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(71) Applicant: **EATON INTELLIGENT POWER LIMITED** [IE/IE]; 30 Pembroke Road, Dublin 4, D04 Y0C2 (IE).

(72) Inventors: **LIN, Thomas**; Room 301, Suite 6, Nr. 1765 Hongqiao road, Shanghai, 200336 (CN). **WEI, Tao**; No.955 Shengli Road, Pudong new district, Shanghai, 201201 (CN).

LIU, Xubo; Room 31-1601, No. 955, Xingyue East Road, Keqiao, District, Shaoxing City, Zhejiang Province (CN). **RAIMONDI, Emanuele**; via bussoleno 61, 10093 Collegno (IT). **ANDRISANI, Nicola**; Strada Decima 66, 10040 Cumiana, Turin (IT). **D'AMORE, Massimo**; Via Morsino 52, 10040 Almese, Turin (IT).

(74) Agent: **SCHWAN SCHORER & PARTNER MBB**; Bauerstrasse 22, 80796 München (DE).

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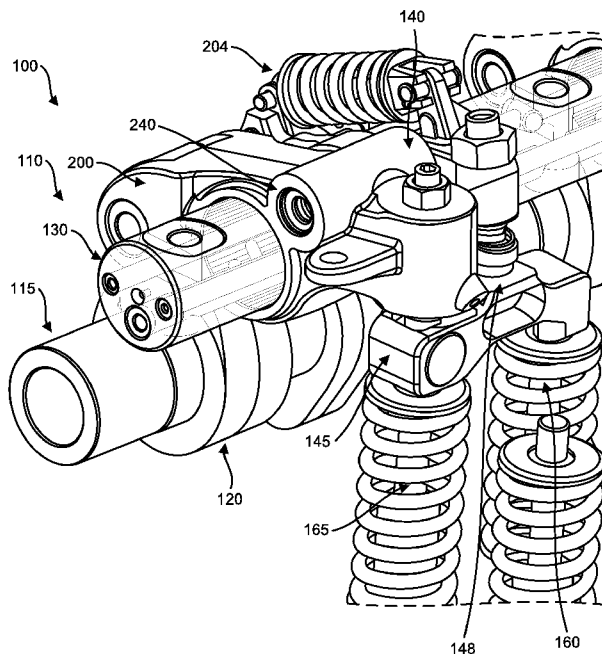


FIG. 1A

(57) **Abstract:** A rocker arm assembly is rotatable about a rocker shaft and includes a first portion and a second portion. The first portion is configured to receive a valve lift profile. The second portion is configured to operatively engage with one or more valves. The rocker arm assembly also includes an actuator assembly switchable between a first state and a second state, and a plunger assembly provided within a plunger bore and having a plunger axis angled to a longitudinal axis of the actuator assembly.



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Rocker Arm Assemblies for Engine Braking

PRIORITY

[0001] This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 63/493,680 filed 31 March 2023, and U.S. Provisional Patent Application No. 63/501,331 filed 10 May 2023, which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] This application relates to engine valvetrains, and more particularly to rocker arm assemblies for use in engine valvetrain assemblies to facilitate engine braking functions.

BACKGROUND

[0003] Internal combustion engines may include valvetrains, wherein, in particular configurations, engine valvetrains may include rocker arms for controlling the opening and closing of intake and/or exhaust valves.

[0004] Particular embodiments of engines may include an engine braking system that, when activated, can provide early and/or additional opening of an exhaust valve. For example, an exhaust valve may be additionally opened early when the piston in that cylinder may be near a top dead center (TDC) position of its compression stroke. By such opening of an exhaust valve by the engine braking system, compression gases may be released by compression release through the exhaust valve. This may cause an engine to function as a power consuming device, which may assist in slowing the vehicle.

SUMMARY OF PARTICULAR EMBODIMENTS

[0005] In particular embodiments, a rocker arm assembly is disclosed, the rocker arm assembly rotatable about a rocker shaft and including: a first portion configured to receive a valve lift profile; and a second portion configured to operatively engage with one or more valves based on the valve lift profile, the second portion including: an actuator assembly switchable between a first state and a second state, the actuator assembly including a valve mechanism actuated by a control member; and a plunger assembly having a plunger axis angled to a longitudinal axis of the actuator assembly, the plunger assembly including: an elongated member having a first end and a second end opposite the first end; a plunger pad slidably disposed at the first end of the elongated

member; and a lash adjustment mechanism associated with the second end of the elongated member, wherein the control member of the actuator assembly is hydraulically actuated to act on the valve mechanism, and wherein, based on an actuation of the actuator assembly, the plunger pad is selectively extendable relative to the elongated member along the plunger axis between a retracted position and an extended position.

[0006] In particular embodiments, which may combine the features of some or all of the above embodiments, the plunger assembly further includes: a collar secured to the plunger pad; and a plunger biasing member disposed between the first end of the elongated member and the collar, wherein the plunger biasing member is configured to bias the plunger pad toward the retracted position.

[0007] In particular embodiments, which may combine the features of some or all of the above embodiments, corresponding to the second state of the actuator assembly, an extending force based on hydraulic pressure acts to overcome a force associated with the plunger biasing member such that the plunger pad extends to the extended position. In particular embodiments, which may combine the features of some or all of the above embodiments, the plunger biasing member includes a spring.

[0008] In particular embodiments, which may combine the features of some or all of the above embodiments, an inner surface of the plunger pad includes a detent, and the elongated member of the plunger assembly further includes a locking assembly provided proximal to the first end and configured to engage with the detent.

[0009] In particular embodiments, which may combine the features of some or all of the above embodiments, corresponding to the second state of the actuator assembly, an extending force based on hydraulic pressure acts to overcome a detent force associated with the locking assembly engaging with the detent such that the plunger pad extends to the extended position.

[0010] In particular embodiments, which may combine the features of some or all of the above embodiments, the detent includes a groove, and wherein the locking assembly includes a protruding feature and a lock biasing member, the lock biasing member configured to bias the protruding feature toward the groove. In particular embodiments, which may combine the features of some or all of the above embodiments, the lock biasing member is disposed along a lock axis angled to the plunger axis. In particular embodiments, which may combine the features of some

or all of the above embodiments, the lash adjustment mechanism is accessible via an upper surface of the rocker arm assembly to facilitate lash adjustment of the plunger assembly.

[0011] In particular embodiments, which may combine the features of some or all of the above embodiments, the lash adjustment mechanism extends above the upper surface of the rocker arm assembly. In particular embodiments, which may combine the features of some or all of the above
5 embodiments, the longitudinal axis of the actuator assembly is oriented perpendicular to the plunger axis.

[0012] In particular embodiments, which may combine the features of some or all of the above embodiments, the second portion further includes a lost motion assembly configured to absorb at
10 least a portion of the valve lift profile. In particular embodiments, which may combine the features of some or all of the above embodiments, the lost motion assembly includes: a lost motion shaft movable within a bore provided along a longitudinal axis of the lost motion assembly; and a lost motion biasing member configured to bias the lost motion shaft toward the one or more valves.

[0013] In particular embodiments, which may combine the features of some or all of the above
15 embodiments, the longitudinal axis of the lost motion assembly is disposed parallel to the plunger axis of the plunger assembly. In particular embodiments, which may combine the features of some or all of the above embodiments, the first portion of the rocker arm assembly includes a roller configured to engage with a cam to receive at least a portion of the valve lift profile.

[0014] In particular embodiments, which may combine the features of some or all of the above
20 embodiments, corresponding to the first state of the actuator assembly, the valve mechanism is held open by the control member so that the plunger pad retracts to the retracted position. In particular embodiments, which may combine the features of some or all of the above embodiments, a rocker arm assembly, the valve mechanism includes a check valve biased against a hydraulic channel opening by a check valve biasing member.

[0015] In particular embodiments, which may combine the features of some or all of the above
25 embodiments, the control member includes a control pin biased against the check valve by a control biasing member, the control member movable along the longitudinal axis of the actuator assembly.

[0016] In particular embodiments, which may combine the features of some or all of the above
30 embodiments, a method of assembling a rocker arm assembly is disclosed, including: providing a plunger assembly proximal to a valve-engaging portion of the rocker arm assembly, the plunger

assembly including an elongated member, a plunger pad slidably disposed at a first end of the elongated member, and a lash adjustment mechanism associated with a second end of the elongated member disposed opposite the first end; providing a hydraulic actuator assembly connected in fluid communication with the plunger assembly such that a longitudinal axis of the hydraulic actuator assembly is angled to a plunger axis of the plunger assembly; and configuring the second end of the elongated member to be accessible via an upper surface of the rocker arm assembly to facilitate lash adjustment of the plunger assembly.

[0017] In particular embodiments, which may combine the features of some or all of the above embodiments, a valvetrain system is disclosed, including: a cam provided with a valve lift profile; one or more valves; a rocker shaft; and a rocker arm assembly rotatable about the rocker shaft, the rocker arm assembly including: a first portion configured to receive the valve lift profile; and a second portion configured to operatively engage with one or more of the valves based on the valve lift profile, the second portion including: an actuator assembly switchable between a first state and a second state, the actuator assembly including a valve mechanism actuated by a control member; and a plunger assembly having a plunger axis angled to a longitudinal axis of the actuator assembly, the plunger assembly including: an elongated member having a first end and a second end opposite the first end; a plunger pad slidably disposed at the first end of the elongated member; and a lash adjustment mechanism associated with the second end of the elongated member, wherein the control member of the actuator assembly is hydraulically actuated to act on the valve mechanism, and wherein, based on an actuation of the actuator assembly, the plunger pad is selectively extendable relative to the elongated member along the plunger axis between a retracted position and an extended position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The present invention will be described in greater detail below based on the exemplary figures. The invention is not limited to the exemplary embodiments. Other features and advantages of various embodiments of the present invention will become apparent by reading the following detailed description with reference to the attached drawings which illustrate the following:

[0019] FIG. 1A illustrates a schematic partial perspective view of an engine valvetrain assembly, according to particular embodiments.

[0020] FIG. 1B illustrates a cross-sectional enlarged view of the engine valvetrain assembly of FIG. 1A.

[0021] FIG. 1C illustrates a schematic cross-sectional partial front view of an engine valvetrain assembly, with a plunger pad of a plunger assembly in a retracted position, according to particular embodiments.

[0022] FIG. 1D illustrates a schematic view of the engine valvetrain assembly of FIG. 1C, with the plunger pad in an extended position.

[0023] FIG. 2A illustrates a schematic cross-sectional perspective view of an exemplary plunger assembly, with a plunger pad in a retracted position, according to particular embodiments.

[0024] FIG. 2B illustrates a schematic view of the exemplary plunger assembly of FIG. 2A, with the plunger pad in an extended position.

[0025] FIG. 2C illustrates a schematic cross-sectional perspective view of a rocker arm assembly, according to particular embodiments.

[0026] FIG. 3A illustrates a schematic perspective view of a rocker arm assembly, according to particular embodiments.

[0027] FIG. 3B illustrates a schematic cross-sectional side view of the rocker arm assembly of FIG. 3A.

[0028] FIG. 4A illustrates a schematic cross-sectional side view of a plunger assembly, according to particular embodiments.

[0029] FIG. 4B illustrates a schematic cross-sectional front view of the plunger assembly of FIG. 4A.

[0030] FIG. 4C illustrates a schematic cross-sectional side view of a plunger assembly, according to particular embodiments.

[0031] FIG. 4D illustrates a schematic cross-sectional side view of a plunger assembly, according to particular embodiments.

[0032] FIG. 4E illustrates a schematic exploded perspective view of particular plunger assembly components, according to particular embodiments.

[0033] FIG. 5A illustrates a schematic cross-sectional top view of an actuator assembly, according to particular embodiments.

[0034] FIG. 5B illustrates a schematic cross-sectional top view of an actuator assembly, according to particular embodiments.

[0035] FIG. 5C illustrates a schematic exploded perspective view of particular actuator assembly components, according to particular embodiments.

[0036] FIG. 6A illustrates a schematic perspective view of a hydraulic supply system of an engine valvetrain assembly, according to particular embodiments.

[0037] FIG. 6B illustrates a schematic perspective view of a hydraulic supply system of an exemplary rocker arm assembly, according to particular embodiments.

5 [0038] FIG. 7A illustrates a schematic cross-sectional side view of an exemplary rocker arm assembly, depicting hydraulic supply to an actuator assembly, according to particular embodiments.

[0039] FIG. 7B illustrates a schematic cross-sectional view of an exemplary rocker arm assembly, depicting hydraulic supply to a plunger assembly, according to particular embodiments.

10 [0040] FIG. 8A illustrates an actuator assembly in a first state, according to particular embodiments.

[0041] FIG. 8B illustrates a plunger assembly in a retracted position, according to particular embodiments.

15 [0042] FIG. 9A illustrates an actuator assembly in a second state, according to particular embodiments.

[0043] FIG. 9B illustrates a plunger assembly in an extended position, according to particular embodiments.

[0044] It should be noted that figures provided may be illustrated schematically rather than literally or precisely; components and aspects of the figures may also not necessarily be to scale. Moreover, while like reference numerals may designate corresponding parts throughout the different views in many cases, like parts may not always be provided with like reference numerals in each view.

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DESCRIPTION OF EXAMPLE EMBODIMENTS

[0045] In accordance with various embodiments of the present disclosure, rocker arm assemblies and related mechanisms, devices, and methodologies are provided herein. While this disclosure may include particular embodiments having specific features and combinations of features as well as particular use cases to provide a better understanding, it will be appreciated that this disclosure is not limited to these particular exemplary embodiments or use cases.

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[0046] In particular embodiments, engine valvetrains may include rocker arms for controlling the opening and closing of intake and/or exhaust valves of an engine. In particular embodiments, a rocker arm may comprise a reciprocating body that may translate rotational motion, such as from

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a cam lobe of a rotating camshaft lobe, into motion that can control the opening and closing of a valve. In particular embodiments, a rocker arm may be configured to rotate about a rocker shaft.

[0047] In particular embodiments, a rocker arm assembly may comprise a first portion configured to receive a valve lift profile. By way of example and not limitation, a first portion may
5 comprise a cam end suitably configured and/or provided in direct or indirect contact with one or more rotating cams to receive a valve lift profile. By way of example and not limitation, a first portion of the rocker arm assembly may be operatively engaged with a cam lobe of a rotating camshaft lobe, such as via rollers, tappets, pushrods, etc.

[0048] In particular embodiments, a rocker arm assembly may comprise a second portion
10 suitably configured to operatively engage with one or more valves based on the valve lift profile received by the first portion. By way of example and not limitation, a second portion of a rocker arm assembly may comprise a valve end or portion and configured to directly or indirectly (e.g., via a valve bridge, sliding pin, swinging and/or connecting platform) interface with one or more valves of the engine.

[0049] In particular embodiments, engine valvetrains in general, and rocker arm assemblies in particular, may be configured to enable particular desirable functions of engine operation. By way of example and not limitation, particular embodiments of engine valvetrains may include an engine braking system that, when activated, can provide early and/or additional opening of an exhaust valve during an engine cycle relative to a normal (i.e., engine braking off, or drive mode) operation,
20 thereby providing a capability to decelerate the vehicle. In particular embodiments, particular subsets of exhaust valves of an engine-braking capable valvetrain may be designated as engine braking valves. In particular embodiments, engine braking valves may be switchably engaged to perform normal exhaust valve operation (when drive mode, i.e., engine braking off mode, is engaged), or operate under specific valve timing protocols to provide engine braking (when engine
25 braking mode is engaged).

[0050] In particular embodiments, an engine cylinder configured for engine braking may be equipped with an integrated engine braking rocker arm, wherein the rocker arm may be configured to actuate both (non-braking) exhaust valves and engine braking valves. By way of example and not limitation, an integrated engine braking rocker arm may apply an engine braking valve lift
30 profile to engine braking valves when an engine braking mode is engaged, and apply a normal exhaust valve lift profile when in drive mode. In particular embodiments, an engine cylinder

configured for engine braking may be equipped with dedicated engine braking rocker arms configured for actuating engine braking valves. In particular embodiments, a dedicated engine braking rocker arm may actuate engine braking valves only. In particular embodiments, a dedicated engine braking rocker arm may only actuate the engine braking valves when an engine
5 braking mode is engaged.

[0051] While particular embodiments of features, combinations of features, illustrations and/or applications of rocker arm assemblies are described herein as non-limiting examples to provide a better understanding, this disclosure contemplates any suitable combinations and/or applications of features described herein. By way of example and not limitation, applications of
10 features disclosed are not limited to engine braking applications. By way of example and not limitation, aspects of plunger assembly features disclosed herein do not require combination with actuator assemblies of any kind, and are fully contemplated as such. By way of example and not limitation, one or more features disclosed herein are contemplated in the context of both integrated rocker arm assemblies and dedicated rocker arm assemblies, as well as other suitable rocker arm
15 configurations, in any suitable combination.

[0052] With reference to the figures, **FIG. 1A** illustrates a schematic partial perspective view of an engine valvetrain assembly, according to particular embodiments. **FIG. 1B** illustrates a cross-sectional enlarged view of the engine valvetrain assembly of FIG. 1A. In particular embodiments, rocker arm assembly 200 may be configured to be rotatable about a rocker shaft 130 provided
20 within a rocker bore 132. As illustrated in FIGs. 1A and 1B by way of non-limiting example, a valvetrain assembly 100 can include a rocker arm assembly 200 having a first portion 110 configured to receive a valve lift profile. In particular embodiments, first portion 110 may be configured to receive a valve lift profile from a suitable assembly. By way of example and not limitation, first portion 110 may receive a valve lift profile from a cam 120, via a roller mechanism
25 125, such as illustrated in FIG. 1B. By way of example and not limitation, first portion 110 may be configured to receive a valve lift profile via a pushrod mechanism (not shown).

[0053] In particular embodiments, rocker arm assembly 200 can comprise a second portion 140 configured to operatively engage, based on the valve lift profile received by rocker arm assembly 200, with one or more of a plurality of valves of valvetrain assembly 100.

[0054] In particular embodiments, such as illustrated in FIGs. 1A and 1B by way of example and not limitation, rocker arm assembly 200 may be configured as a dedicated exhaust rocker arm

assembly. By way of example and not limitation, in particular configurations wherein a rocker arm assembly 200 may be configured as a dedicated exhaust rocker arm assembly, rocker arm assembly 200 can be configured to operatively engage with a specific subset of exhaust valves, such as engine braking valve 165. By way of example and not limitation, in particular configurations wherein a rocker arm assembly 200 may be configured as a dedicated exhaust rocker arm, each cylinder may be additionally provided with a separate exhaust rocker arm assembly, such as exhaust rocker arm assembly 204, to facilitate normal non-engine braking related exhaust valve operation. By way of example and not limitation, exhaust rocker arm assembly 204 where present can be configured to act on multiple exhaust valves, such as both the main exhaust valve 160 as well as engine braking valve 165, via a suitable mechanism, such as a common central portion 148 of valve bridge 145. In particular embodiments, rocker arm assembly 200 may be configured to operatively engage with engine braking valve 165 via a suitable mechanism, such as a swinging pin mechanism 155 (illustrated in FIGs. 1A and 1B by way of non-limiting example), or a sliding pin 150 (illustrated in FIG. 9B by way of non-limiting example).

[0055] By way of example and not limitation, sliding pin 150, swinging pin mechanism 155, and/or other suitable mechanisms may be configured to permit a suitable plunger of rocker arm assembly 200 to engage with engine braking valve 165 without affecting normal operation of main exhaust valve 160 and/or valve bridge 145. In particular embodiments, sliding pin 150, swinging pin mechanism 155, and/or other suitable mechanisms may be configured to maintain valve bridge 145 in a horizontal, parallel, and/or other desirable orientation, such as to permit a plunger of rocker arm assembly 200 to engage with engine braking valve 165 without inadvertently applying valve lift to main exhaust valve 160, and/or otherwise causing undesirable friction, stress, fatigue, and/or wear on the valvetrain.

[0056] In particular embodiments, rocker arm assembly 200 may comprise a plunger assembly 210. In particular embodiments, plunger assembly 210 may be configured as a switchable plunger assembly 210. In particular embodiments, plunger assembly 210 may comprise a suitable plunger interface to engage with a valve interface. By way of example and not limitation, a suitable plunger interface may comprise a plunger pad 220. In particular embodiments, rocker arm assembly 200 may comprise an actuator assembly 240 configured to switchably facilitate movement of a plunger surface (e.g., extension and/or retraction between a first position and a second position), such as of plunger pad 220 of plunger assembly 210.

[0057] FIG. 1C illustrates a schematic cross-sectional partial front view of an engine valvetrain assembly, with a plunger pad of a plunger assembly in a retracted position, according to particular embodiments. FIG. 1D illustrates a schematic view of the engine valvetrain assembly of FIG. 1C, with the plunger pad in an extend position.

5 [0058] FIG. 2A illustrates a schematic cross-sectional perspective view of an exemplary plunger assembly, with a plunger pad in a retracted position, according to particular embodiments. FIG. 2B illustrates a schematic view of the exemplary plunger assembly of FIG. 2A, with the plunger pad in an extended position.

[0059] It will be appreciated that while particular figures may illustrate specific embodiments of plunger assembly 210 and/or actuator assembly 240, either alone, or in combination with each other, or in combination with other rocker arm and/or valvetrain assembly elements, any suitable embodiments and/or combinations are fully contemplated herein. By way of example and not limitation, FIG. 2A and 2B may depict a different embodiment of plunger assembly 210 relative to FIG. 2C, or FIG. 4C; such distinctions are not to read as limiting particular features, combinations, and/or applicability of any embodiment(s). By way of another non-limiting example, an embodiment of plunger assembly 210 may be deployed in a rocker arm assembly 200 lacking a lost motion assembly (such as illustrated in FIGs. 2A and 2B), or it may be deployed in combination with a lost motion assembly 270 (such as illustrated in FIGs. 3A and 3B).

10 [0060] In particular embodiments, plunger assembly 210 may comprise a selectively extendable plunger pad 220. In particular embodiments, plunger pad 220 may be extendable between a retracted position (away from a valve interface) and an extended position (toward a valve interface), such as based on an actuation of actuator assembly 240. In particular embodiments, rocker arm assembly 200 can be configured so that, based on energizing and/or suitable actuation by actuator assembly 240 when an engine braking mode is enabled, plunger pad 220 of plunger assembly 210 can extend to operatively engage with engine braking valve 165. In particular embodiments, in an extended position, plunger pad 220 may be configured to be substantially stiff, i.e., to support and resist a force received from contact with a corresponding valve interface. By way of example and not limitation, plunger pad 220 in an extended position, which may correspond to an energized, or on, actuator assembly 240 configuration and an engine braking mode, may be configured to contact swinging pin mechanism 155 or sliding pin 150 to transfer at least a portion of a received valve lift profile to engine braking valve 165.

[0061] In particular embodiments, rocker arm assembly 200 can be configured so that, based on de-energizing and/or suitable actuation by actuator assembly 240 when an engine braking mode is disabled (i.e., in engine braking off or drive mode), plunger pad 220 of plunger assembly 210 can retract and/or soften, collapse, and/or become compliant, so as to not exert and/or support forces relative to engine braking valve 165. In particular embodiments, in a retracted position, plunger pad 220 may be configured to be substantially collapsed, soft, and/or compliant, i.e., unable support and/or resist forces due to contact with a corresponding valve interface. By way of example and not limitation, plunger pad 220 in a retracted position, which may correspond to a de-energized, or off, actuator assembly configuration and a normal or drive mode (engine braking off), may be configured to collapse under contact with swinging pin mechanism 155 or sliding pin 150.

[0062] In particular embodiments, plunger assembly 210 may comprise an elongated member, such as shaft 214. In particular embodiments, plunger pad 220 may be slidably disposed at an end of shaft 214. By way of example and not limitation, plunger pad 220 may comprise a cavity, such as chamber 230, such that a suitably formed portion of shaft 214 may fit within the cavity. In particular embodiments, shaft 214 may be fixed in place, such as with a nut 212. In particular embodiments, such as illustrated by way of non-limiting example in at least FIGs. 1B, 1C, 2A, and 4D, and 8B, corresponding to a retracted position of plunger assembly 210, plunger pad 220 may slide over fixed shaft 214 away from a valve interface. In particular embodiments, such as illustrated by way of non-limiting example in at least FIGs. 1D, 2B, and 9B, corresponding to an extended position of plunger assembly 210, plunger pad 220 may slide over fixed shaft 214 toward a valve interface.

[0063] FIG. 2C illustrates a schematic cross-sectional perspective view of a rocker arm assembly, according to particular embodiments.

[0064] In particular embodiments, plunger assembly 210 may comprise a plunger axis (P.A.) associated with a longitudinal axis of shaft 214, and/or an axis of motion of plunger pad 220. In particular embodiments, actuator assembly 240 may comprise an actuator axis (A.A.) associated with a longitudinal axis of actuator assembly 240. In particular embodiments, such as illustrated by way of non-limiting example in at least FIGs. 2A-2C and 3A, a plunger axis of plunger assembly 210 may be angled, and/or non-parallel, to a longitudinal axis of actuator assembly 240.

By way of example and not limitation, an actuator axis of actuator assembly 240 may be provided at right angles to a plunger axis of plunger assembly 210.

[0065] In particular embodiments, a lash adjustment mechanism may be associated with an end of the elongated member of plunger assembly 210. By way of example and not limitation, a lash adjustment mechanism may be associated with a second end of shaft 214, which may be provided opposite to a first end configured to engage and/or operatively connect with plunger pad 220. In particular embodiments, a first end of shaft 214 may be adjustable for calibration, maintenance, and/or adjustment (e.g., lash adjustment) based on temporarily loosening nut 212 to set a desired longitudinal position of shaft 214 within a bore of plunger assembly 210. In particular embodiments, the lash adjustment mechanism is accessible via an upper surface of the rocker arm assembly 200, for e.g., to facilitate lash adjustment of the plunger assembly 210. By way of example and not limitation, the lash adjustment mechanism may extend above the upper surface of the rocker arm assembly, e.g., for easy access and maintenance.

[0066] FIG. 3A illustrates a schematic perspective view of a rocker arm assembly, according to particular embodiments. FIG. 3B illustrates a schematic cross-sectional side view of the rocker arm assembly of FIG. 3A. In particular embodiments, such as illustrated in FIGs. 3A and 3B by way of non-limiting example, rocker arm assembly 200 may be configured as an integrated rocker arm assembly. By way of example and not limitation, a rocker arm assembly 200 configured as an integrated rocker arm assembly may be configured to actuate multiple exhaust valves (e.g., main exhaust valve 160 and engine braking valve 165) for non-engine braking exhaust valve operation, as well as selectively actuate a particular engine-braking related exhaust valve (e.g., only engine braking valve 165) based on engine braking valve lift protocols when engine braking mode is engaged. In particular embodiments, such as when configured as an integrated engine braking rocker arm, rocker arm assembly 200 may comprise a lost motion assembly 270.

[0067] In particular embodiments, lost motion assembly 270 may comprise one or more shafts, and/or a screw coupled to a shaft. By way of example and not limitation, lost motion assembly 270 may comprise a screw 274 and a lost motion shaft 278 provided within a bore of lost motion assembly 270. In particular embodiments, screw 274 may comprise an adjustable lash screw. In particular embodiments, screw 274 may be coupled to a nut 272. In particular embodiments, lost motion assembly 270 may be provided with a lost motion biasing member 276. By way of example and not limitation, biasing member 276 may comprise a spring. By way of example and not

limitation, biasing member 276 may be used to absorb at least a portion of a valve lift profile received by rocker arm assembly 200. In particular embodiments, lost motion shaft 278 may comprise a valve end configured to directly or indirectly engage with one or more valves. In particular embodiments, a valve end of lost motion shaft 278 may be configured to engage with a valve bridge, such as valve bridge 145 (for e.g., a central portion 148). In particular embodiments, a valve end of lost motion shaft 278 may comprise a suitable interface, such as a plunger end, plunger pad, and/or an E-foot, e.g., E-foot 280.

[0068] In particular embodiments of lost motion assembly 270, such as depicted in FIGs. 3A and 3B as a non-limiting illustrative example, lost motion shaft 278 may be configured to translate along a longitudinal lost motion axis (L.M.A.) of lost motion assembly 270.

[0069] In particular embodiments, such as in embodiments of rocker arm assembly 200 configured as an integrated rocker arm assembly, a plunger assembly 210 configured to be switchable based on actuator assembly 240 may be combined with a lost motion assembly 270 to selectively add, subtract, and/or engage with main exhaust valve 160 and engine braking valve 165 based on a received valve profile, so that a separate exhaust rocker arm assembly 204 is not required for exhaust valve operation. In particular embodiments, rocker arm assembly 200 may be configured to receive a valve lift profile (e.g., from a cam) comprising a composite valve profile. By way of example and not limitation, a composite valve profile can include a combination of valve lifts intended to operate a specific one or both of main exhaust valve 160 and engine braking valve 165, based on a selected mode (e.g., engine braking or drive). In particular embodiments, a composite valve profile may comprise a normal or main exhaust valve profile as well as an engine braking valve profile.

[0070] By way of example and not limitation, such as in an exemplary integrated engine braking rocker arm, a rocker arm assembly 200 may receive a valve lift profile comprising a main lift section, modified approach and/or descent sections (i.e., on and off ramps) of a main lift section based on engine braking requirements, and/or one or more discrete engine braking lift sections. In particular embodiments, rocker arm assembly 200 may be configured so that lost motion assembly 270 can absorb portions of a composite valve lift profile corresponding to engine braking operation, and transfer only portions of the composite valve lift profile needed for normal exhaust valve operation (i.e., non-engine braking operation, also called drive mode). In particular embodiments, lost motion assembly 270 may be configured to act on valve bridge 145 to operate

both main exhaust valve 160 and engine braking valve 165. Accordingly, in particular embodiments, lost motion assembly 270 may be configured to receive a composite valve lift profile, absorb portions of the profile corresponding to engine braking, and impart a valve lift profile corresponding to normal exhaust valve operation to both exhaust valves. In particular
5 embodiments, such as described herein with respect to embodiments of rocker arm assembly 200 configured as a dedicated rocker arm assembly, plunger pad 220 may be actuated by actuator assembly 240 to selectively engage with engine braking valve 165 when engine braking mode is enabled.

[0071] In particular embodiments, a lost motion axis of lost motion assembly 270 may be
10 oriented parallel to a plunger axis of plunger assembly 210.

[0072] **FIG. 4A** illustrates a schematic cross-sectional side view of a plunger assembly, according to particular embodiments. **FIG. 4B** illustrates a schematic cross-sectional front view of the plunger assembly of FIG. 4A.

[0073] In particular embodiments of plunger assembly 210, contact of plunger pad 220 with a
15 corresponding valve interface, such as swinging pin mechanism 155 or sliding pin 150, can apply significant forces, loads, shocks, impulses, and/or wear on plunger assembly 210. While such contact may be needed when plunger pad 220 is extended based on energizing or switching on actuator assembly 240, in particular embodiments, incidental contact between plunger pad 220 and a corresponding valve interface may continue to occur when plunger pad 220 is in a collapsed or
20 soft state based on de-energizing actuator assembly 240, as such embodiments may lack a positive means to sufficiently constrain, support, and/or hold plunger pad 220 in a retracted position when plunger pad 220 is collapsed or soft.

[0074] In particular embodiments of plunger assembly 210, such as illustrated in at least FIGs. 4A-4E, plunger assembly 210 may comprise particular mechanisms to secure, constrain, support,
25 and/or hold plunger pad 220 in a retracted position when plunger pad 220 is collapsed, or soft. In particular embodiments, such plunger securing mechanisms may be configured to release and/or permit extension of plunger pad 220 based on actuator assembly 240, such as due to an extending force applied by actuator assembly 240 when it is energized, or switched on.

[0075] In particular embodiments of plunger assembly 210, a first end of shaft 214 configured
30 to operatively engage with plunger pad 220 may comprise a locking assembly. By way of example and not limitation, a locking assembly of plunger assembly 210 may comprise one or more

extendable and/or protruding locking features, such as one or more lock balls 216. By way of example and not limitation, lock balls 216, or other suitable locking features, may be biased outward from the first end of shaft 214, and/or toward a corresponding receiving feature of plunger pad 220, by one or more lock biasing members.

5 [0076] FIG. 4C illustrates a schematic cross-sectional side view of a plunger assembly, according to particular embodiments. By way of example and not limitation, a lock biasing member may comprise one spring 218 (such as illustrated in the embodiment of FIG. 4A). By way of example and not limitation, a lock biasing member may comprise multiple springs (for e.g., two
10 springs 218 as illustrated in the embodiment of FIG. 4C). In particular embodiments, each of one or more lock biasing members may be disposed along a lock axis (L.A.) angled to the plunger axis (P.A.) of plunger assembly 210. By way of example and not limitation, such as illustrated in FIG. 4A, a lock axis of plunger assembly 210 may be oriented perpendicular to the plunger axis.

[0077] In particular embodiments of plunger assembly 210, an inner surface of plunger pad 220 may comprise a receiving feature configured to engage with and/or receive a corresponding
15 locking feature of a locking assembly associated with shaft 214. By way of example and not limitation, such as illustrated in FIGs. 4A and 4B, an inner surface of plunger pad 220 may comprise a detent, such as groove 219.

[0078] In particular embodiments of plunger assembly 210, a locking assembly may be configured so that one or more suitable locking features and/or receiving features distributed
20 between shaft 214 and plunger pad 220 engage to retain plunger pad 220 in a retracted position with actuator assembly 240 is de-energized and/or in an off state, but released when actuator assembly 240 is energized or on to permit plunger pad 220 to extend to an extended position. By way of example and not limitation, an extending force associated with energizing or switching on actuator assembly 240 may be configured to apply a force sufficient to overcome a locking and/or
25 retaining force applied by a locking assembly of plunger assembly 210 for temporarily holding plunger pad 220 at a retracted position when actuator assembly 240 is off, thereby permitting plunger pad 220 to extend to an extended position.

[0079] In particular embodiments, plunger assembly 210 may comprise a clip 222, such as to provide a longitudinal constraint or limit to an extension of plunger pad 220. In particular
30 embodiments, plunger assembly 210 may comprise one or more shims, such as shim 224, such as to adjust one or more longitudinal travel limits of plunger pad 220.

[0080] FIG. 4D illustrates a schematic cross-sectional side view of a plunger assembly, according to particular embodiments. FIG. 4E illustrates a schematic exploded perspective view of particular plunger assembly components, according to particular embodiments.

[0081] In particular embodiments of plunger assembly 210, such as depicted in FIG. 4D by way of non-limiting example, plunger assembly 210 may comprise a plunger biasing member 226. In particular embodiments, plunger biasing member 226 may be configured to bias plunger pad 220 toward a retracted position. By way of example and not limitation, plunger biasing member 226 may comprise a spring. In particular embodiments, plunger assembly 210 may comprise a suitable retaining feature, such as collar 221, configured to support and/or retain plunger biasing member 226. In particular embodiments, plunger biasing member 226 may be disposed between a first end (proximal to plunger pad 220) of an elongated member (e.g., shaft 214) of plunger pad 220, and a retaining feature of plunger biasing member 226 (e.g., collar 221). In particular embodiments of plunger assembly 210, an extending force applied based on actuator assembly 240 being energized or switched on may be sufficient to overcome a biasing force applied by plunger biasing member 226 to bias and/or retain plunger pad 220 in a retracted position.

[0082] It will be appreciated that while particular plunger securing mechanisms may be illustrated herein in combination with particular type(s) of actuator assemblies and/or actuator assembly 240 as non-limiting examples, the features and functions of any plunger securing assemblies disclosed herein are fully contemplated in the context of securing a plunger of any suitable kind, and/or for any suitable application, which are not limited to particular type(s) of plunger mechanisms or capsules, or to engine valvetrains, and/or to engine braking applications.

[0083] In particular embodiments, actuator assembly 240 may be switchable between a first state and a second state. In particular embodiments, a first state of actuator assembly 240 may correspond to a de-energized and/or off state of actuator assembly 240. In particular embodiments, a second state of actuator assembly 240 may correspond to an energized and/or on state of actuator assembly 240. In particular embodiments, actuator assembly 240 may comprise a valve mechanism. In particular embodiments, actuator assembly 240 may comprise a control member, for e.g., to engage with a valve mechanism.

[0084] In particular embodiments, actuator assembly 240 may comprise a suitable actuation mechanism configured to selectively extend and retract a plunger assembly, such as plunger pad 220 of plunger assembly 210. In particular embodiments, actuator assembly 240 may comprise an

electromagnetically actuated assembly configured (for e.g., using a solenoid) to selectively extend and retract plunger pad 220 of plunger assembly 210. While particular actuator assemblies may be described in greater detail herein as non-limiting illustrations, this disclosure fully contemplates any suitable actuator assembly for performing the functions disclosed herein.

5 [0085] In particular embodiments, actuator assembly 240 may comprise a hydraulically actuated assembly configured to selectively extend and retract plunger pad 220 of plunger assembly 210. In particular embodiments, a control member of actuator assembly 240 may be hydraulically actuated to act on a valve mechanism of actuator assembly 240.

[0086] FIG. 5A illustrates a schematic cross-sectional top view of an actuator assembly, according to particular embodiments. FIG. 5B illustrates a schematic cross-sectional top view of an actuator assembly, according to particular embodiments. FIG. 5C illustrates a schematic exploded perspective view of particular actuator assembly components, according to particular embodiments.

15 [0087] In particular embodiments, actuator assembly 240 may be formed and/or assembled within a bore or cavity of rocker arm assembly 200. In particular embodiment, actuator assembly 240 may be contained within rocker arm assembly 200 after modular assembly, such as using a locking screw 245.

[0088] In particular embodiments, actuator assembly 240 may comprise an upper chamber 242. In particular embodiments, actuator assembly 240 (e.g., upper chamber 242) may be connected in fluid communication to a controllable high pressure hydraulic fluid line, such as through hydraulic supply inlet 260. In particular embodiments, actuator assembly 240 may comprise a lower chamber 244. In particular embodiments, lower chamber 244 may be controllably separated from upper chamber 242, such as by a check valve 246. In particular embodiments, check valve 246 may comprise a check valve housing 247. In particular embodiments, actuator assembly 240 (e.g., lower chamber 244) may be connected in fluid communication to plunger assembly 210, such as via hydraulic actuation passage 264.

25 [0089] In particular embodiments, check valve 246 may comprise a check ball 248, or other suitable valve member. In particular embodiments, check ball 248 may be supported by a check ball retainer 249. By way of example and not limitation, check ball 248 may be biased (e.g., by ball biasing member 254) against a flow passage of check valve 246, such that check ball 248 may act to close the flow passage unless check ball 248 is externally acted upon.

[0090] In particular embodiments, plunger assembly 210 may comprise a control member, such as control pin 250. In particular embodiments, control pin 250 may be supported by a retainer 256. In particular embodiments, control pin 250 may be positionally constrained and/or adjusted, such as by clip 258. In particular embodiments, control pin 250 may be biased by a control pin
5 biasing member 252 toward check ball 248. In particular embodiments, control pin biasing member 252 may comprise a spring. In particular embodiments, ball biasing member 254 may comprise a spring. In particular embodiments, a longitudinal axis of actuator assembly 240 may be oriented along an axis of motion of control pin 250.

[0091] **FIG. 6A** illustrates a schematic perspective view of a hydraulic supply system of an
10 engine valvetrain assembly, according to particular embodiments. **FIG. 6B** illustrates a schematic perspective view of a hydraulic supply system of an exemplary rocker arm assembly, according to particular embodiments.

[0092] **FIG. 7A** illustrates a schematic cross-sectional side view of an exemplary rocker arm
assembly, depicting hydraulic supply to an actuator assembly, according to particular
15 embodiments. **FIG. 7B** illustrates a schematic cross-sectional view of an exemplary rocker arm assembly, depicting hydraulic supply to a plunger assembly, according to particular embodiments.

[0093] In particular embodiments, hydraulic supply inlet 260 of actuator assembly 240 may be connected to, and supplied by, a hydraulic supply passage, such as engine hydraulic supply
20 passage 262 depicted in at least FIGs. 6B and 7A. In particular embodiments, in turn, engine hydraulic supply passage 262 may connect to a controlled hydraulic fluid line 330.

[0094] In particular embodiments, such as illustrated in FIG. 6A by way of non-limiting
example, one or more oil control valves 320 (OCVs) of an exemplary hydraulic supply system 300
of an engine may be provided to receive a pressurized hydraulic fluid line 310, and controllably
connect (by opening) or disconnect (by closing) the pressurized supply from pressurized hydraulic
25 fluid line 310 to controlled hydraulic fluid line 330. In particular embodiments, therefore, a
hydraulic embodiment of actuator assembly 240 may be energized, or switched on, by using one
or more oil control valves 320 to suitably supply pressurized hydraulic fluid to that actuator
assembly 240, and de-energized, or switched off, by closing corresponding oil control valves 320
to deprive supply of pressurized hydraulic fluid to that actuator assembly 240.

[0095] By way of example and not limitation, particular hydraulic embodiments of actuator assembly 240 may energized or switched on to engage an engine braking mode, and de-energized or switched off to disengage engine braking and change to drive mode.

[0096] In particular embodiments, as depicted in FIG. 7B by way of non-limiting example, actuator assembly 240 (e.g., lower chamber 244) may be connected in fluid communication to plunger assembly 210, such as via hydraulic actuation passage 264. By way of example and not limitation, although certain features of FIGs. 4A and 4B are not limited to hydraulically actuated operation, other features depicted therein may be used to illustrate hydraulic operation of plunger assembly 210 embodiments.

[0097] In particular embodiments, when plunger assembly 210 receives pressurized hydraulic fluid from an energized, or on, actuator assembly 240 via hydraulic actuation passage 264 (depicted in FIG. 4A), chamber 230 is filled with the pressurized fluid. In particular embodiments, plunger assembly 210 may comprise one or more hydraulic channels 228, as depicted in FIG. 4B by way of non-limiting example, to permit pressurized hydraulic fluid, when provided by actuator assembly 240, to act on an inner surface of plunger pad 220 with an extending force, such that plunger pad 220 may be forced to extend toward a valve interface. In particular embodiments, when a supply of pressurized hydraulic fluid is terminated, such as by de-energizing or switching off actuator assembly 240, any remaining hydraulic fluid is free to flow and return via hydraulic channels 228 and/or through hydraulic actuation passage 264, such that plunger pad 220 is free to return to its retracted position. In particular embodiments, contact and/or receipt of force from a valve interface (e.g., swinging pin mechanism 155 or sliding pin 150) may act to accelerate removal of residual hydraulic fluid in plunger assembly 210 following de-energizing of actuator assembly 240. As discussed elsewhere, in particular embodiments, when actuator assembly 240 is de-energized or switched off, plunger assembly 210 may be configured via biasing and/or securing mechanisms to further induce plunger pad 220 toward a retracted position, and/or restrain or support plunger pad 220 at the retracted position.

[0098] FIG. 8A illustrates an actuator assembly in a first state, according to particular embodiments. FIG. 8B illustrates a plunger assembly in a retracted position, according to particular embodiments. In particular embodiments, a first state of actuator assembly 240 may correspond to a de-energized, and/or off, state of actuator assembly 240.

[0099] In particular embodiments, during operation in a de-energized or off state of actuator assembly 240, pressurized hydraulic fluid supply to actuator assembly 240 is switched off, for e.g., based on closing one or more oil control valves 320 of the engine, thereby cutting off pressurized hydraulic fluid supply to actuator assembly 240 via hydraulic supply inlet 260. In particular
5 embodiments, accordingly, control pin 250 is biased by control pin biasing member 252 to push open check ball 248, and thereby to permit free flow of residual hydraulic fluid through the open flow passage 251 of check valve 246. By way of example and not limitation, as there is no supply of pressurized hydraulic fluid in this state, both chambers (upper chamber 242 and lower chamber 244) of actuator assembly 240 can comprise low pressure and/or residual hydraulic fluid. By way
10 of example and not limitation, accordingly, plunger pad 220 of plunger assembly 210 can be collapsed and/or unable to resist or apply force on a valve interface, such as swinging pin mechanism 155 or sliding pin 150.

[0100] FIG. 9A illustrates an actuator assembly in a second state, according to particular embodiments. FIG. 9B illustrates a plunger assembly in an extended position, according to
15 particular embodiments. In particular embodiments, a second state of actuator assembly 240 may correspond to an energized, and/or on, state of actuator assembly 240.

[0101] In particular embodiments, during operation in an energized, or on, state of actuator assembly 240, pressurized hydraulic fluid supply to actuator assembly 240 can be switched on, such as based on opening one or more oil control valves 320 of the engine, thereby connecting
20 actuator assembly 240 to a pressurized supply of hydraulic fluid via hydraulic supply inlet 260, and thereby pressurizing upper chamber 242. In particular embodiments, accordingly, control pin 250 can be pushed (rightward, in the frame of reference of FIG. 8A) against the force of control pin biasing member 252 based on receiving the pressure of pressurized hydraulic fluid in upper chamber 242, thereby disengaging or withdrawing contact with check ball 248.

[0102] In particular embodiments, accordingly, in this state of disengagement of control pin
25 250 with respect to check ball 248, check ball 248 can now operate in this state to open or close fluid flow passage of check valve 246 based on a pressure differential between upper chamber 242 and lower chamber 244. In particular embodiments, accordingly, lower chamber 244 can receive pressurized hydraulic fluid to supply to plunger assembly 210 via hydraulic actuation passage 264,
30 wherein the pressurized hydraulic fluid can act to extend plunger pad 220, as previously described herein. In particular embodiments, when plunger pad 220 receives forces from a valve interface

(such as swinging pin mechanism 155 or sliding pin 150), a further rise in hydraulic fluid pressure in lower chamber 244 based on the received force can act to displace and hold check ball 248 closed against the flow passage of check valve 246, thereby sealing lower chamber 244 and permitting plunger pad 220 to remain stiffly extended to resist and apply forces relative to the valve interface.

Miscellaneous

[0103] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

[0104] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. It will be understood that changes and modifications may be made by those of ordinary skill within the scope of the following claims. In particular, the present invention covers further embodiments with any combination of features from different embodiments described above and below. Additionally, statements made herein characterizing the invention refer to an embodiment of the invention and not necessarily all embodiments.

[0105] The terms used in the claims should be construed to have the broadest reasonable interpretation consistent with the foregoing description. For example, the use of the article “a” or “the” in introducing an element should not be interpreted as being exclusive of a plurality of elements. Likewise, the recitation of “or” should be interpreted as being inclusive, such that the recitation of “A or B” is not exclusive of “A and B,” unless it is clear from the context or the foregoing description that only one of A and B is intended. Further, the recitation of “at least one of A, B and C” should be interpreted as one or more of a group of elements consisting of A, B and C, and should not be interpreted as requiring at least one of each of the listed elements A, B and C, regardless of whether A, B and C are related as categories or otherwise. Moreover, the recitation of “A, B and/or C” or “at least one of A, B or C” should be interpreted as including any singular

entity from the listed elements, e.g., A, any subset from the listed elements, e.g., A and B, or the entire list of elements A, B and C.

[0106] Numerical ranges recited in this application should be construed to be inclusive of the end points of the stated ranges. Particular axes, such as one or more lateral and/or longitudinal
5 axes, which may be omitted herein in some illustrations, should be construed to exist in every illustration or situation where it is relevant or referred to.

CLAIMS:

1. A rocker arm assembly, the rocker arm assembly rotatable about a rocker shaft and comprising:

a first portion configured to receive a valve lift profile; and

5 a second portion configured to operatively engage with one or more valves based on the valve lift profile, the second portion comprising:

an actuator assembly switchable between a first state and a second state, the actuator assembly comprising a valve mechanism actuated by a control member; and

a plunger assembly comprising:

10 an elongated member having a first end and a second end opposite the first end;

a plunger pad slidably disposed at the first end of the elongated member;

and

15 a lash adjustment mechanism associated with the second end of the elongated member,

wherein a longitudinal axis of the actuator assembly is angled to a plunger axis of the plunger assembly,

wherein the control member of the actuator assembly is hydraulically actuated to act on the valve mechanism, and

20 wherein, based on an actuation of the actuator assembly, the plunger pad is selectively extendable relative to the elongated member along the plunger axis between a retracted position and an extended position.

2. The rocker arm assembly of claim 1, wherein the plunger assembly further comprises:

a collar secured to the plunger pad; and

a plunger biasing member disposed between the first end of the elongated member and the collar, wherein the plunger biasing member is configured to bias the plunger pad toward the retracted position.

30

3. The rocker arm assembly of claim 2, wherein, corresponding to the second state of the actuator assembly, an extending force based on hydraulic pressure acts to overcome a force associated with the plunger biasing member such that the plunger pad extends to the extended position.

5

4. The rocker arm assembly of claim 2, wherein the plunger biasing member comprises a spring.

5. The rocker arm assembly of claim 1, wherein an inner surface of the plunger pad comprises a detent, and the elongated member of the plunger assembly further comprises a locking assembly provided proximal to the first end and configured to engage with the detent.

10

6. The rocker arm assembly of claim 5, wherein, corresponding to the second state of the actuator assembly, an extending force based on hydraulic pressure acts to overcome a detent force associated with the locking assembly engaging with the detent such that the plunger pad extends to the extended position.

15

7. The rocker arm assembly of claim 5, wherein the detent comprises a groove, and wherein the locking assembly comprises a protruding feature and a lock biasing member, the lock biasing member configured to bias the protruding feature toward the groove.

20

8. The rocker arm assembly of claim 7, wherein the lock biasing member is disposed along a lock axis angled to the plunger axis.

9. The rocker arm assembly of claim 1, wherein the lash adjustment mechanism is accessible via an upper surface of the rocker arm assembly to facilitate lash adjustment of the plunger assembly.

25

10. The rocker arm assembly of claim 9, wherein the lash adjustment mechanism extends above the upper surface of the rocker arm assembly.

30

11. The rocker arm assembly of claim 1, wherein the longitudinal axis of the actuator assembly is oriented perpendicular to the plunger axis.

12. The rocker arm assembly of claim 1, the second portion further comprising a lost motion assembly configured to absorb at least a portion of the valve lift profile.

13. The rocker arm assembly of claim 12, wherein the lost motion assembly comprises:
a lost motion shaft movable within a bore provided along a longitudinal axis of the lost motion assembly; and
a lost motion biasing member configured to bias the lost motion shaft toward the one or more valves.

14. The rocker arm assembly of claim 13, wherein the longitudinal axis of the lost motion assembly is disposed parallel to the plunger axis of the plunger assembly.

15. The rocker arm assembly of claim 1, wherein the first portion of the rocker arm assembly comprises a roller configured to engage with a cam to receive at least a portion of the valve lift profile.

16. The rocker arm assembly of claim 1, wherein, corresponding to the first state of the actuator assembly, the valve mechanism is held open by the control member so that the plunger pad retracts to the retracted position.

17. The rocker arm assembly of claim 1, wherein the valve mechanism comprises a check valve biased against a hydraulic channel opening by a check valve biasing member.

18. The rocker arm assembly of claim 17, wherein the control member comprises a control pin biased against the check valve by a control biasing member, the control member movable along the longitudinal axis of the actuator assembly.

19. A method of assembling a rocker arm assembly, comprising:

providing a plunger assembly proximal to a valve-engaging portion of the rocker arm assembly, the plunger assembly comprising an elongated member, a plunger pad slidably disposed at a first end of the elongated member, and a lash adjustment mechanism associated with a second end of the elongated member disposed opposite the first end;

5 providing a hydraulic actuator assembly connected in fluid communication with the plunger assembly such that a longitudinal axis of the hydraulic actuator assembly is angled to a plunger axis of the plunger assembly; and

configuring the second end of the elongated member to be accessible via an upper surface of the rocker arm assembly to facilitate lash adjustment of the plunger assembly.

10

20. A valvetrain system comprising:

a cam provided with a valve lift profile;

one or more valves;

a rocker shaft; and

15 a rocker arm assembly rotatable about the rocker shaft, the rocker arm assembly comprising:

a first portion configured to receive the valve lift profile; and

a second portion configured to operatively engage with one or more of the valves based on the valve lift profile, the second portion comprising:

20 an actuator assembly switchable between a first state and a second state, the actuator assembly comprising a valve mechanism actuated by a control member; and

a plunger assembly comprising:

25 an elongated member having a first end and a second end opposite the first end;

a plunger pad slidably disposed at the first end of the elongated member; and

a lash adjustment mechanism associated with the second end of the elongated member,

30 wherein a longitudinal axis of the actuator assembly is angled to a plunger axis of the plunger assembly,

wherein the control member of the actuator assembly is hydraulically actuated to act on the valve mechanism, and

wherein, based on an actuation of the actuator assembly, the plunger pad is selectively extendable relative to the elongated member along the plunger axis between a retracted position and an extended position.

5

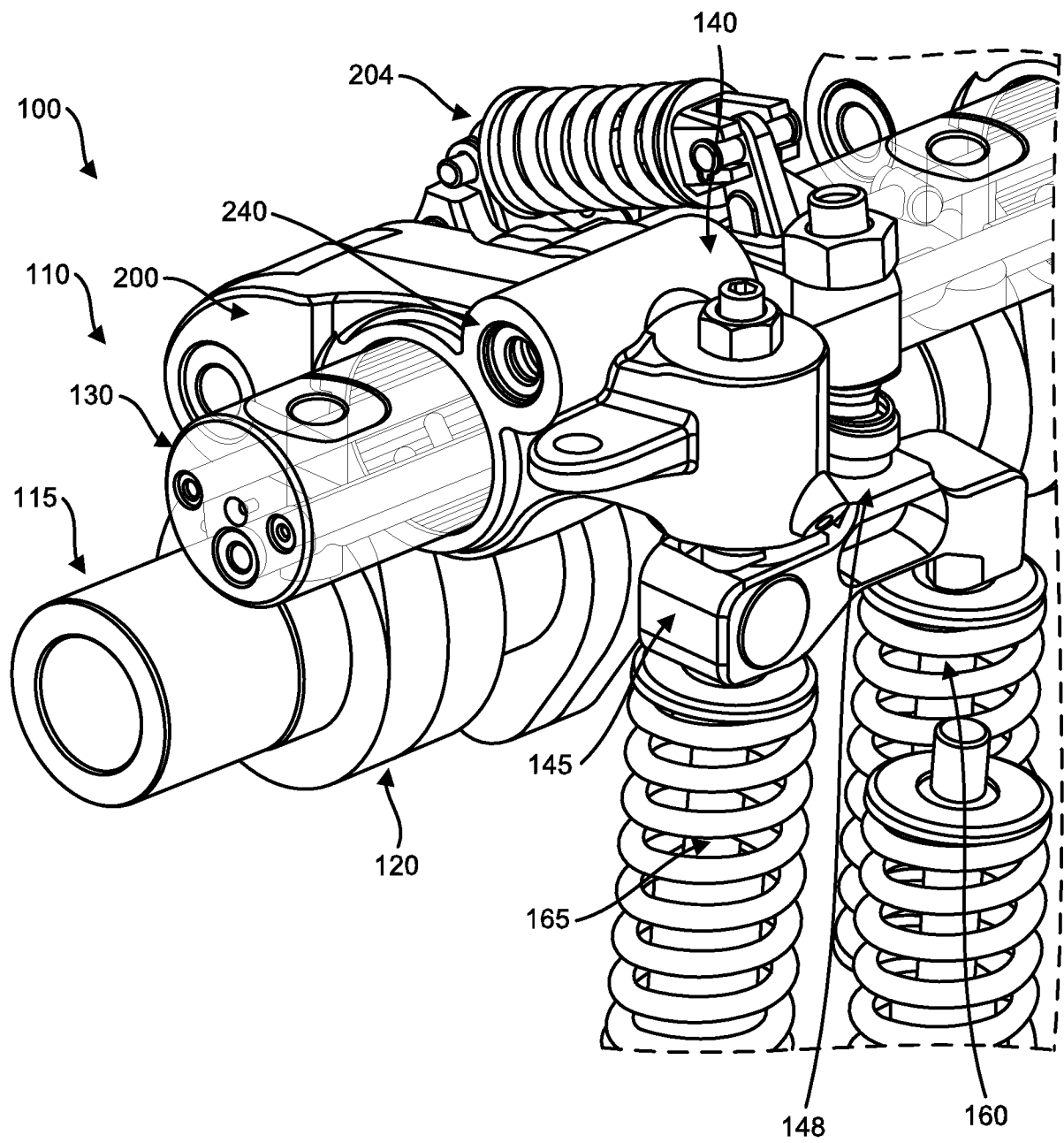


FIG. 1A

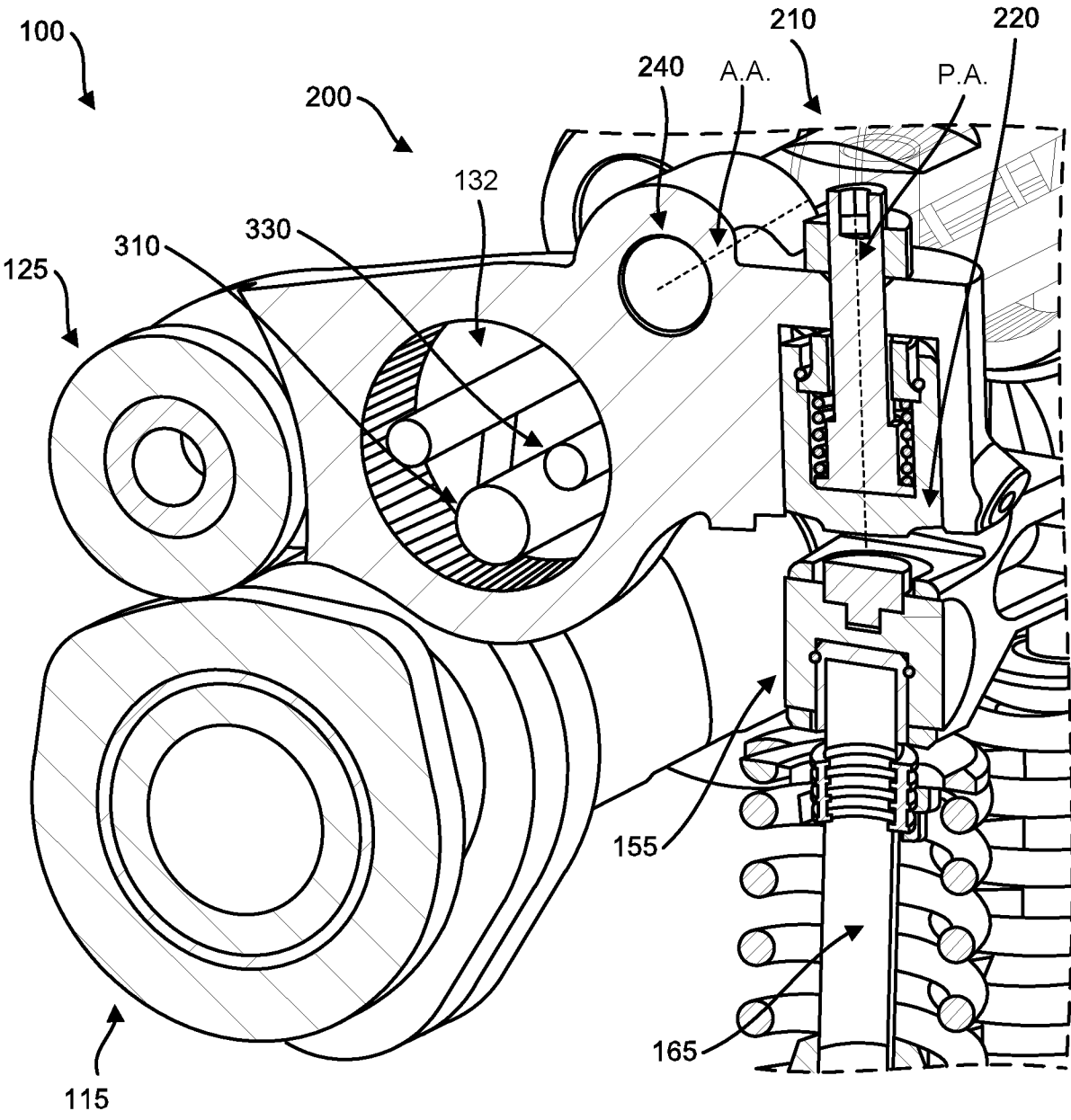


FIG. 1B

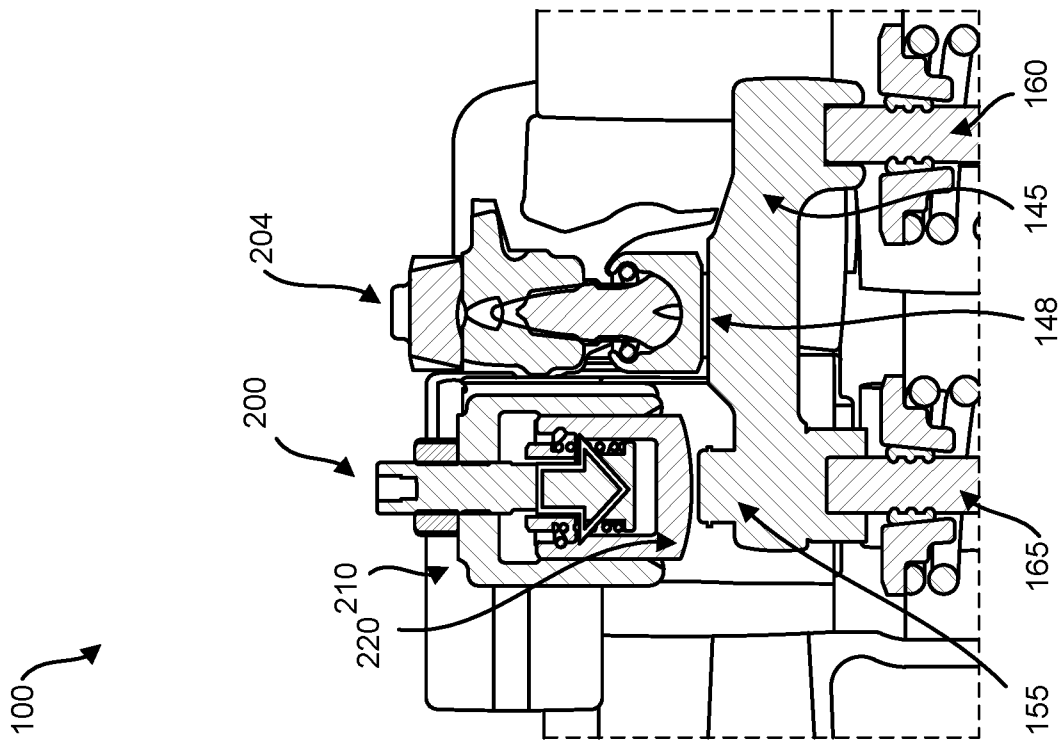


FIG. 1D

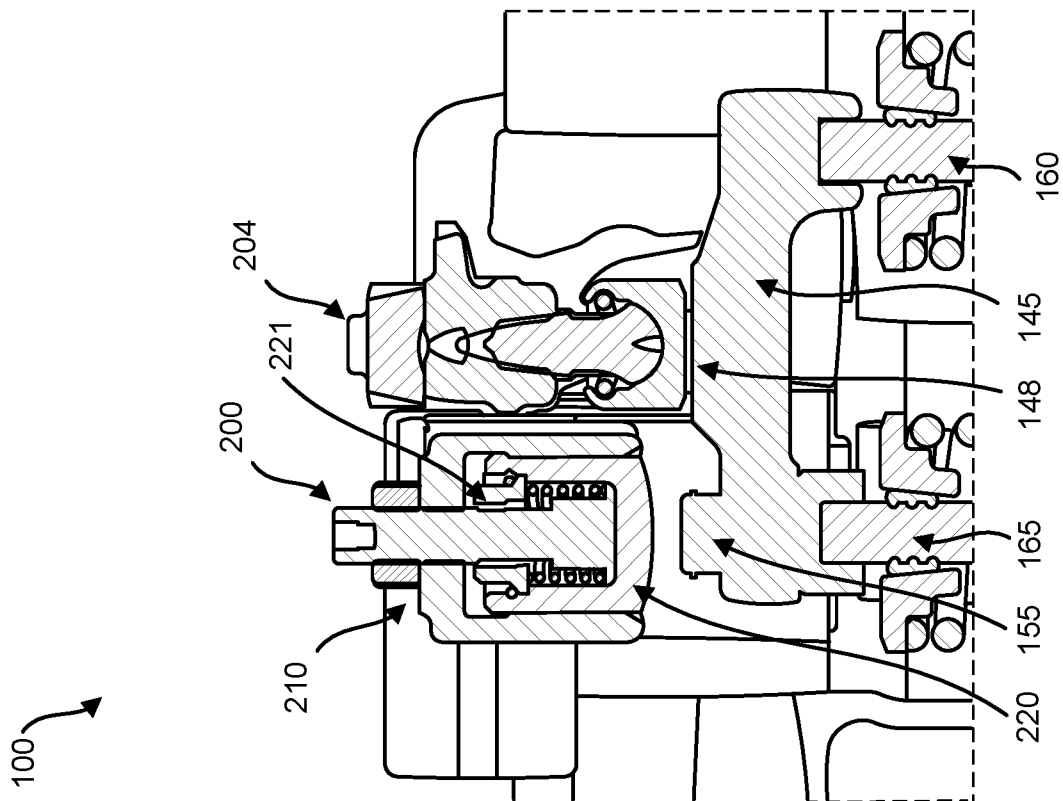


FIG. 1C

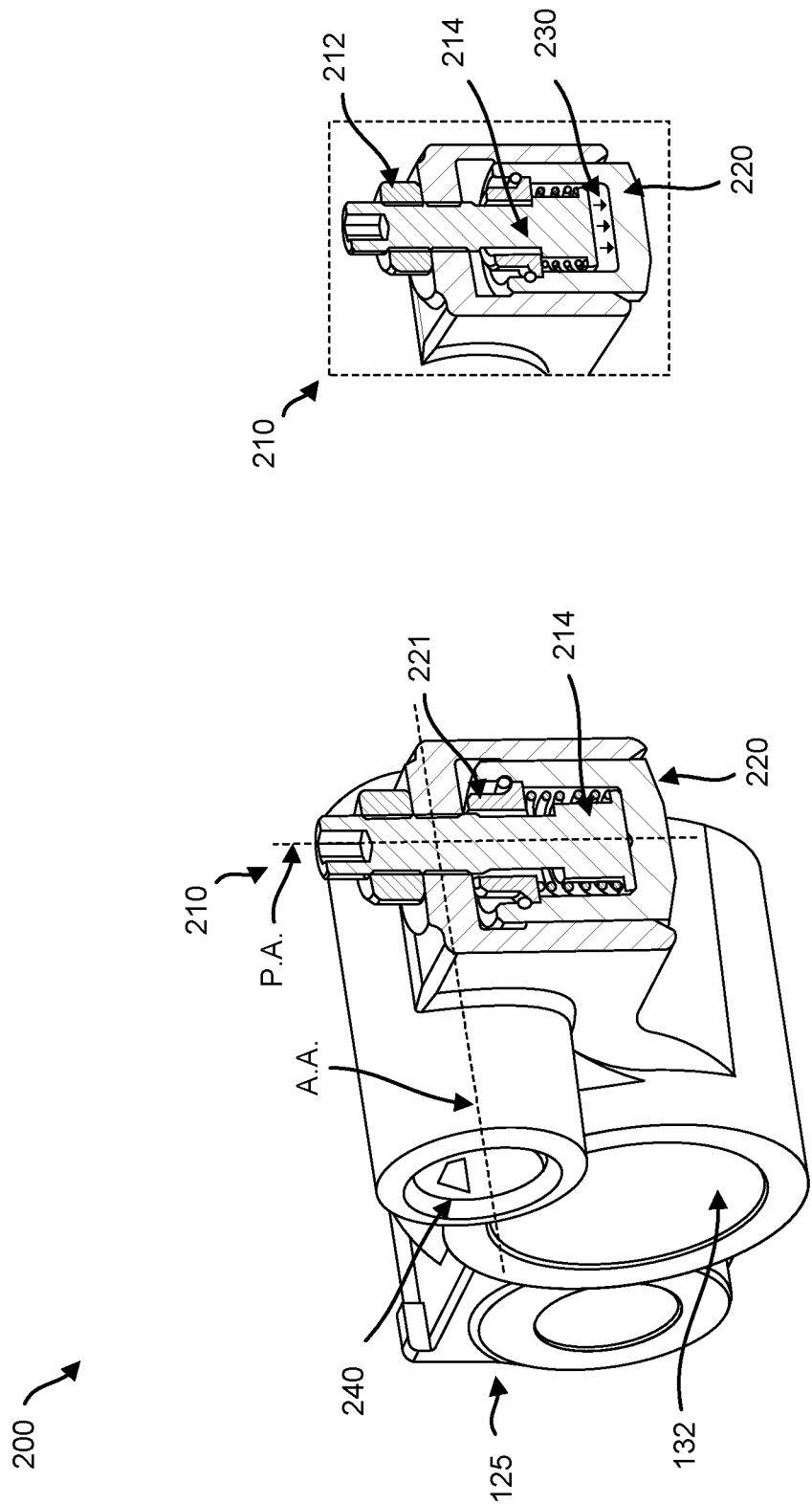


FIG. 2B

FIG. 2A

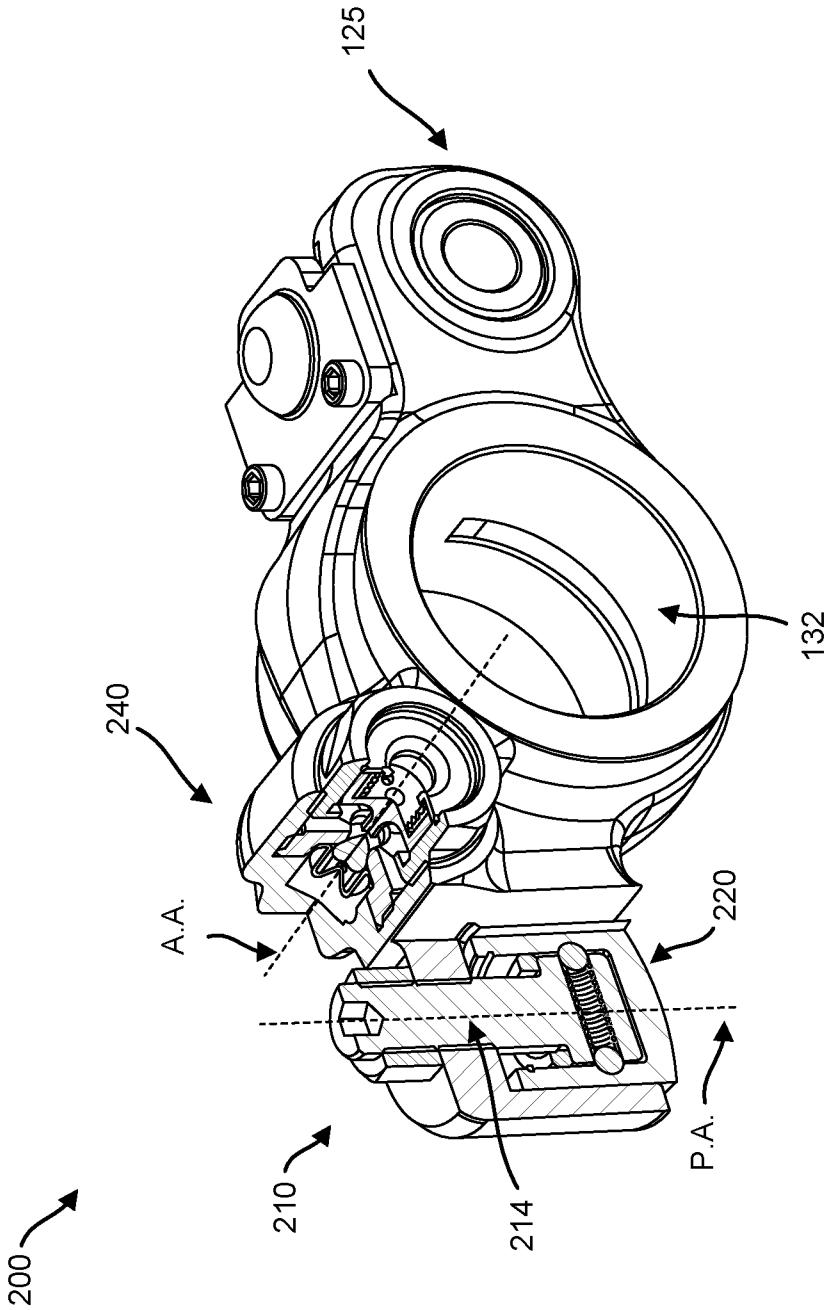


FIG. 2C

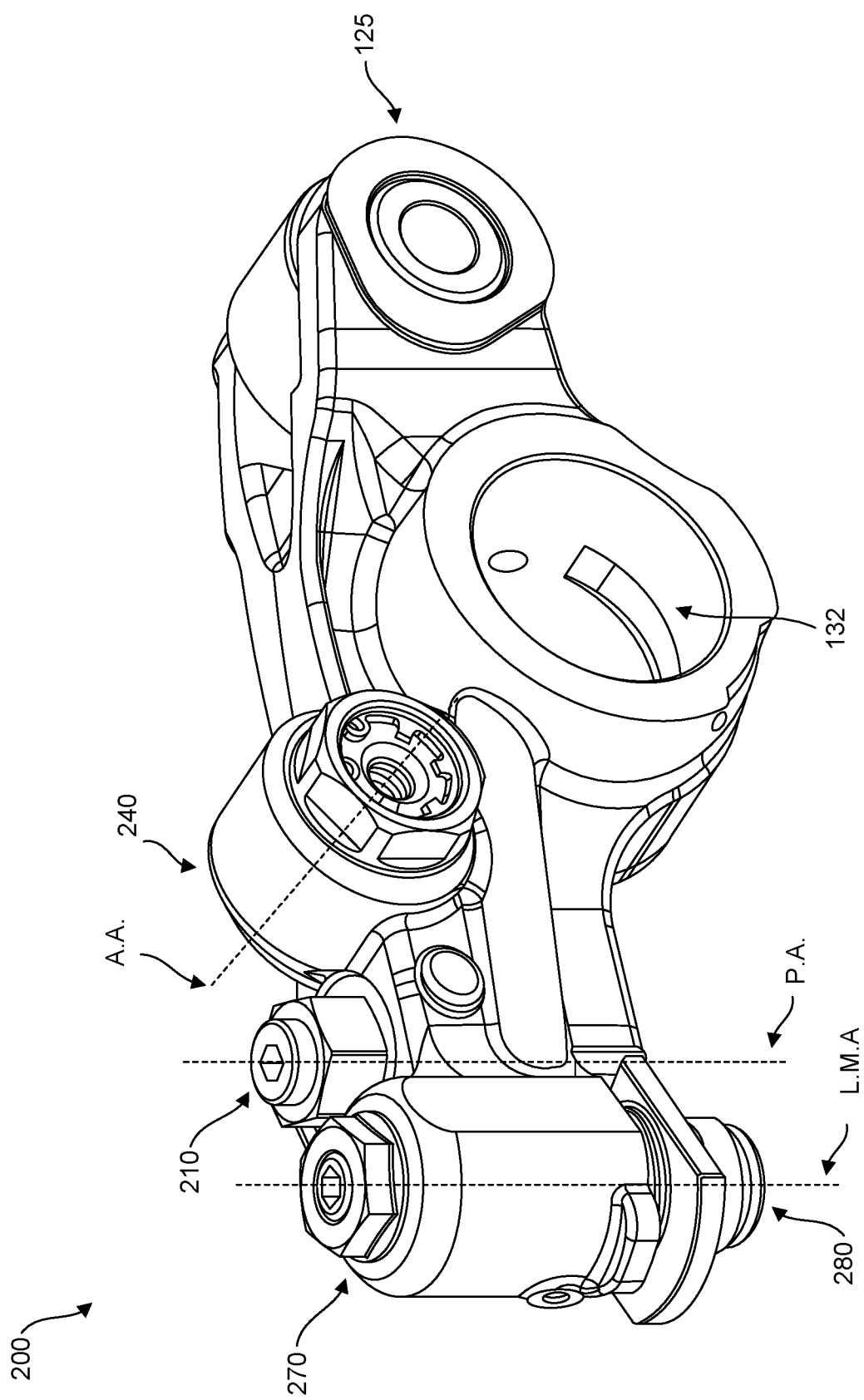


FIG. 3A

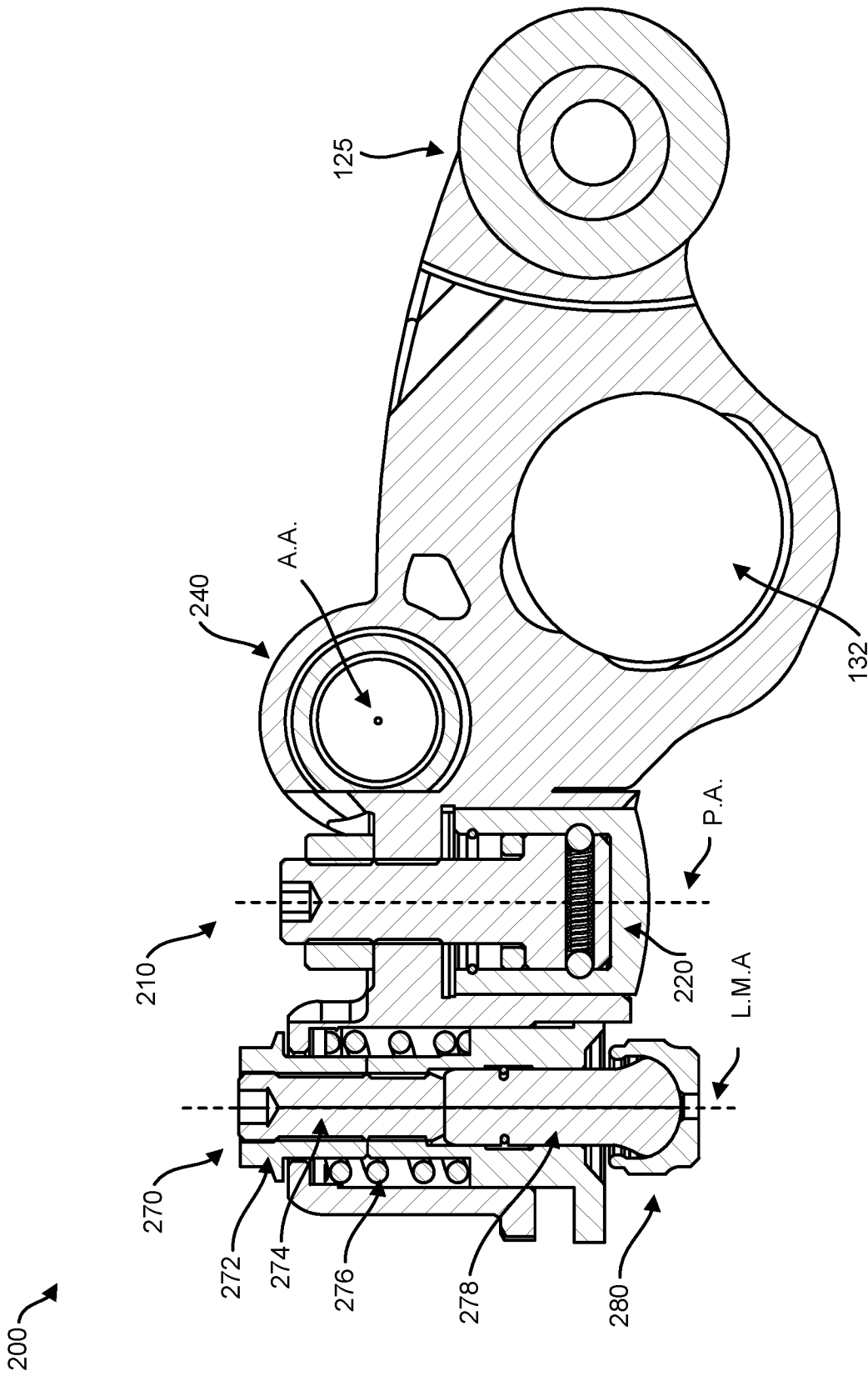


FIG. 3B

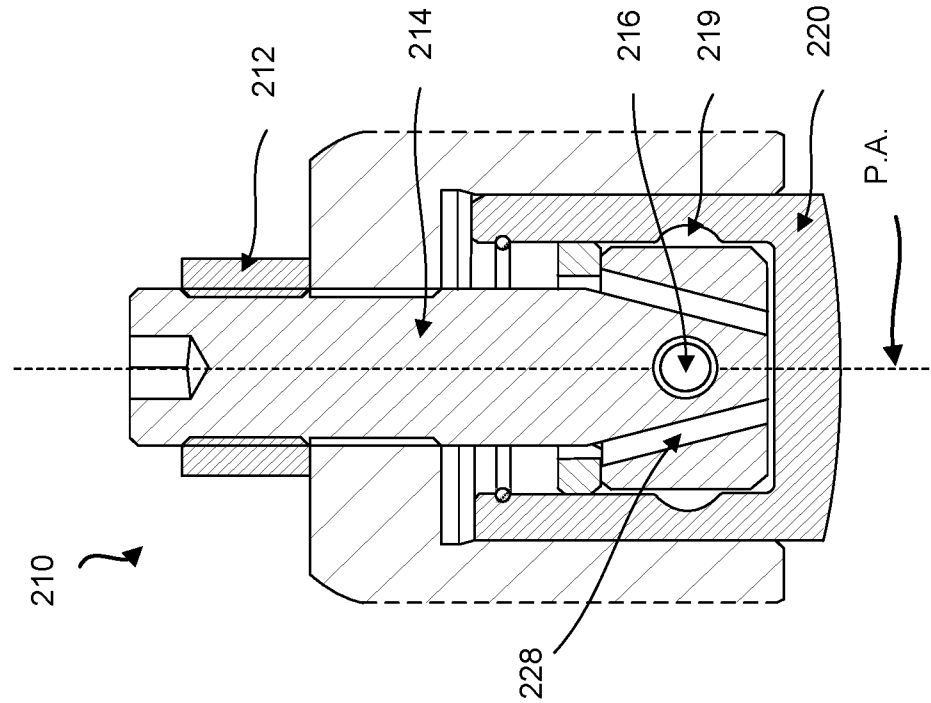


FIG. 4B

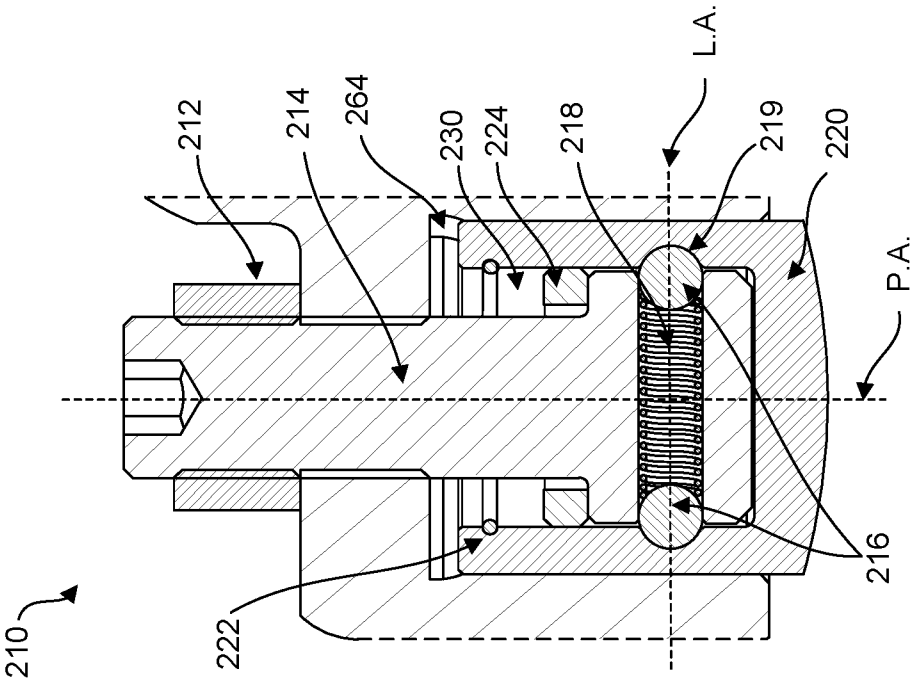


FIG. 4A

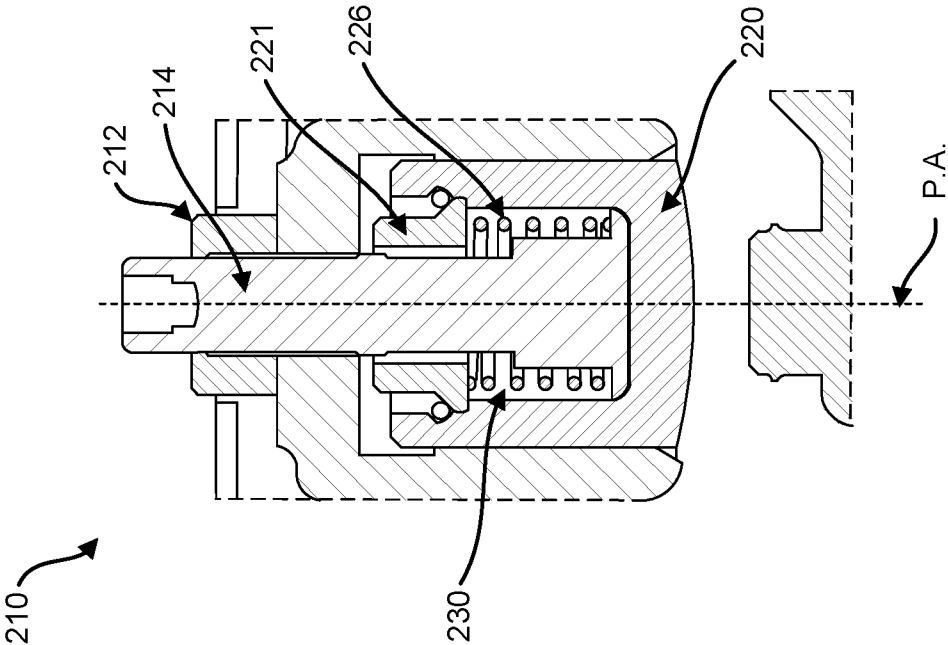


FIG. 4D

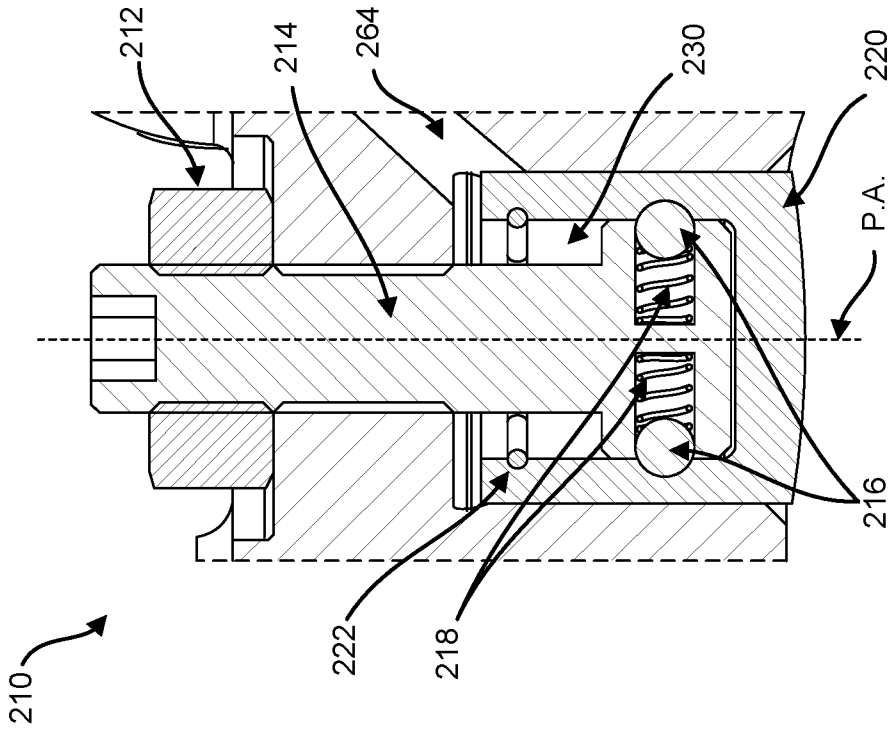


FIG. 4C

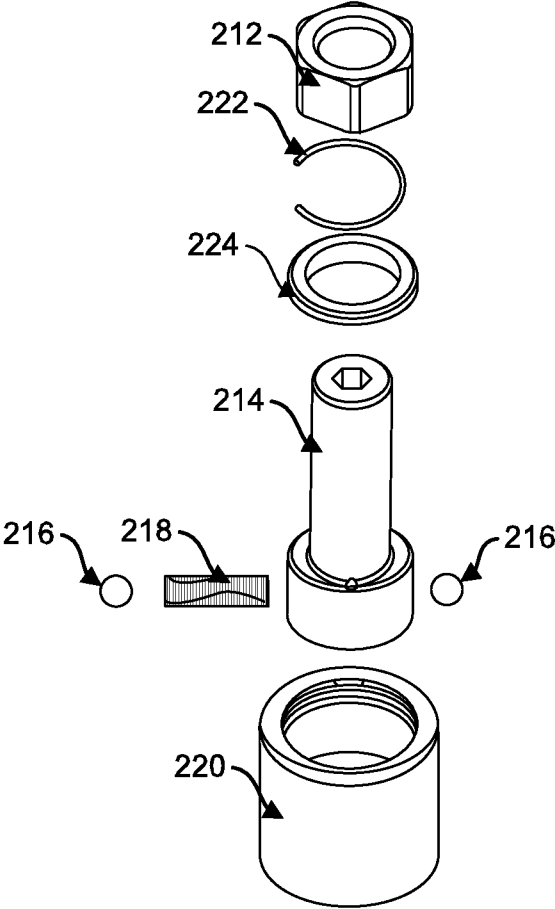


FIG. 4E

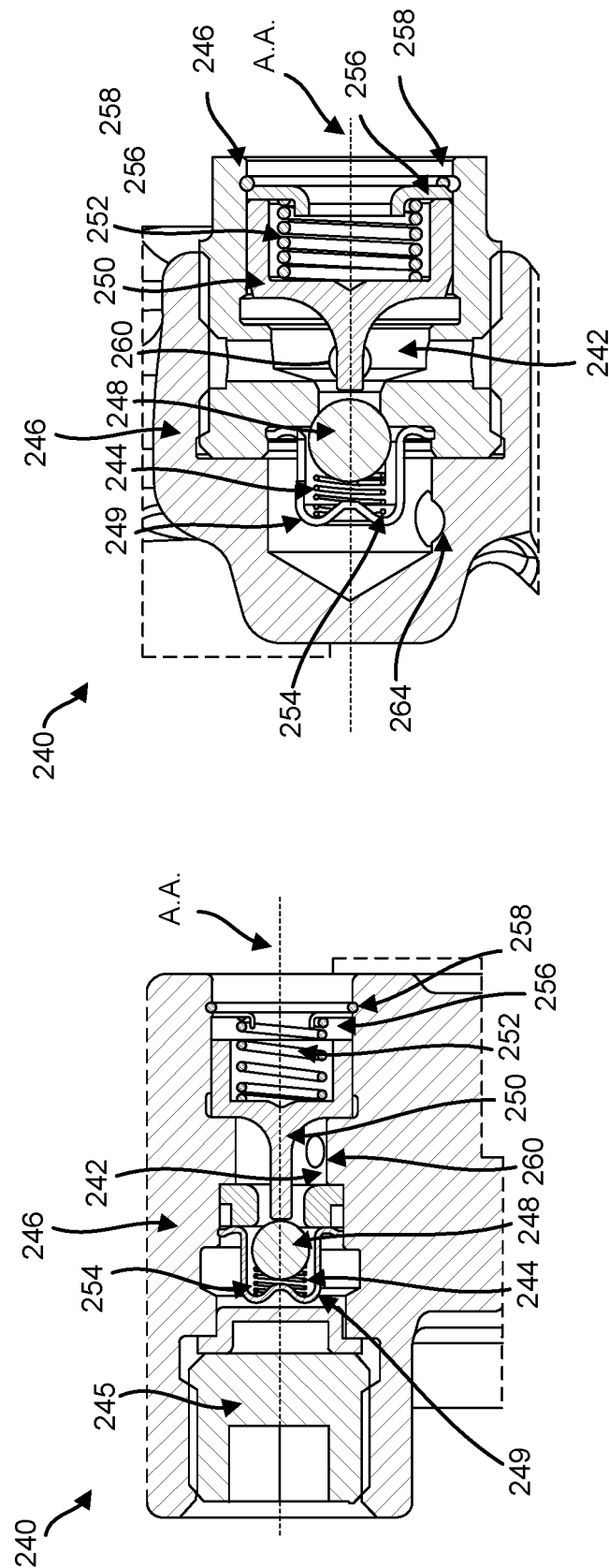


FIG. 5A

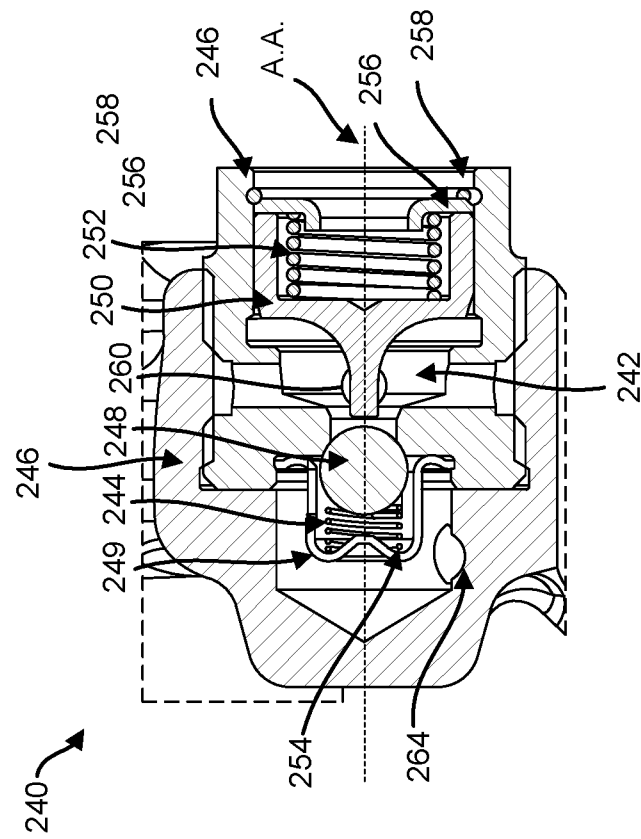


FIG. 5B

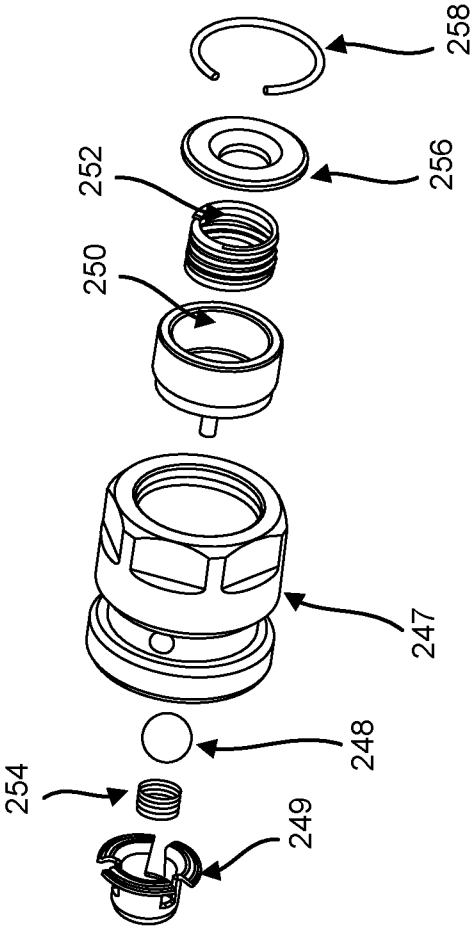


FIG. 5C

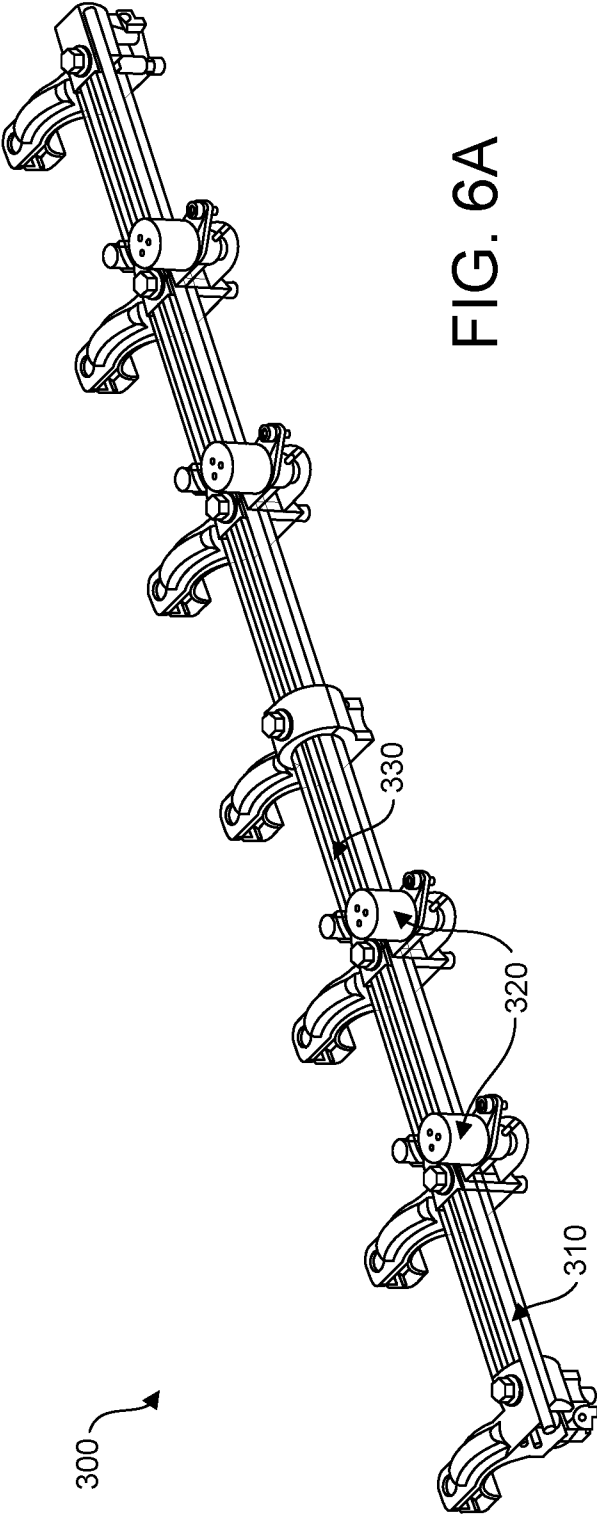


FIG. 6A

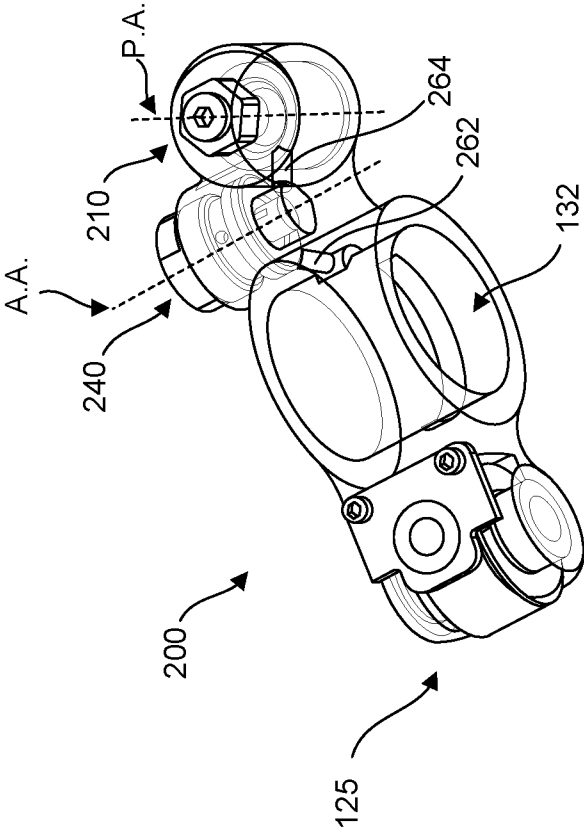


FIG. 6B

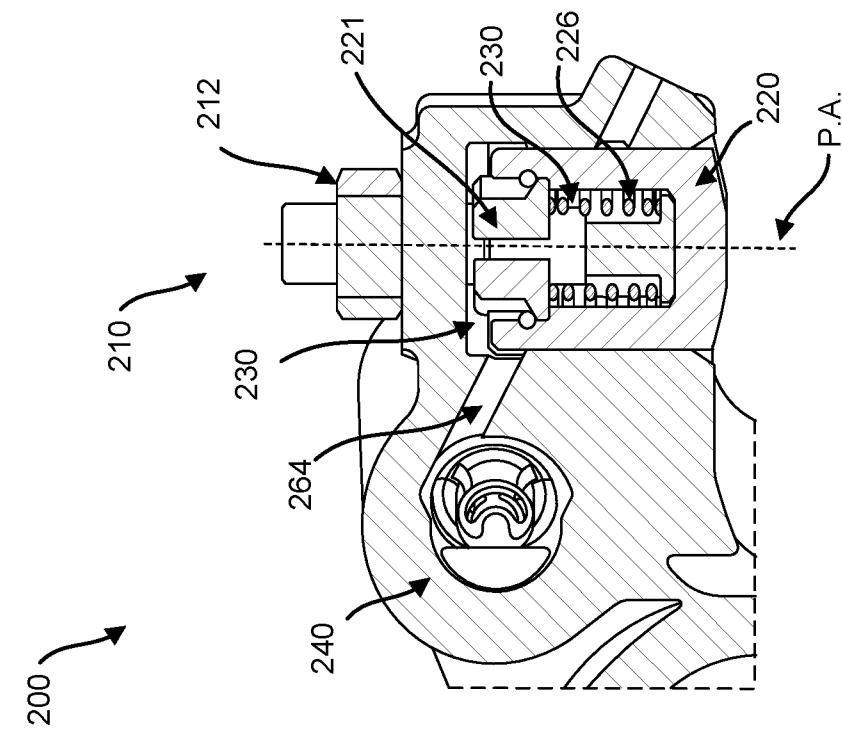


FIG. 7A

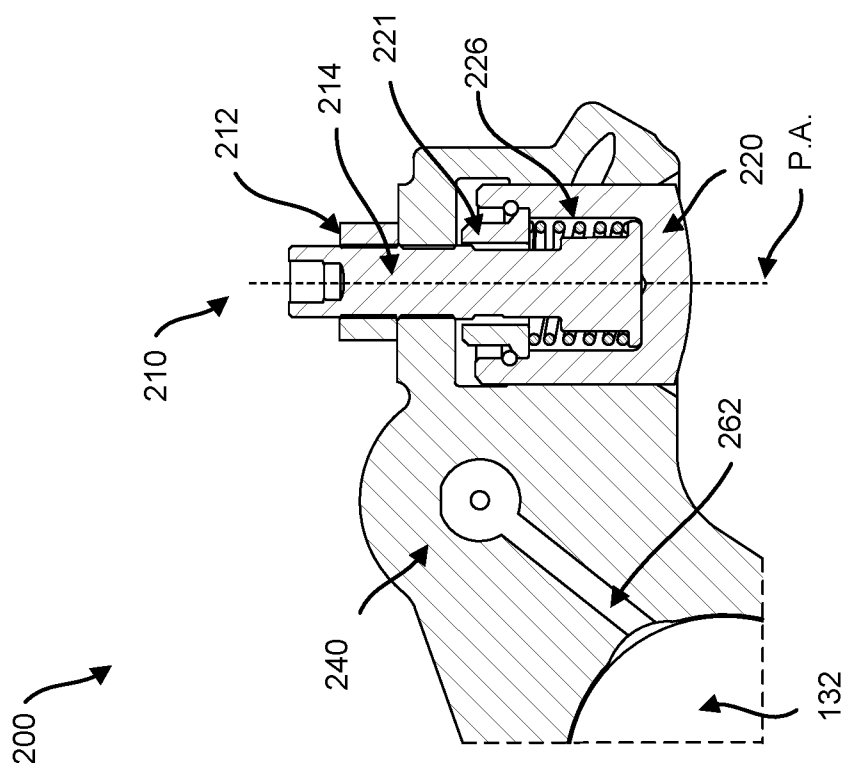


FIG. 7B

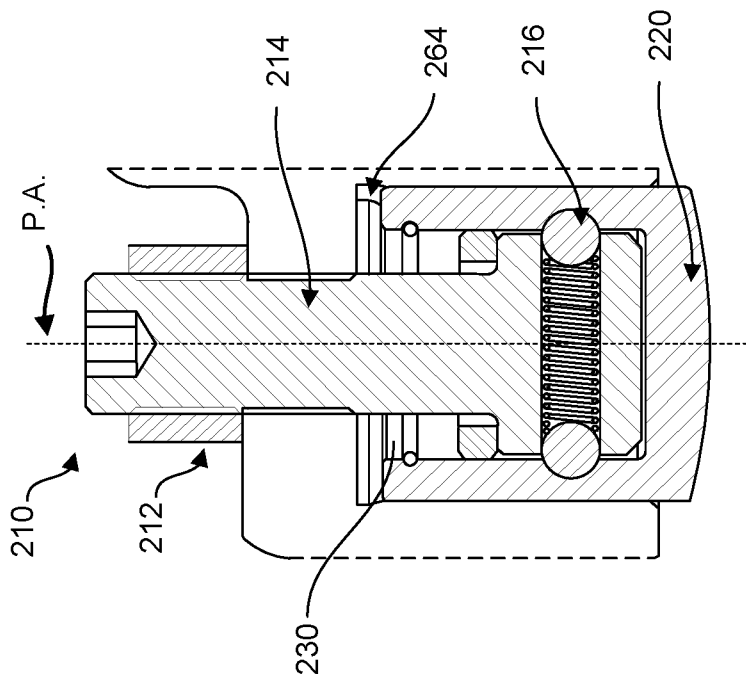


FIG. 8B

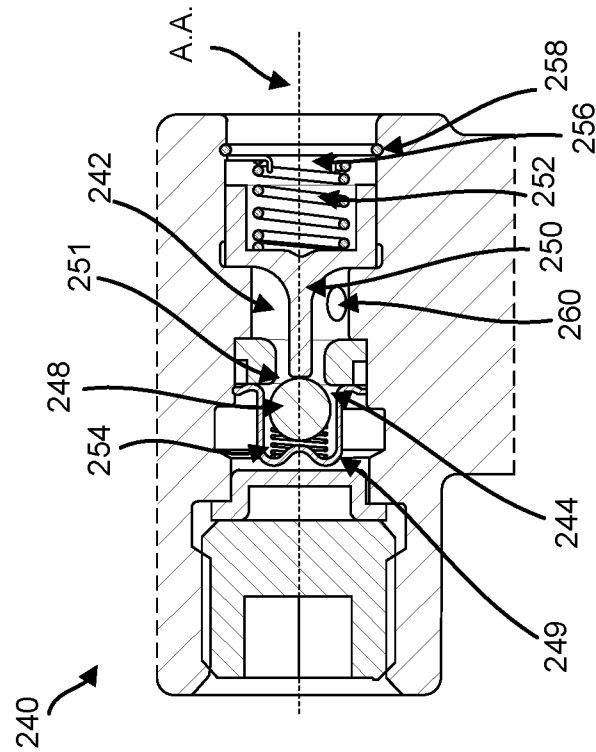


FIG. 8A

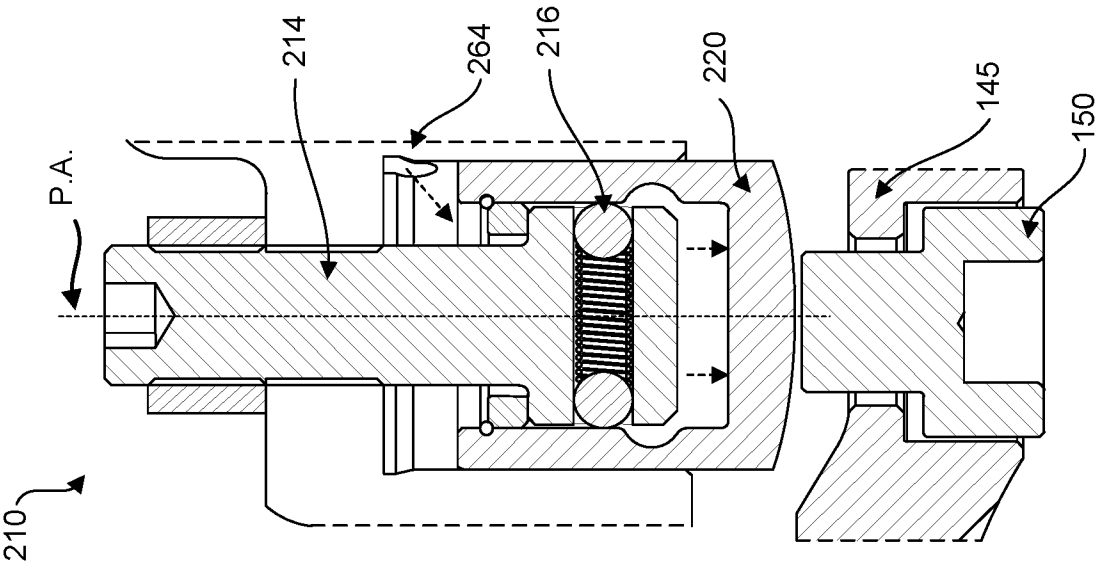


FIG. 9B

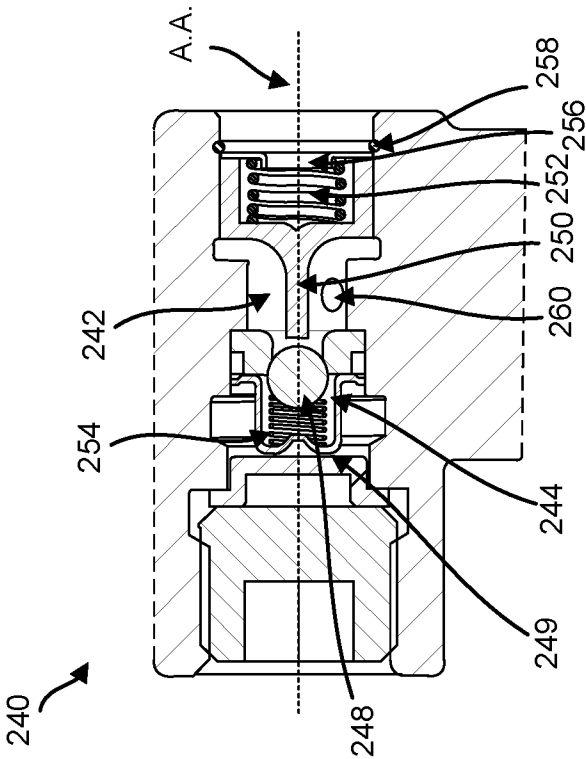


FIG. 9A

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/025070

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	F01L1/18	F01L1/24
	F01L13/00	F01L13/06
ADD.	F01L1/26	
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) F01L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2017 113783 A1 (MAN TRUCK & BUS AG [DE]) 27 December 2018 (2018-12-27)	1-4, 11-16, 19,20
Y	abstract; figures 1,5,7,8,10	17,18
A	paragraph [0042] - paragraph [0045] paragraph [0056] - paragraph [0063] paragraph [0073] - paragraph [0077] -----	5-10
Y	WO 2022/228732 A1 (EATON INTELLIGENT POWER LTD [IE]) 3 November 2022 (2022-11-03) abstract; figure 4 paragraph [0032] -----	17,18
X	US 2021/108542 A1 (GRYNBERG PHILIPPE [FR] ET AL) 15 April 2021 (2021-04-15) abstract; figures 2,4,6,8,9,14a,14b paragraph [0057] - paragraph [0061] paragraph [0073] paragraph [0089] -----	1,19,20
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 23 May 2024		Date of mailing of the international search report 06/06/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Van der Staay, Frank

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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