FIG. 6A). The bearing **160** bounded by seals **140** (FIG. 3A) may spin within the outer journal housing **100** along with the journal **150**. By adjusting the position of the outer journal housing **100** relative to the inner journal housing **200** with an adjustment mechanism comprising fasteners **115**, an operator may adjust the position of the outer journal housing **100** independent of the inner journal housing **200**. Adjusting the position of the outer journal housing **100** adjusts the eccentricity of the journal **150**. The clearance **125** and flush fluid **155** will likewise be adjusted with the outer journal housing **100**.

[0079] FIG. 3C is a side view of an exemplary outer journal housing **100**. The journal **150** generally extends through the outer journal housing **100**. Fasteners **115** may extend through fastener holes **105** in the feet **192** on the legs **120** to adjustably engage the legs **120** to the inner

journal housing **200**. FIG. 3C shows inner fastener holes **117** and outer fastener holes **113** extending from a first end (depicted) of the past portion **192** to a second end (opposite the first end and seen in FIG. 6A) of the foot **192**. The fastener holes **105** may extend through the foot **192** top to bottom, end to end as depicted in FIG. 3C, or side to side such that the fastener holes **105** would extend from a left side of a foot **192** on a leg **120** to a right side of a foot **192** on a leg **120** and *vice versa*. Line A – A bisects the exemplary embodiment of the outer journal housing **100** vertically.

[0080] FIG. 3D is a side view of an exemplary outer journal housing **100** bisected along the line A – A in FIG. 3C. A bearing **160** may rest in a bearing adapter **107**. Multiple drain ports **102** for fluid, such as flush fluid, (see **155** in FIG. 3B) may traverse the outer journal housing **100**. The drain ports **102** communicate with the bearing holes **110** to permit fluid to enter and exit the outer journal housing **100** and enter and exit the clearance **125** between the journal and the bearing **160** or other internal component of the outer journal housing **100**. An oil seal **135** may be placed on each of either end of the outer journal housing **100**. The oil seal **135** may be used to help prevent fluid leakage.

[0081] FIG. 4A is a front view of an exemplary inner journal housing **200**. An exemplary inner journal housing **200** may have flanges **227** and wings **294** configured to complement the feet **192** on the legs **120**. In the depicted exemplary embodiment, the flanges **227** extend from the exterior wall of the inner journal housing **200** and have wings **294** disposed at outer corners of the flanges **227**. A journal **150** is disposed within the inner journal housing **200** and defines a clearance **125** between the journal **150** and a bearing **260**, packing rings **240**, or other internal components of the inner journal housing **200**.

[0082] FIG. 4B is a side cross-sectional view of an exemplary inner journal housing **200** of FIG. 2B bisected vertically along line B – B. In this exemplary depiction, the inner journal housing **200** is a pack box and the seal retainer **130** is a packing gland follower **270**. Packing rings **240** become compressed as the adjacent bearing **260** expands axially. When the high-pressure rotary valve is deactivated and the bearing **260** cools, the bearing **260** returns to the bearing's **260** near-ambient temperature length. The packing rings **240** generally do not return to the packing ring's **240** near ambient temperature length, and therefore form one or more spaces between the packing rings **240** and the bearing **260**. A packing gland follower **270** is used to re-pack the packing rings **240** to close the one or more spaces and maintain or re-form a pressure seal in the

high-pressure rotary valve system. A shoulder bushing and pack box housing as described in PCT App. No. PCT/US14/66099 may desirably be used for the inner journal housing **200**. The bearing may have bearing holes **210** through which fluid may flow. The lower portion of the inner journal housing **200** may be disposed within an opening in the high-pressure rotary valve housing **534** and an end bell flange **575** engaged to the rotary valve housing **534** (FIG. 5) such that the inner journal housing **200** is not integrally engaged to the high-pressure rotary valve housing **534**.

[0083] FIG. 5 depicts a portion of a high-pressure rotary valve system **500** having an exemplary assembly of journal housings disposed around a journal **150**. Particulate lignocellulosic material may fall into the high-pressure rotary valve housing **534** via chute **518**. Conduit **557** pipes steam, liquor, or other fluid into the rotary valve housing **534** through the end bell flange **575**. The rotor (see **35**, FIG. 2) rotates the particulate lignocellulosic material through the rotary valve housing to be pressurized and prepared for entry into a high-pressure system. Material within the high-pressure rotary valve may exit through outlet **524**. The journal **550** desirably extends through both the inner journal housing **200** and the outer journal housing **100**.

[0084] The feet **192** disposed on the legs **120** of the outer journal housing **100** is disposed within a receiving area defined by the flange **227** and wings **294** of the inner journal housing **200**. Fasteners **115** (FIG. 6A) disposed through fastener holes **105** in the feet **192**, wings **294**, or flange **227** create an exemplary adjustment mechanism **300** (FIG. 6A) configured to adjustably engage the outer journal housing **100** to the inner journal housing **200**. The adjustment mechanism **300** allows the outer journal housing **100** to be adjusted laterally relative to the end bell flange **575** independently of the inner journal housing **200**. In other alternative embodiments, the adjustment mechanism **300** is configured to both adjust the outer journal housing **100** laterally and axially relative to the journal **150** or end bell flange **575** independent of the inner journal **200** and to adjust the outer journal housing **100** laterally and axially relative to the journal **150** or end bell flange **575** dependent on the inner journal **200**, such that the outer journal housing **100** and inner journal housing **200** move as one assembly relative to the journal **150** or end bell flange **575**.

[0085] FIG. 6A is a front view of an exemplary combined journal assembly **600** comprising an outer journal housing **100** and inner journal housing **200** having an adjustment mechanism **300**. Outer fasteners **613** and inner fasteners **617** extend through fastener holes **105** defined by the feet

192 and the wings **294**. In this illustrative depiction, the fastener holes **105** extend end to end such that a first end is at the top of the exemplary assembly and the second end is at the bottom of the exemplary assembly. In other exemplary embodiments, fastener holes **105** extending from a right side to a left side, or diagonally through the adjustment mechanism **300** may be used. The combined journal assembly **600** engages the end bell flange **575** via a support plate **626**. The outer journal housing **100** surrounds an oil seal **130** configured to prevent fluid **125** (FIG. 3B) from exiting the outer journal housing **100**. Fluid **125** may enter the inner journal housing **200** via a fluid inlet **603**. Steam may enter the high-pressure rotary valve system **500** via steam inlet pipe **557**. Steam may be used to dislodge debris from the high-pressure rotary valve system by means of the flush valve **686**. The entire combined journal assembly **600** may be offset from a vertical axis at angle θ . Angle θ may be a range of 30 degrees to -30 degrees with respect to the vertical axis. Without being bounded by theory, offsetting the combined journal assembly **600** by angle θ as much as 30 degrees relative to a vertical axis may permit desirable lateral journal housing adjustments configured to both change journal eccentricity and journal attitude angle. The combined journal assembly **600** may be angled in relation to the direction of journal rotation.

[0086] Outer adjustment fasteners **613** may extend through outer fastener holes **113** (FIG. 3C) in the feet **192** extending from legs **120** of the outer journal housing **100** and in the wings **294** of the inner journal housing **200**. Inner adjustment fasteners **617** may extend through inner fastener holes **117** (FIG. 3C) in the feet **192** extending from the legs **120** in the outer journal housing **100** and in the wings **294** of the inner journal housing **200**. Rotating the outer adjustment fasteners **613** changes the position of the outer journal housing **100** relative to the inner journal housing **200** while rotating the inner adjustment fasteners **617** changes the position of both the inner journal housing **200** and the outer journal housing **100** relative to the journal **150**, or an end bell flange **575**, or other portion of the high-pressure rotary housing **534**.

[0087] FIG. 6B is a cross sectional side view of FIG. 6A taken along line C—C. FIG. 6B illustrates inner journal housing **200** partially disposed within an opening defined by areas of the high-pressure rotary valve housing **534**. It will be understood that areas of the high-pressure rotary valve housing **534** may include areas in an end bell flange **575** or other plate or structure forming an end of the high-pressure rotary valve housing **534**. Neither the inner journal housing **200** nor the outer journal housing **100** are integrally engaged to the high-pressure rotary valve

housing and thereby allow the exemplary combined journal housing assembly **600** to move with the journal **150** relative to the high-pressure rotary valve housing **534**. In certain exemplary embodiments, a sleeve may be disposed in the outer clearance **685** defined by the interior of the high-pressure rotary valve housing **534** and the exterior of the inner journal housing **200**. In other exemplary embodiments, packing rings **240** or other seals **130** may be used to fill outer clearance **685** to minimize loss of steam and other fluid from the high-pressure rotary valve housing **534**.

[0088] It will be understood that the modifications of FIGS. 3, 4, 6B, and 7 could be employed in combination with one another as well as individually in the systems depicted in FIGS. 5, 6A, and 8.

[0089] Conventional high-pressure rotary valves systems generally employ a torque arm grounded in building steel to prevent the motor from spinning in a direction opposite the rotational direction of the shaft. However, the use of a single torque arm tends to create an inherently unbalanced system of forces. For example, if the motor is exhibiting a force in a counter-clockwise direction, a single torque arm generally exerts a tangential force at a single point along the counter-clockwise rotation. At the point at which the torque arm engages the motor, the torque arm ideally exerts a tangential force equal and opposite to the tangential force of the motor. However, these forces rarely negate each other completely because on the opposite side of the single engagement point, the motor generally exhibits a tangential force in the same direction as the force of the torque arm. Forces may also become unbalanced due to changes in shaft torque resulting from changes in rotor or shaft load. Over time, net force may move the central rotational axis of the motor, shaft, or rotor away from the center axis of the bearings and journal housings, thereby contributing to shaft bending, chatter, welding, etc. For example, if the unbalanced force is a net force in the upward direction, the single torque arm will tend to lift the motor and shaft in an upward direction thereby imparting bending stress and torsional stress to the shaft. Over time, the bending and torsional stress can contribute to chatter within the high-pressure rotary valve system and negatively affect the productivity of the high-pressure rotary valve system.

[0090] Previous systems were forced to balance the resulting torque from high-pressure rotary valves systems using building structures external from the system itself. These systems connected one end of the torque arm to adjacent building steel.

[0091] To address this problem, Applicant has recognized the problem of unbalanced torque arms and discloses an exemplary system in accordance with the present disclosure comprising both a combined journal housing assembly **600**, wherein the combined journal housing assembly **600** is configured to be adjusted and is not integrally engaged to the high-pressure rotary housing **534** and a balanced torque arm assembly configured to be pre-loaded with torque and flexibly engaged to the high-pressure rotary valve system **800**.

[0092] FIG. 7 is a front view of an exemplary motor plate **700** with extensions **778** configured to accommodate a first end of a turnbuckle **897** (FIG. 8). The motor plate **700** engages a motor **865**. Although motor plate extensions are described herein, it will be understood that the motor plate extensions represent the point at which the turnbuckle engages the motor plate. Therefore, the motor plate extensions may be absent as long as the turnbuckles engage the motor plate in a radially symmetric manner.

[0093] FIG. 8 is perspective view of a high-pressure rotary valve system **800** having an exemplary pre-loaded torque arm assembly **845** comprising a motor plate **700** flexibly engaged to braces **880** via turnbuckles **890**. Two turnbuckles **890** are spaced 180 degrees apart from each other to allow for even distribution of torque from the motor **865**. Each turnbuckle may comprise a first end **898**, a first ball rod end **847**, a turnbuckle rod **852**, a second ball rod end **849**, and a second end **897**. More than two turnbuckles **890** may be used if each turnbuckle **890** is substantially equidistant from adjacent turnbuckles **890**. In other exemplary embodiments, the turnbuckles **890** may be distributed symmetrically around the motor plate **700**.

[0094] The motor plate **700** encircles the motor **865**. A motor adaptor **843** may be disposed between the motor **865** and the motor plate **700**. FIG 8 depicts four turnbuckles **890**. “Turnbuckle” describes a structure or apparatus configured to withstand the torque imparted to the torque arm assembly **845** while remaining sufficiently flexible to accommodate journal expansion, vibrations, and changes in rotor balance during high-pressure rotary valve operation. The motor plate **700** may be configured to have a number of extensions **778** corresponding to the number of turnbuckles **890**. A first end **898** of the turnbuckle **890** fixedly engages an extension **778** on the motor plate **700**. A second end **897** of the turnbuckle **890** fixedly engages a brace **880**. The first and second ends **898**, **897** may be clamp ends. Fasteners **115** may fixedly engage the turnbuckle ends **897**, **898** to the motor plate **700** and brace **880**. The turnbuckles flexibly engage the motor plate **700** to the braces **880**. The end or ends of the braces **880** not engaged to

the turnbuckle **890** are fixedly engaged to the high-pressure rotary valve housing **534**. In other exemplary embodiments, the end or ends of the braces **880** not engaged to the turnbuckle **890** may be engaged to building steel, the ground, or other structure ancillary to the high-pressure rotary valve system. In still other exemplary embodiments, the at least one brace **880** may be fixedly engaged the high-pressure rotary valve housing **534** and at least one other brace **880** may be fixedly engaged to a structure ancillary to the high-pressure rotary valve housing **534**.

[0095] The braces **880** may be 7 shaped, V shaped, or other shape configured to withstand near constant torque from the motor **865** and motor plate **700**. By tightening a turnbuckle **890**, operators may pre-load the exemplary torque arm assembly **845** with torque in an opposite direction from the torque released from the motor **865**. By pre-loading at least one turnbuckle **890** in the torque arm assembly **845**, operators may substantially reduce or eliminate backlash from the motor **865**.

[0096] In an exemplary method, one turnbuckle **890** is preloaded with torque while the other turnbuckles **890** are left slack. Without being bounded by theory, the pre-loaded turnbuckle **890** and the evenly-distributed motor plate **700**, turnbuckles **890**, and braces **880**, permit balancing of torque and thereby mitigate loss of rotational energy and increasing rotor and journal stability. The flexible turnbuckles may desirably allow the motor to adjust naturally in response to thermal expansion and other changing conditions within the high-pressure rotary valve housing. The motor's adjustment may cancel out these forces.

[0097] In an exemplary method, an operator may engage engaging a separate turnbuckle **890** to three of at least four extensions **778** of a motor plate **700**, wherein the at least four extensions **778** are distributed around the motor plate **700** such that each extension is equidistant from either adjacent extension **778**, and wherein each turnbuckle **890** comprises a first end engaged to a first ball rod end, a turnbuckle rod, and a second ball rod end engaged to a second end, wherein each extension of the motor plate is engaged to the first end **898** of the turnbuckle **890** and each second end **897** of each turnbuckle **890** is engaged to a separate brace **880**. The operator may then engage the first end **989** of a fourth turnbuckle **890** to a fourth extension **778** of the motor plate **700** and the second end **897** of the fourth turnbuckle **890** to a fourth brace **880**. By rotating the turnbuckle rod **849** of the fourth turnbuckle **890** to tighten the first ball end **847** and second ball end **849**, the operator may introduce torque into the torque arm assembly **845**. The operator may then adjust the fourth turnbuckle **890** to arrive at an appropriate amount of torque to

counteract the torque of the motor **865**. The operator may additionally adjust one or more of the other turnbuckles **890** to balance the torque in the system and reduce fatigue caused by unbalanced torque.

[0098] Additionally, the flexible nature of the turnbuckles **890** allows the torque arm assembly **845** to accommodate offset angle adjustments in the outer journal housing **100** and inner journal housing **200**. By leaving one or more turnbuckles **890** loose, the torque arm assembly **845** is configured to be flexibly engaged to the exemplary high-pressure rotary valve system **800** such that the torque arm assembly **845** can accommodate and absorb journal vibrations, motor vibrations, journal eccentricity and attitude angle offsets, and thereby reduce instances of rotor chatter, welding, and similar problems that may result from an unbalanced system. Although four turnbuckles **890** and braces **880** are shown herein, it will be understood that two or more or three or more turnbuckles and braces may be used in exemplary embodiments of the torque arm assembly so long as the turnbuckles **890** and braces **880** are distributed in a radially symmetric manner around the motor plate. A radial symmetric distribution means that symmetric exists among the points at which the first turnbuckle end **898** engages the motor plate **700** along at least one axis of the rotor plate.

[0099] While this invention has been particularly shown and described with references to exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims.

CLAIMS

What is claimed is:

1. A system comprising:

a high-pressure rotary valve housing having an area defining an opening in the high-pressure rotary valve housing;

an inner journal housing partially disposed within the area defining an opening in the high-pressure rotary valve housing, wherein an exterior wall of the inner journal housing defines an outer clearance between the area defining an opening in the high-pressure rotary valve housing and the inner journal housing;

a flange extending from a portion of the exterior wall of the inner journal housing not disposed within the opening in the high-pressure rotary valve housing;

an outer journal housing having feet disposed on the flange;

an adjustment mechanism comprising the feet of the outer journal housing, wherein the adjustment mechanism adjustably engages the feet to the flange of the inner journal housing, and wherein the adjustment mechanism is configured to move the inner journal housing laterally with respect to the outer journal housing.

2. The system of claim 1, wherein the adjustment mechanism further comprises wings disposed on the flange, wherein the wings define wing fastener holes, wherein the feet define feet fastener holes, and wherein at least one fastener extends into both a foot fastener hole and a wing fastener hole.
3. The system of claim 2, wherein the feet fastener holes extend through the ends of the feet.
4. The system of claim 2 or 3, wherein the feet fastener holes extend through the sides of the feet and at least one wing fastener hole aligns with the at least one foot fastener hole.
5. The system of any of claims 1 to 4, wherein the foot in the adjustment mechanism further comprises at least one foot fastener hole extending through a top of the foot, wherein the flange has at least one flange fastener hole aligning with the foot fastener hole, and wherein at least one fastener extends into the foot faster hole and flange fastener hole.
6. The system of any of claims 1 to 5, wherein the inner journal housing is a pack box and the outer journal housing is a bearing housing.

7. The system of any of claims 1 to 6, wherein packing rings are disposed in the outer clearance.
8. The system of any of claims 1 to 7, wherein a sleeve is disposed within the outer clearance.
9. The system of any of claims 1 to 8 further comprising a torque arm assembly, wherein the torque arm assembly comprises a motor plate disposed around a motor, at least two turnbuckles having a first end and a second end, wherein each first end is engaged to the motor plate, wherein each second end of each turnbuckle is engaged to a brace, and wherein each brace is engaged to a stationary structure.
10. The system of claim 9, wherein each brace is engaged to a stationary structure equidistant from each adjacent brace.
11. The system of claim 9 or 10, wherein the torque arm assembly further comprises four turnbuckles and four braces, wherein each first turnbuckle end is disposed 90 degrees from either adjacent turnbuckle first end and, wherein each second turnbuckle end is disposed 90 degrees from either second turnbuckle end.
12. The system of any of claims 9 to 11, wherein the torque arm assembly further comprises four turnbuckles and fourth braces, wherein each first turnbuckle end is disposed 120 degrees from a first adjacent first end and 60 degrees from a second adjacent first end.
13. The system of any of claims 9 to 12, wherein the first end of the turnbuckle is disposed radially symmetrically around the motor plate.
14. The system of any of claims 1 to 13, wherein the first journal housing and second journal housing comprise a journal housing assembly.
15. The system of claim 14, wherein the journal housing assembly has an offset angle of between 0 degrees and 30 degrees relative to a vertical line bisecting the rotary valve housing along the length of a shaft extending into the high-pressure rotary valve housing.
16. A method for pre-loading the motor plate with torque comprising:
 - engaging a separate turnbuckle to three of at least four extensions of a motor plate, wherein the at least four extensions are distributed around the motor plate such that each extension is equidistant from either adjacent extension, and wherein each turnbuckle comprises a first end engaged to a first ball rod end, a turnbuckle rod, and a second ball rod end engaged to a second end, wherein each extension of the motor plate is engaged to

the first end of the turnbuckle and each second end of each turnbuckle is engaged to a separate brace;

engaging the first end of a fourth turnbuckle to a fourth extension of the motor plate and the second end of the fourth turnbuckle to a fourth brace; and

rotating the turnbuckle rod of the fourth turnbuckle to tighten the first ball end and second ball end.

17. The method of claim 16 wherein the motor plate, turnbuckles, and braces comprise a torque arm assembly.

18. The method of claim 16 or 17 further comprising rotating the turnbuckle rod of the fourth turnbuckle such that the torque arm assembly retains about 100 foot pounds of torque.

19. A high-pressure rotary valve system comprising:

a high-pressure rotary valve housing having an area defining an opening in the high-pressure rotary valve housing;

an inner journal housing partially disposed within the area defining an opening in the high-pressure rotary valve housing, wherein an exterior wall of the inner journal housing defines an outer clearance between the area defining an opening in the high-pressure rotary valve housing and the inner journal housing;

a flange extending from a portion of the exterior wall of the inner journal housing not disposed within the opening in the high-pressure rotary valve housing;

an outer journal housing having feet disposed on the flange;

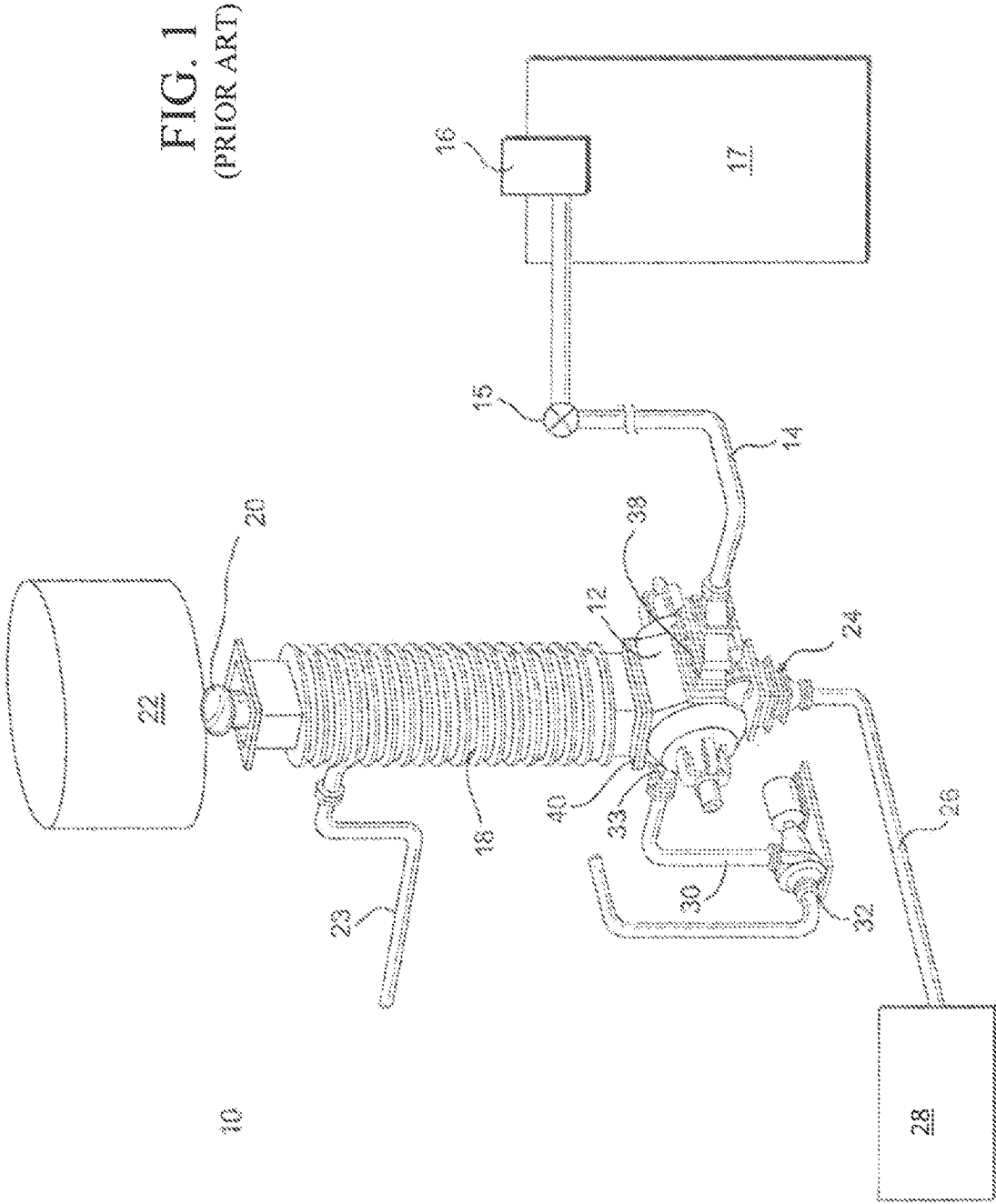
a journal extending through the outer journal housing and inner journal housing;

an adjustment mechanism comprising the feet of the outer journal housing, wherein the adjustment mechanism adjustably engages the feet to the flange of the inner journal housing, and wherein the adjustment mechanism is configured to move the inner journal housing laterally with respect to the outer journal housing;

a motor engaged to a journal end;

a torque arm assembly comprising a motor plate, at least two turnbuckles, and at least two braces, wherein the turnbuckles have a first end and a second end, wherein the second end of each turnbuckle is engaged to a separate brace, wherein the first end of each turnbuckle is engaged to the motor plate such that each first end is equally distant

from an adjacent first end of an adjacent turnbuckle, and wherein the end or ends of the brace not engaged to the second end of the turnbuckle is engaged to a stationary structure.



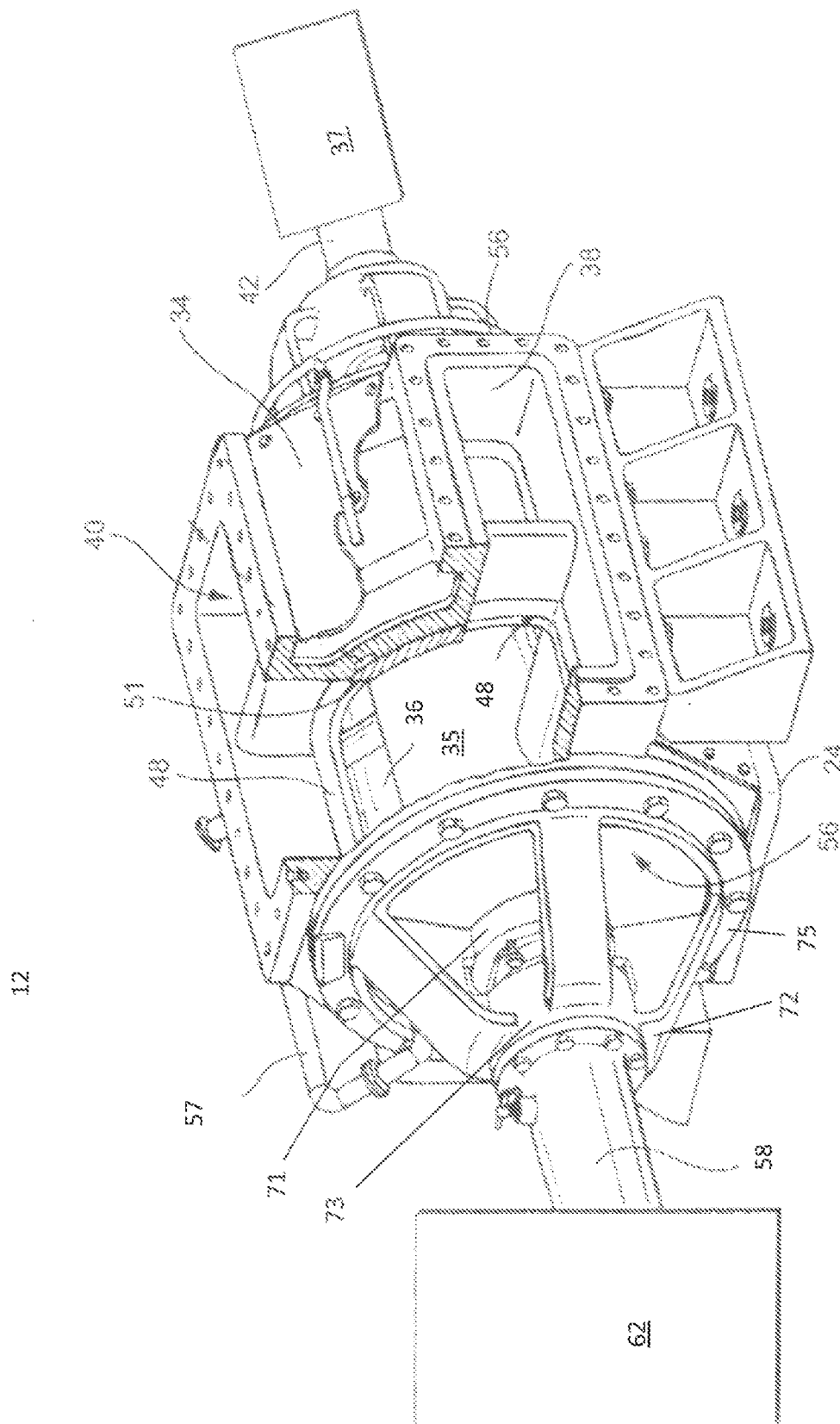
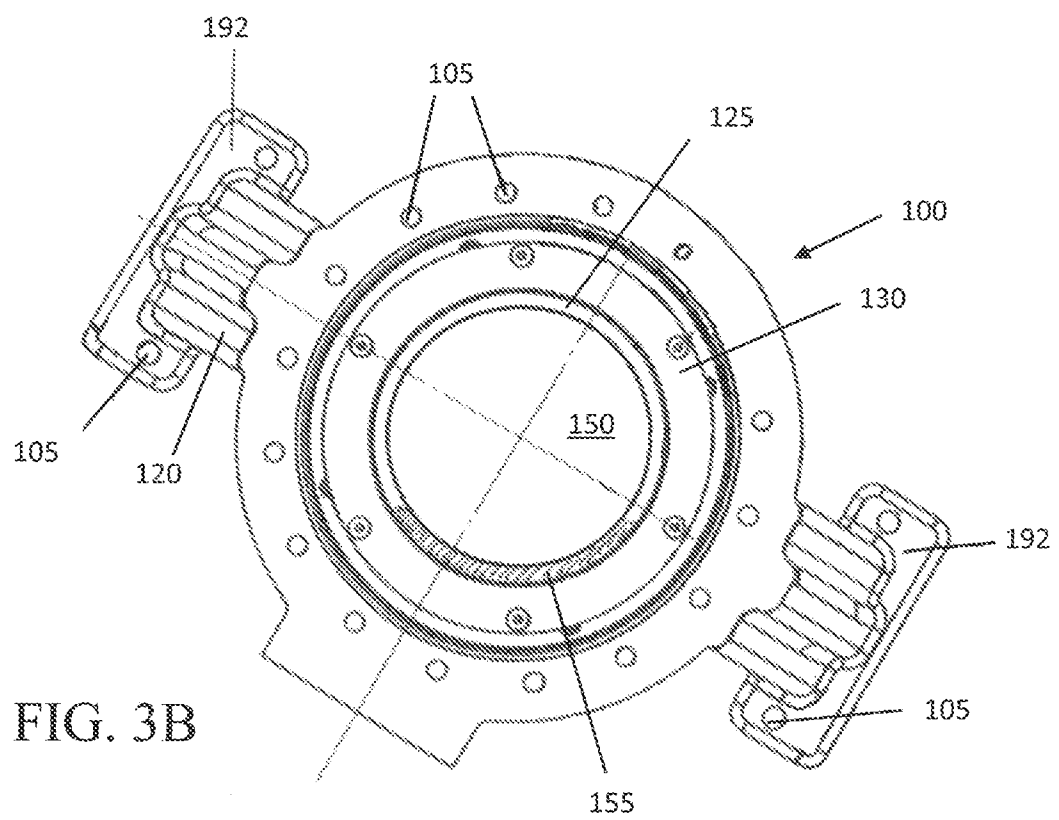
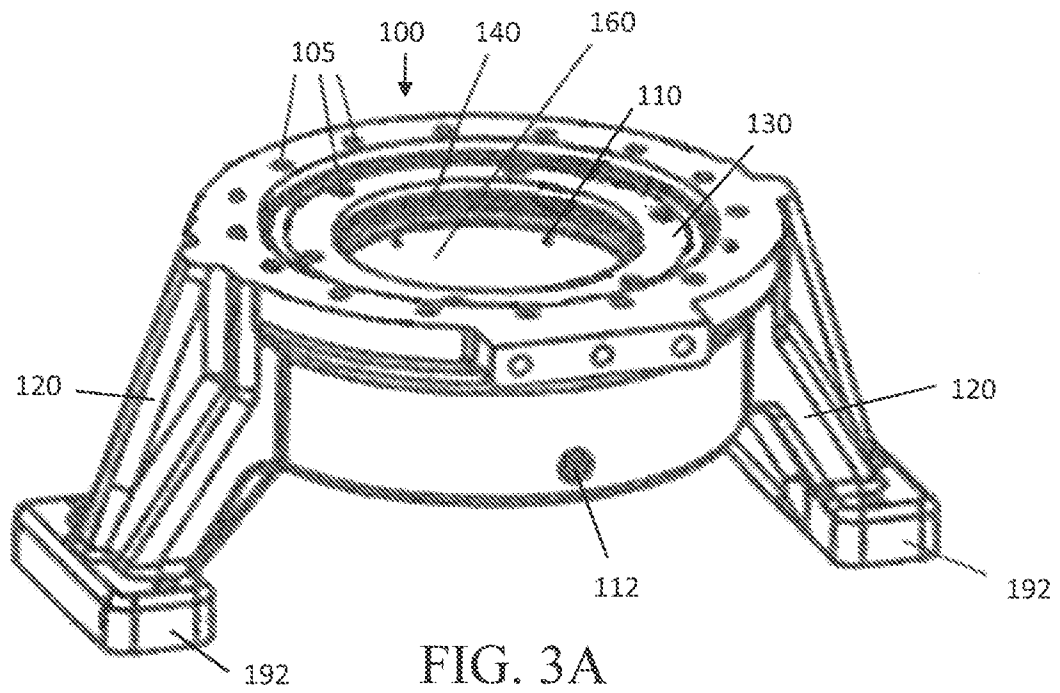


FIG. 2
(PRIOR ART)



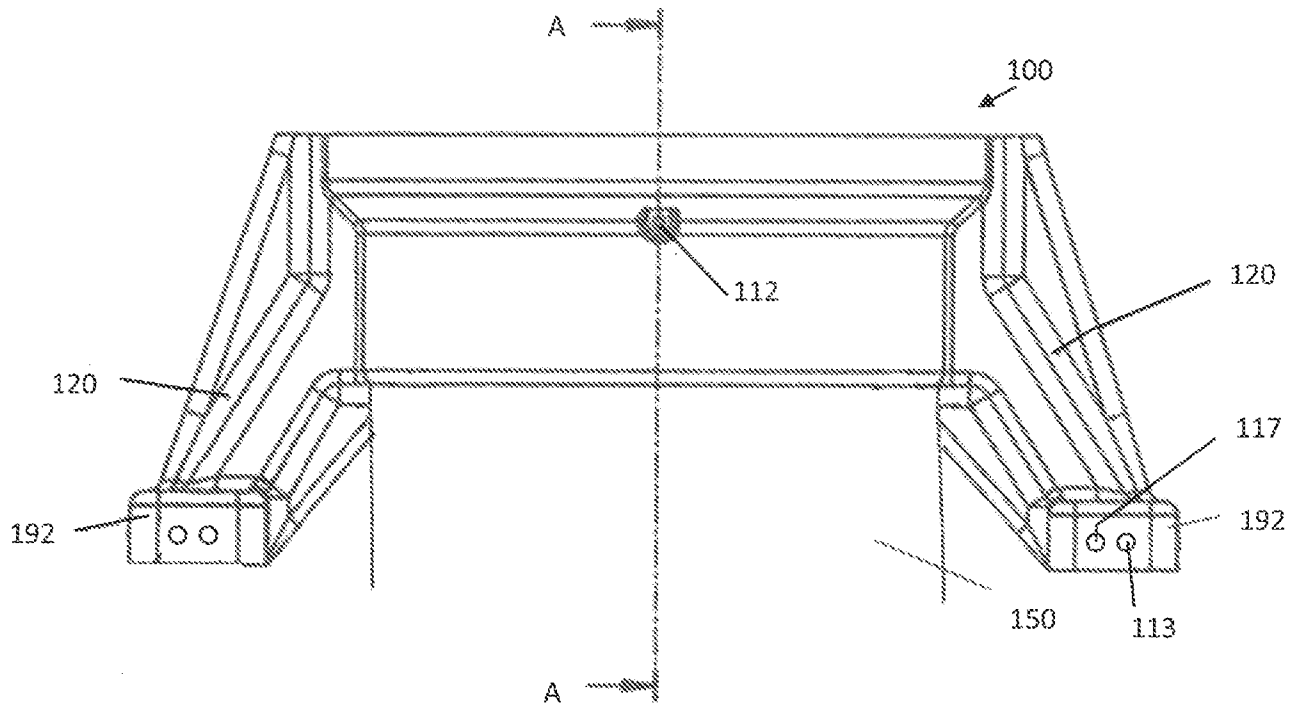


FIG. 3C

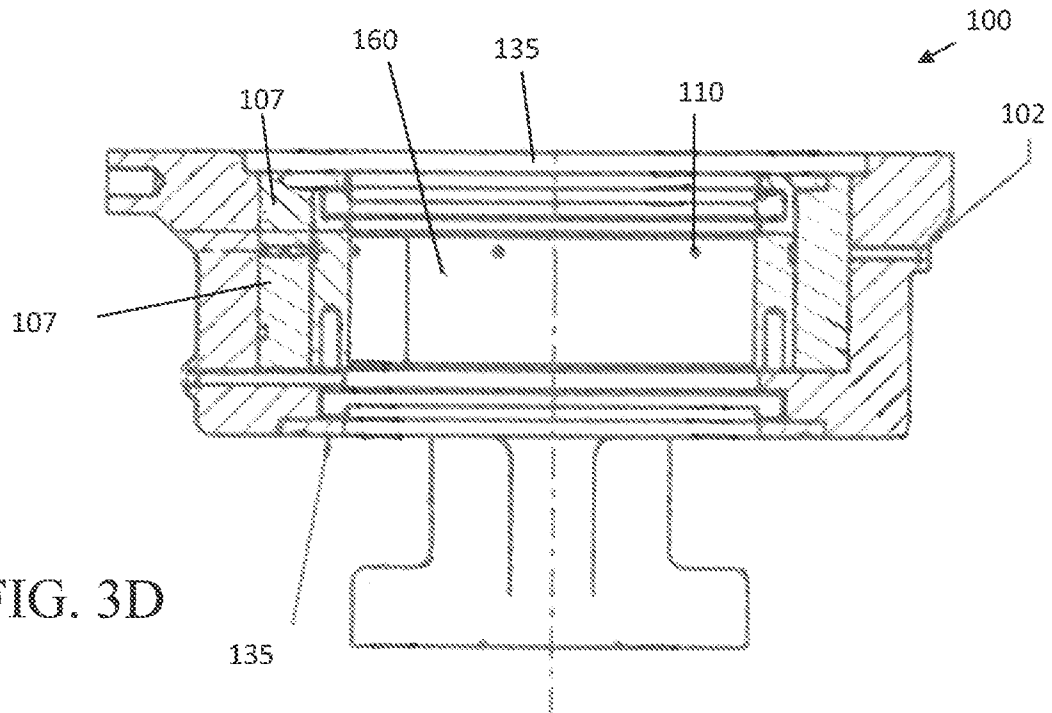
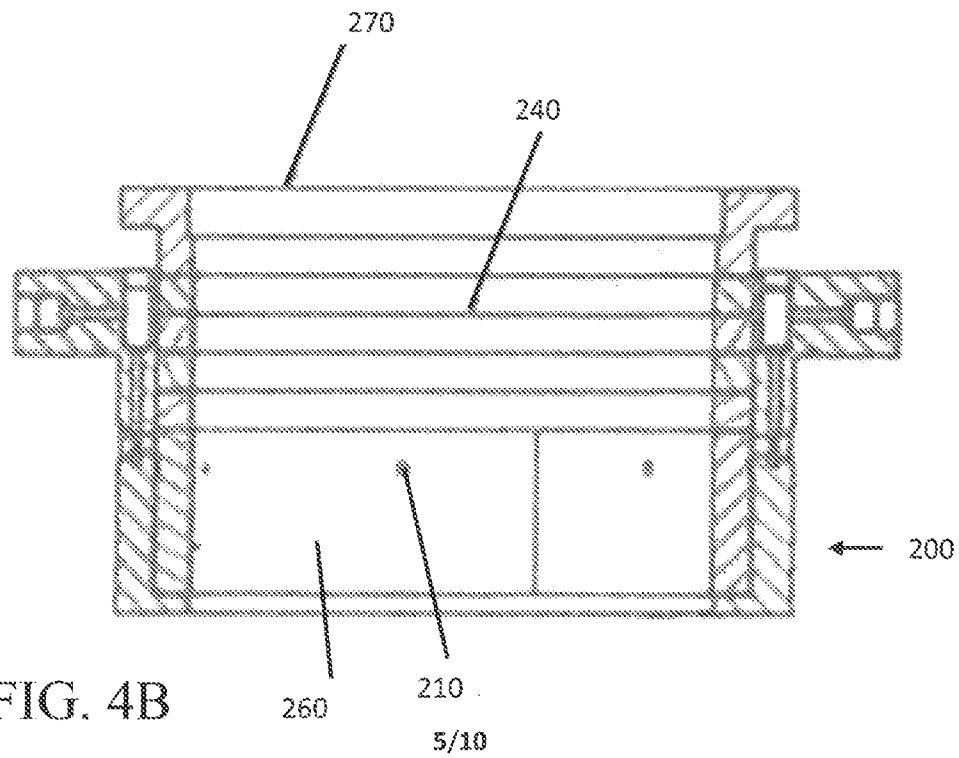
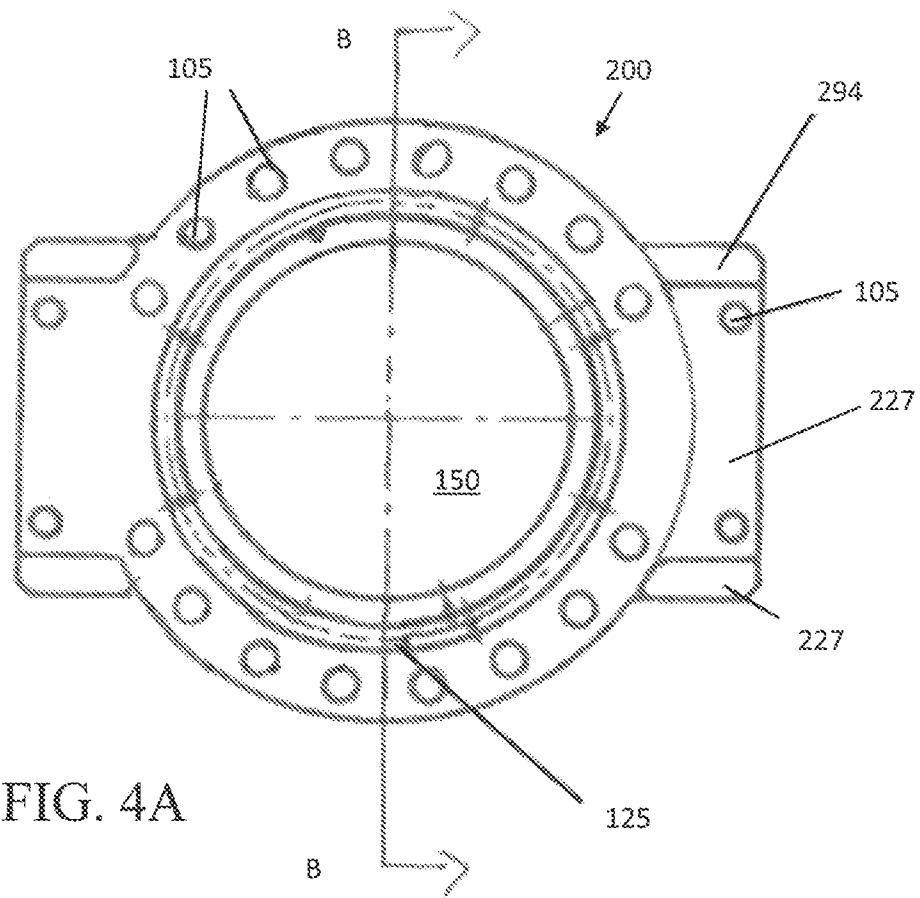


FIG. 3D



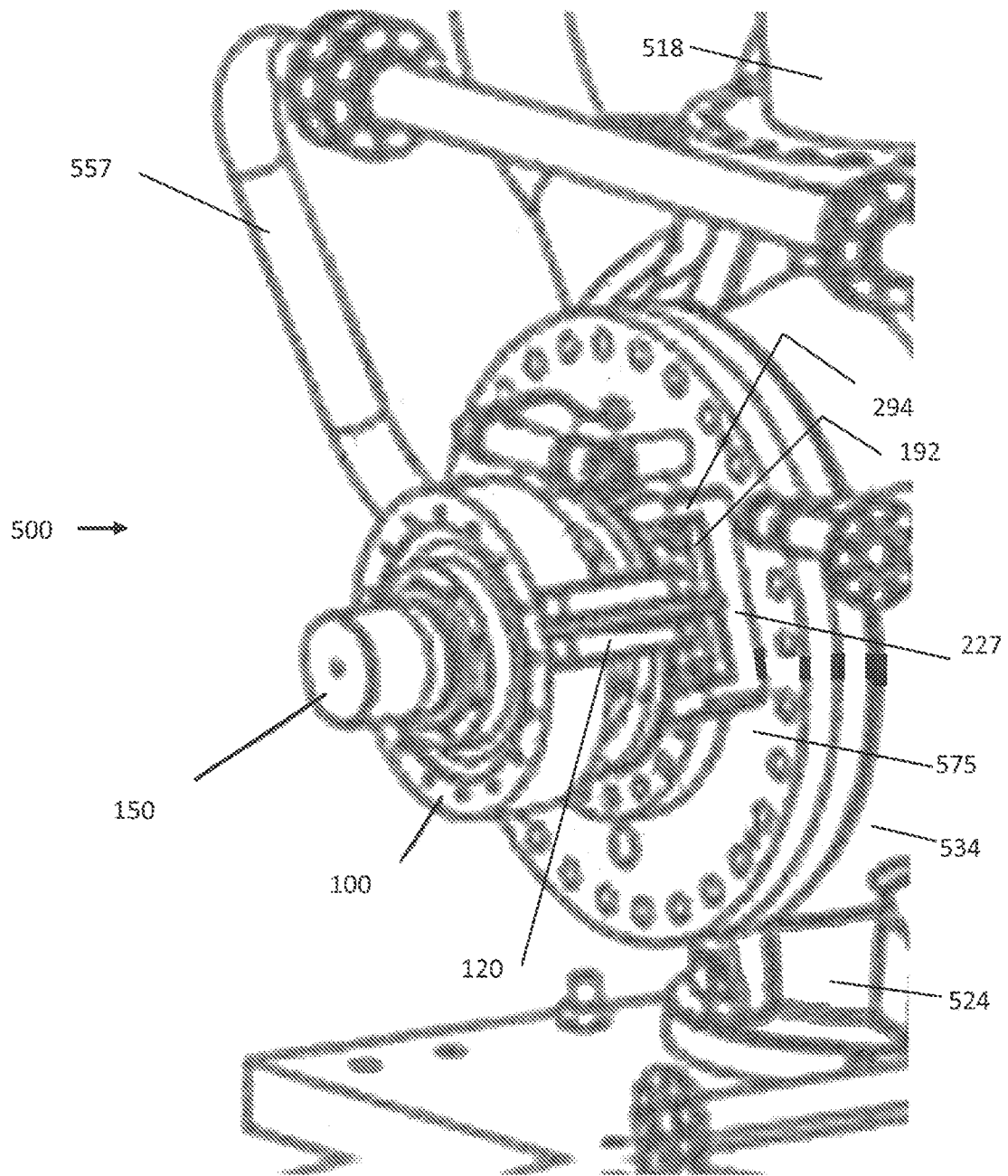


FIG. 5

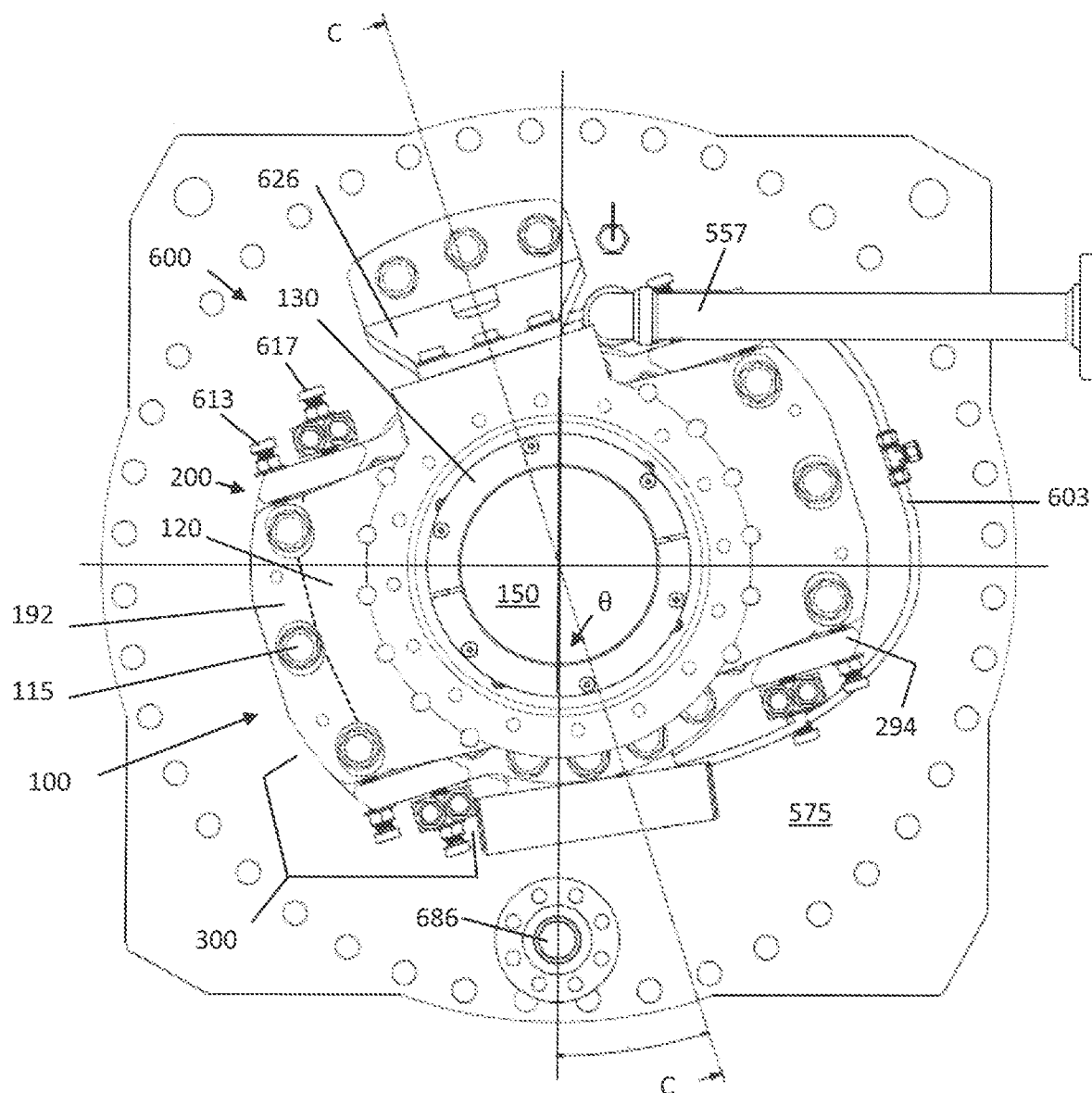


FIG. 6A

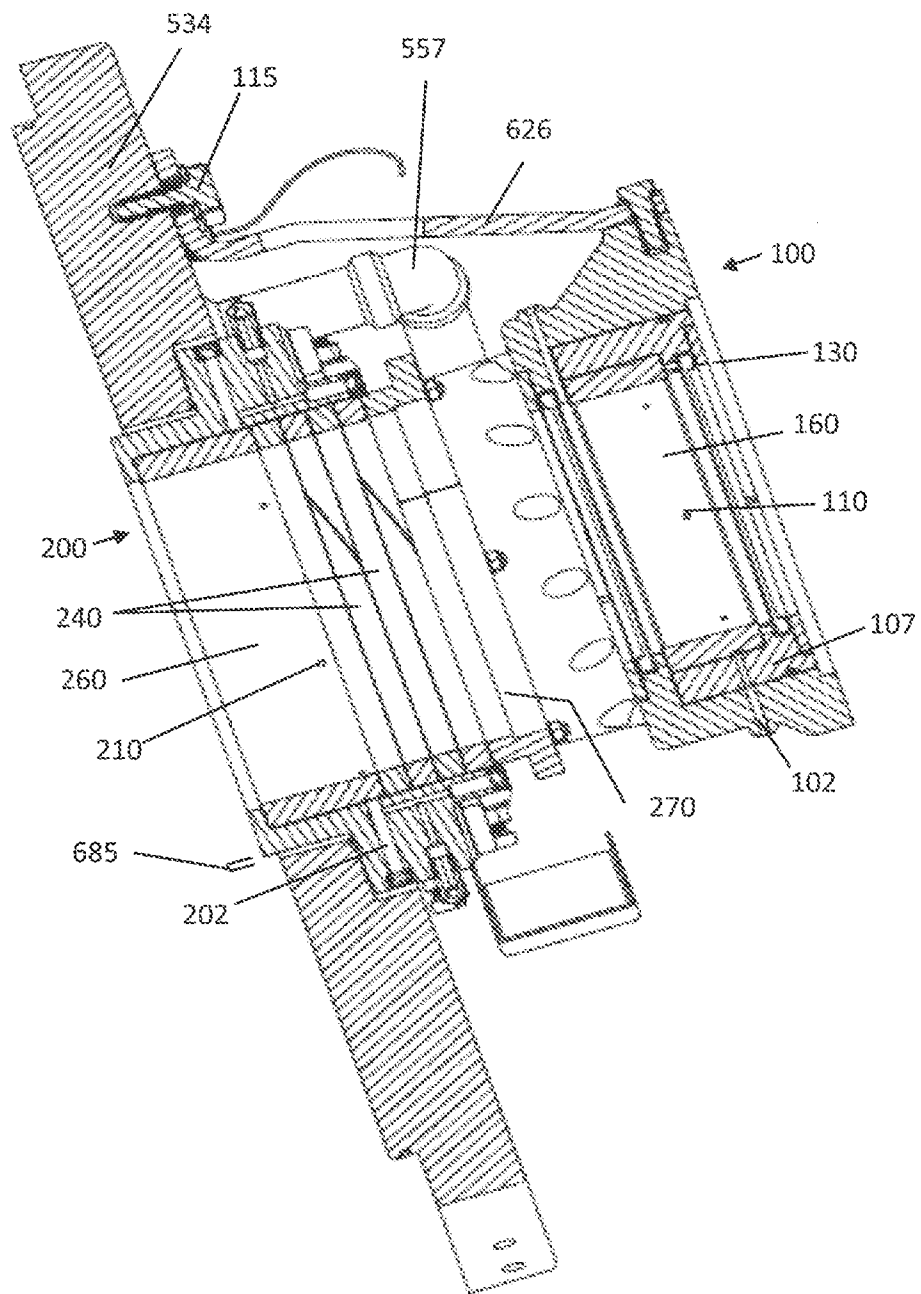


FIG. 6B

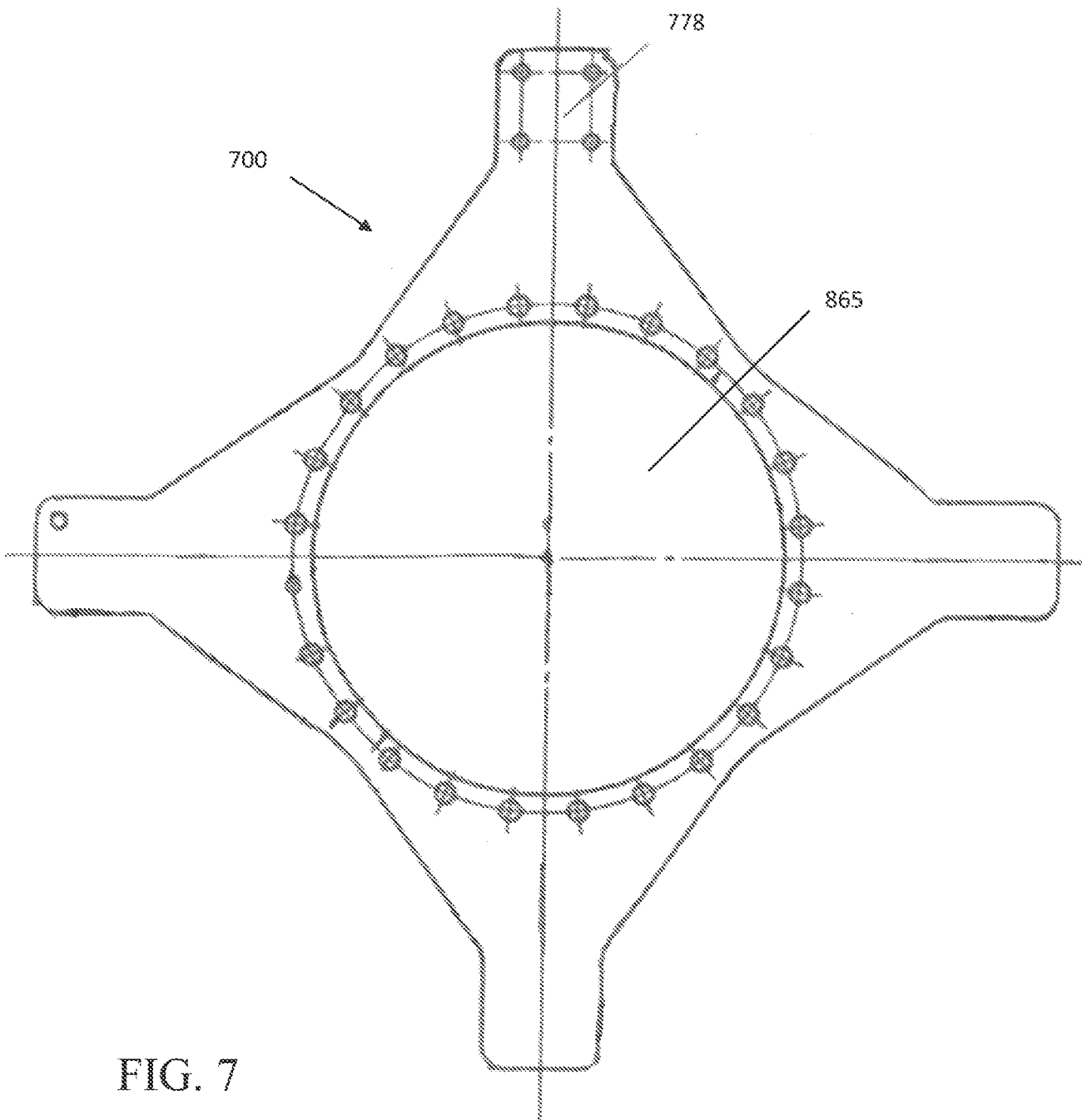


FIG. 7

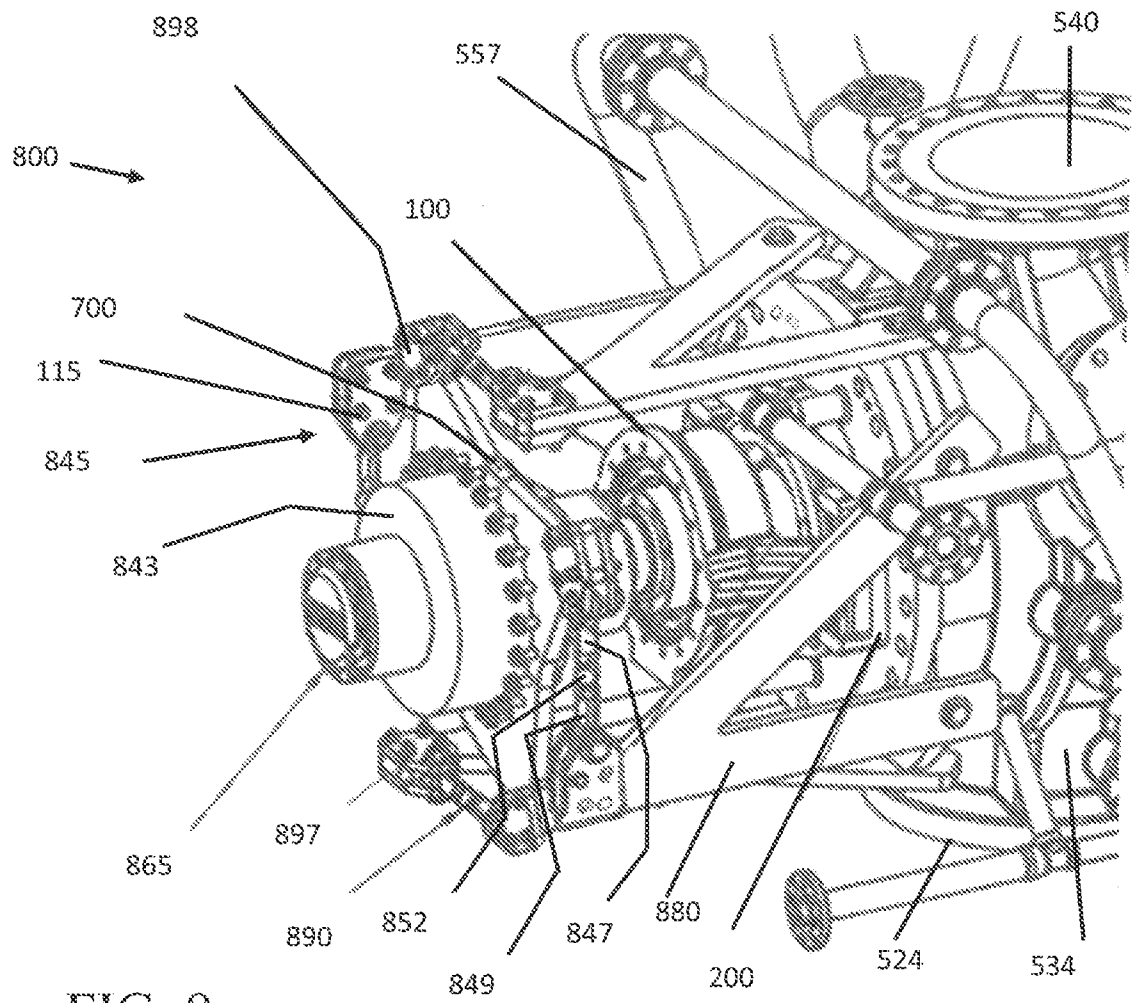


FIG. 8