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(54) Switching finger follower assembly

(57) A finger follower assembly (30) for variably activating a valve of an internal combustion engine having a camshaft with at least one lobe. The finger follower assembly includes a follower body (54), a shaft (78), a cam follower (80), and a latching mechanism (58). The cam follower is supported by the shaft and is configured for engagement with the at least one lobe (42,44). The cam follower is configured to pilot on the camshaft to maintain an alignment of the cam follower with respect to the at least one lobe. The latching mechanism selectively latches and unlatches the cam follower to the follower body to provide a first valve lift capability and a second valve lift capability.

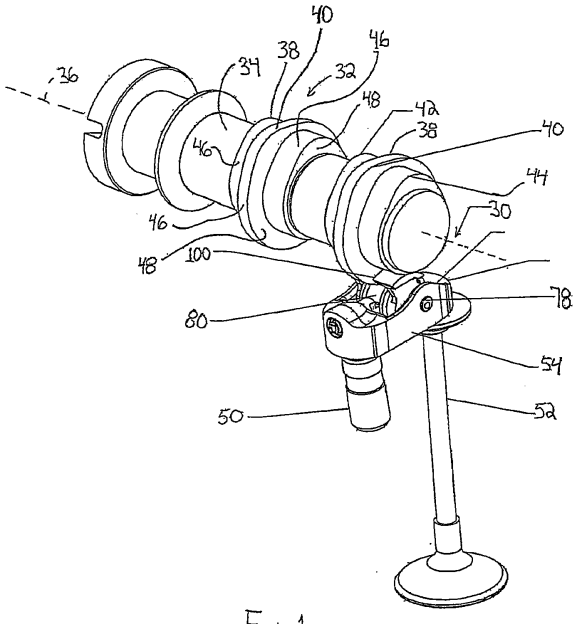


FIG. 1

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Description

BACKGROUND

[0001] The present invention relates to mechanisms for altering the actuation of valves in internal combustion engines, and more particularly to finger follower type rocker arms for changing between high and low valve lifts.

[0002] Variable valve activation (VVA) mechanisms for internal combustion engines are known. It is known to lower the lift of one or more valves of a multiple-cylinder engine, especially intake valves, during periods of light engine load. Such deactivation can improve fuel efficiency.

[0003] Various approaches have been disclosed for changing the lift of valves in a running engine. One approach is to provide an intermediary cam follower arrangement which is rotatable about the engine camshaft and is capable of changing both the valve lift and timing. In such an approach, the camshaft typically includes both high-lift and low-lift lobes for each such valve. Such an arrangement can be complicated and costly to manufacture and difficult to install during engine assembly.

[0004] Another known approach is to provide a deactivation mechanism in the hydraulic lash adjuster (HLA) upon which a cam follower rocker arm pivots. Such an arrangement is advantageous in that it can provide variable lift from a single cam lobe by making the HLA either competent or incompetent to transfer the motion of the cam eccentric to the valve stem. A shortcoming of providing deactivation at the HLA end of a rocker arm is that, because the cam lobe actuates the rocker near its longitudinal center point, the variation in lift produced at the valve-actuating end can be only about one-half of the extent of travel of the HLA deactivation mechanism.

[0005] Still another known approach is to provide a deactivation mechanism in the valve-actuating end of a rocker arm cam follower (opposite from the HLA pivot end) which locks and unlocks the valve actuator portion from the follower body. Unlike the HLA deactivation approach, this approach typically requires both high-lift and low-lift cam lobes to provide variable lift.

[0006] Another known approach is to provide a rocker arm cam follower with a finger body having a first cam follower positioned within the fmger body and a secondary cam follower. In some designs, the first cam follower is selectively moveable relative to the finger body and in other designs the secondary cam followers are selectively moveable relative to the finger body. The moveable members generally are axially moveable or pivot about a secondary axis which adds complexity to the design or fails to provide smooth motion.

SUMMARY OF THE INVENTION

[0007] In one embodiment the invention provides a finger follower assembly for variably activating a valve of an internal combustion engine having a camshaft with at least one lobe. The finger follower assembly includes a follower body, a shaft, a cam follower and a latching mechanism. The follower body has a first end portion configured to couple to the engine, a second end portion configured to couple to the valve of the engine, and an aperture formed in the follower body between the first and second end portions. The shaft is coupled to the follower body and transverses the aperture. The cam follower is supported at least partially within the aperture by the shaft and is configured for engagement with the at least one lobe. The cam follower is configured to pilot on the camshaft to maintain an alignment of the cam follower with respect to the at least one lobe. The latching mechanism selectively latches and unlatches the cam follower to the follower body to provide a first valve lift capability and a second valve lift capability.

[0008] In another embodiment the invention provides the follower body having a first end portion configured to couple to the engine, a second end portion configured to couple to the valve of the engine, and an aperture formed in the first end portion. The latching mechanism includes a base portion, a piston movable relative to the base portion between an extended position and a retracted position, and a biasing member. The biasing member is coupled between the base portion and the piston to bias the piston toward the retracted position, and the base portion, the piston, and the biasing member are at least partially located within the aperture.

[0009] In yet another embodiment the invention provides the latching mechanism having an engagement surface and the cam follower having an engagement surface configured to engage the engagement surface of the latching mechanism. At least one of the engagement surfaces is at least partially convex.

[0010] In yet another embodiment the invention provides the latching mechanism at least partially defining a fluid chamber, and the finger follower assembly further including a vent passageway formed in the first end portion of the follower body and providing selective fluid communication between the fluid chamber and an outer surface of the follower body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 is a perspective view of a camshaft and a finger follower assembly embodying the present invention.

[0012] Fig. 2 is an exploded view of the finger follower assembly of Fig. 1.

[0013] Fig. 3 is a cross section view of the linger follower assembly of Fig. 1 taken along lines 3-3 of Fig. 14.

[0014] Fig. 4 is a cross section view of the finger follower assembly of Fig. 1 taken along lines 4-4 of Fig. 14 illustrating a piston of the finger follower assembly in a retracted position.

[0015] Figs. 5-6 are perspective views of a lateral cam follower of the finger follower assembly of Fig. 1.

[0016] Fig. 7 is an end view of the lateral cam follower

of Fig. 5.

[0017] Fig. 8 is a side view of the lateral cam follower of Fig. 5.

[0018] Fig. 9 is a cross section view of the finger follower assembly of Fig. 1 taken along lines 9-9 of Fig. 14 illustrating the piston between the retracted position and an extended position.

[0019] Fig. 10 is a perspective view of a latching mechanism of the finger follower assembly of Fig. 1 illustrating the piston in the retracted position.

[0020] Fig. 11 is a bottom view of the latching mechanism of Fig. 10.

[0021] Fig. 12 is a perspective view of the latching mechanism of Fig. 10 illustrating the piston in the extended position.

[0022] Fig. 13 is a bottom view of the latching mechanism of Fig. 12.

[0023] Fig. 14 is a perspective view of the finger follower assembly of Fig. 1 illustrating the piston in the retracted position.

[0024] Fig. 15 is a cross section view of the finger follower assembly of Fig. 14 taken along lines 15-15 of Fig. 14.

[0025] Fig. 16 is a cross section view of the finger follower assembly of Fig. 14 taken along lines 16-16 of Fig. 14.

[0026] Fig. 17 is a perspective view of the finger follower assembly of Fig. 1 illustrating the piston in the extended position.

[0027] Fig. 18 is a cross section view of the finger follower assembly of Fig. 17 taken along lines 18-18 of Fig. 17.

[0028] Fig. 19 is a cross section view of the finger follower assembly of Fig. 17 taken along lines 19-19 of Fig. 17.

[0029] Fig. 20 is a perspective view of the finger follower assembly of Fig. 1 illustrating the piston in the extended position and the lateral cam follower in a downward position.

[0030] Fig. 21 is a cross section view of the finger follower assembly of Fig. 20 taken along lines 21-21 of Fig. 20.

[0031] Fig. 22 is a cross section view of the finger follower assembly of Fig. 20 taken along lines 22-22 of Fig. 20.

[0032] Fig. 23 is a perspective view of an alternative construction of the finger follower assembly of Fig. 1.

[0033] Figs. 24-32 are cross section views of the finger follower assembly of Fig. 23 taken along lines 23-23 through 32-32, respectively, of Fig. 23.

[0034] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms "mounted," "connected," "supported," and "coupled" and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings. In addition, the invention will be described with reference to the accompanying drawing figures wherein like numbers represent like elements throughout. Certain terminology, for example, "top", "bottom", "right", "left", "front", "frontward", "forward", "back", "rear", "rearward", "upwardly" and "downwardly" is used in the following description for relative descriptive clarity only and is not intended to be limiting.

DETAILED DESCRIPTION

[0035] Fig. 1 illustrates a finger follower rocker assembly 30 for use with an internal combustion engine having a camshaft assembly 32. The camshaft assembly 32 includes a camshaft 34 that rotates about an axis 36. The illustrated camshaft assembly 32 includes a plurality of cam assemblies 38 that are coupled to the camshaft 34 for rotation with the camshaft 34. Each of the cam assemblies 38 includes a central cam lobe 40, a first lateral cam lobe 42 and a second lateral cam lobe 44. The first and second lateral lobes 42 and 44 are adjacent the central lobe 40. Each of the cam lobes 40, 42, 44 includes a perimeter surface 46 and side walls 48 that are generally normal to the perimeter surface 46. In the illustrated construction, the central cam lobe 40 has a larger profile or outer dimension than the lateral cam lobes 42 and 44 such that the central cam lobe 40 includes side wall portions 48 that extend beyond the perimeter surfaces 46 of the lateral cam lobes 42 and 44. In the illustrated construction, the internal combustion engine further includes a lash adjuster 50 and an engine valve 52.

[0036] Referring to Figs. 2 and 4, the finger follower assembly 30 includes a follower body 54, a follower assembly 56, and a latching mechanism 58. The follower body 54 includes a first end portion 60 and a second end portion 62. The first end portion 60 includes a concave socket 64 and a bore 66. The concave socket 64 couples to an engine through the lash adjuster 50 (Fig. 1). As best seen in Fig. 4, the bore 66 partially receives the latching mechanism 58. The illustrated bore 66 is generally cylindrical and defines an inner dimension D 1 that is generally constant. The second end portion 62 is coupled to the valve 52 (Fig. 1).

[0037] Referring to Figs. 2 and 3, the follower body 54 further includes opposed side walls 68 that extend between the end portions 60, 62. The illustrated side walls 68 partially define an aperture 70 between the first and

second end portions 60, 62. The side walls 68 include an inner surface 72 that defines an inner width W1 of the aperture 70 and an outer surface 74 that defines an outer width W2 of the follower body 54. The side walls 68 each further include an aperture 76. The apertures 76 of the side walls 68 are aligned such that apertures 68 receive a shaft 78 having a shaft axis 79.

[0038] Referring to Figs. 2 and 4, the follower assembly 56 includes a lateral cam follower 80 and a central cam follower 82. The central cam follower 82 includes an inner cylindrical race 84 and an outer cylindrical race 86 with rolling elements 88 positioned therebetween such that the outer cylindrical race 86 is rotatable about the shaft axis 79. In the illustrated construction, the inner cylindrical race 84 is coupled to the shaft 78 using a loose fit such that the inner cylindrical race 84 is movable along the shaft axis 79 and around the shaft axis 79, the purpose of which will be discussed below.

[0039] Referring to Figs. 3 and 5-8, the lateral follower 80 has a body portion 90 with a through bore 92 that receives the shaft 78 to couple the lateral follower 80 to the follower body 54. The lateral follower 80 pivots or rotates about the shaft 78 and is movable along the shaft 78 in a direction parallel to the shaft axis 79.

[0040] Referring to Figs. 8 and 9, the body portion 90 of the lateral follower 80 further includes an actuator receiving aperture 94. The actuator receiving aperture 94 is partially defined by a downwardly facing surface 96. As best seen in Fig. 9, the downwardly facing surface 96 of the lateral follower 80 is at least partially convex (e.g., radiused, logarithmic profile, etc.) such that the surface 96 defines a crowned profile when viewed in the cross section illustrated in Fig. 9, the purpose of which will be discussed below.

[0041] As best seen in Figs. 3 and 7, the body portion 90 of the lateral follower 80 defines a width W3 that is less than the inner width W1 of the aperture 70 such that there are gaps 98 between the inner surfaces 72 of the follower body walls 68 and the body portion 90 of the lateral follower 80. While Fig. 3 illustrates the gaps 98 with a substantially equal length L1, the follower body 90 is movable in a direction parallel to the shaft axis 79 such that the length L1 of the gaps 98 can vary.

[0042] Referring to Figs. 5-8, the lateral follower 80 further includes first and second contact portions 100, 102 that extend upwardly from the body portion 90 to define a gap 104 therebetween. The contact portions 100, 102 each include a convex contact surface 106, 108 respectively, having a width W4, W5, respectively. In one construction the widths W4 and W5 both are approximately 8.25 mm. In other constructions, the widths W4 and W5 can be greater than or less than 8.25 mm.

[0043] Referring to Fig. 3, in the illustrated construction, a ratio of the total width of the contact surfaces 106 and 108 (W4 + W5) to the outer width W2 of the follower body 54 (i.e., (W4 + W5)/W2) is approximately 70%. In other constructions the ratio can be greater or less than 70%.

[0044] As best seen in Figs. 5-7, the first and second contact portions 100 and 102 further define lateral contact portions 110 and 112, respectively. The lateral contact portions 110 and 112 are generally normal to the convex contact surfaces 106 and108, respectively, and the lateral contact portions 110 and 112 partially define the gap 104 between the contact portions 100 and 102.

[0045] Referring to Figs. 3 and 5, the body portion 90 of the lateral follower 80 further defines a generally centrally located slot 114 that receives and retains the central follower 82 partially within the body portion 90 of the lateral follower 80.

[0046] The illustrated lateral follower 80 is integrally formed as a single piece, such as by casting, molding, machining and the like. In other constructions, the lateral follower 80 can be a two-piece design, such that the first and second contact portions are separate components. In such constructions, the contact portions and can be interconnected by a member such that the contact portions are coupled for co-rotation about the shaft 78 and movement along the shaft axis 79.

[0047] Referring to Figs. 1 and 3, when the follower assembly 30 is assembled with the camshaft assembly 32, the central lobe 40 of the cam assembly 38 is received in the gap 104 between the first and second contact portions 100 and 102 of the lateral follower 80. Thus, the central lobe 40 is captured between the contact portions 100 and 102 of the lateral follower 80. Because the central lobe 40 has a larger profile than the lateral lobes 42 and 44, the side wall portions 48 of the central lobe 40 are available to pilot the lateral contact portions 110 and 112 of the lateral follower 80 at all rotational positions of the lateral follower 80 and the camshaft 34. Due to manufacturing tolerances or variations and thermal expansions or contractions, the location of the cam assembly 38 can vary along the camshaft axis 36. However, because the lateral follower 80 pilots on the central lobe 40, the central lobe 40 can contact either of the lateral contact surfaces 110 or 112 of the lateral follower 80 to move the lateral follower 80 relative to the valve 52 and within the follower body 54 to maintain proper relative position of the lateral follower contact surfaces 106 and 108 with respect to the lateral lobes 42 and 44. The gaps 98 between the follower body 54 and the lateral follower body 90 allow the lateral follower 80 to move in a direction parallel to the shaft axis 79 along the shaft 78. Furthermore, because the lateral follower 80 is one piece, the entire lateral follower 80 will move in a direction parallel to axis 79 along the shaft 78. In addition, the central follower 82, which is retained in the slot 114 of the lateral follower 80, will move in a direction parallel the shaft axis 79 with the lateral follower 80. Therefore, the central follower 80 maintains proper alignment with the central lobe 40. Such movement of the central follower 80 is facilitated by the loose fit of the inner race 84 of the central follower 82 on the shaft 78.

[0048] Because the lateral follower 80 pilots in this manner on the central lobe 40, the lateral follower 80 and

central follower 82 remain aligned with the cam assembly 38 regardless of the manufacturing variations or thermal variations that may change the position of the cam assembly 38. Such as feature allows the widths W4 and W5 of the contact surfaces 106 and 108 to be maximized such that the widths W4 and W5 of the contact surfaces 106 and 108 are generally equal to the width of the perimeter surfaces 46 of the lateral lobes 42 and 44, respectively, and the contact surfaces 106 and 108 generally contact the lateral lobes 42 and 44, respectively, along their entire width W4 and W5. Generally, it is desirable to increase the width of the contact between the lateral lobes 42 and 44 and the contact surfaces 106 and 108 so that the lateral follower 80 is capable of carrying a larger valve lift load. Because the lateral follower 80 can move along the shaft 78 in response to a change in position of the cam assembly 38, the lateral lobes 40 and 42 and both of the contact surfaces 106 and 108 remain aligned to facilitate contact along substantially the entire width of the contact surfaces 106 and 108.

[0049] Referring to Figs. 3 and 14, a biasing member 116 is coupled to the follower body 54 and the lateral follower 80 such that the biasing member 116 biases the lateral follower 80 about the axis 79 of the shaft 78 upwardly in the direction of arrow 117 (Fig. 14). In the illustrated construction, the biasing member 116 is a torsion spring. In other constructions, the biasing member can take other suitable forms.

[0050] Referring to Fig. 2, the illustrated latching mechanism 58 includes a piston 120, a biasing member 122, a shaft 124, and an end cap or base 126. Referring to Fig. 9, the piston 120 is a generally cylindrical member that includes a blind bore 128. As illustrated, the portion of the piston 120 received in the bore 66 has a generally constant outer dimension. The piston 120 further includes a locking projection 130 that extends from an end of the piston 120. The locking projection 130 includes an upwardly facing surface 132 and a downwardly facing surface 134. As best seen in Fig. 9, the upwardly facing surface 132 of the locking projection 130 is generally planar.

[0051] Referring to Figs. 9 and 17, the illustrated piston 120 further includes vent apertures 136 that extend through the piston 120 and provide fluid communication between piston bore 128 and the exterior of the finger follower assembly 30.

[0052] Referring to Figs. 9-13, the piston 120 further includes a slot 138 that provides fluid communication between the concave socket 64 and the bore 128 of the piston 120. The slot 138 receives a tang or tab 140 that extends from the base 126. When the finger follower 30 is assembled, the base 126 is generally fixed with respect to the follower body 54 and the tang 140 engages the slot 138 to limit the amount of rotational movement of the piston 120 about the shaft 124. As best seen in Fig. 11, there is a gap 142 or clearance between the tang 140 and the piston 120 to provide only a limited amount of rotational movement of the piston 120 with respect to the base 126 and follower body 54. Referring to Fig. 9 and 11, the gap 142 allows the piston 120 to rotate in order to align the upwardly facing surface 132 of the piston 120 and the downwardly facing surface 96 of the lateral follower 80 when the surfaces 132 and 96 engage such that the surfaces 132 and 96 are generally parallel (Fig. 23). However, the slot 138 restricts rotation of the piston 120 in order to ensure that the locking projection 130 can be received in the aperture 94 of the lateral follower 80.

[0053] Referring to Fig. 9, the shaft 124 includes a first end portion 148 and a second end portion 150. The second end portion 150 includes a recess 152 that receives a clip 154 to couple the base 126 to the shaft 124. The first end portion 148 includes an enlarged end portion or shoulder 156 that acts as a stop for the biasing member 122. The illustrated biasing member 122 is a tapered coil spring. The biasing member 122 includes a first end 157a and a second end 157b and the biasing member 122 is tapered such that the outer dimension of the coil spring is smaller at the first end 157a and larger at the second end 157b. The first end 157a of the biasing member 122 acts against the enlarged end portion 156 of the shaft 124 and the second end 157b of the biasing member 122 acts against a washer member 158 that is between the second end 157b of the biasing member 122 and a clip 160 that is received in a recess 162 formed in the piston 120. The biasing member 122 biases the piston 120 toward the retracted or unlatched position shown in Fig. 16.

[0054] Referring to Fig. 9, 13, and 14, the illustrated latching mechanism 58 is a generally fully self contained latching mechanism that is received in the bore 66 formed in the first end portion 60 of the follower body 54. The illustrated latching mechanism 58 has a relatively low mass moment of inertia because of the compact nature of the latching member 58. The low mass moment of inertia of the finger follower 30 is also facilitated by the latch mechanism 58 being located relatively close to spherical socket 64, which is the location where the finger follower 30 pivots.

[0055] As best seen in Figs. 14 and 15, when the latching mechanism 58 is assembled with the follower body 54, the biasing member 116 of the lateral follower 80 is able to contact the engagement portion 130 of the piston 120. Therefore, regardless of the axial location of the lateral follower 80 with respect to the shaft 78 or whether the piston 120 is in the retracted or extended position, the biasing member 116 does not block the piston 120 from moving into to the aperture 94 of the lateral follower 80.

[0056] Referring to Fig. 1, during operation of the engine, the camshaft 34 rotates about the camshaft axis 36 and oil is supplied from a pressurized source to the finger follower assembly 30 through the lash adjuster 50.

[0057] Referring to Fig. 1 and 14-16, oil enters the finger follower assembly from the lash adjuster 50 and passes through an aperture 144 between the socket 64 and the bore 66, and then passes through the slot 138 in the piston 120. When low lift of the engine valve 52 is desired,

the oil supplied to the finger follower 30 is at a relatively low pressure. Therefore, the biasing member 122, which has a natural tendency to expand in the illustrated construction, retains the piston 120 in the unlatched or retracted position (Figs. 15-17).

[0058] With the piston 120 in the unlatched position, the high lift or lateral lobes 42 and 44 will contact surfaces 106 and 108 of the lateral follower 80 and cause a pivoting force on the lateral follower 80. In the unlocked condition, the lateral follower 80 simply pivots about the shaft axis 79 without imparting any significant force on the finger body 54. The lateral follower 80 is biased toward the lateral lobes 42 and 44 by the biasing member 116 and therefore the contact surfaces 106 and 108 generally remain in contact with the lateral lobes 42 and 44. Meanwhile, the central or low lift lobe 40 contacts the central follower 82 to cause the outer race 86 to rotate about the shaft 78. The lift of the valve 52 is controlled by the low lift lobe 40 through the central follower 82.

[0059] Referring to Fig. 9, the loose fit of the inner race 84 on the shaft 78 enables relative rotational and axial movement of the inner race 84 with respect to the shaft 78. Relative rotational motion of the inner race 84 with respect to the shaft 78 allows the inner race 84 to precess with respect to the shaft 78. Precessing of the inner race 84 extends the life of the central follower 82 because the number of fatigue cycles at any given portion of the inner race 84 is reduced.

[0060] Referring to Figs. 1 and 17-19, when high lift of the engine valve 52 is desired, the oil supplied from the lash adjuster 50 increases. Once the oil pressure is at a sufficient pressure to compress the biasing member 122, the piston 120 moves from the retracted or unlatched position (Fig. 16) to the extended or latched position (Fig. 19).

[0061] Fig. 9 illustrates the piston 120 in a partially extended position. The tapered biasing member 122 facilitates travel of the oil, generally indicated by the arrows 170, around the biasing member 122 in order to allow the pressurized oil to extend the piston 120.

[0062] Referring to Figs. 1 and 17-19, in the extended position the locking projection 130 of the piston 120 extends into the aperture 94 of the lateral follower 80 thereby interconnecting the lateral follower 80 and the follower body 54. Thus, as the lateral or high lift lobes 42 and 44 contact the lateral follower 80 the finger follower assembly 30 pivots on the lash adjuster 50 to provide relatively high lift of the engine valve 52. Meanwhile, a limited amount of oil is allowed to escape from the bore 126 of the piston 120 through the vent apertures 136 to provide lubrication for the lateral follower 80, the central follower 82, and the cams 40, 42, and 44.

[0063] Referring to Figs. 9, 19, and 22, when the locking projection 130 is received within the aperture 94 of the lateral follower 80 there is clearance between the locking projection 130 and the lateral follower 80 to allow the locking projection 130 to be received within the aperture 94 without resistance. Therefore, when the lateral lobes 42 and 44 push downwardly on the lateral follower 80, the lateral follower 80 rotates from the position of Fig. 19 to the position of Fig. 22, where the convex downwardly facing engagement surface 96 (Fig. 9) of the lateral follower 80 contacts the planar upwardly facing engagement surface 132 of the piston 120. The convex curvature of the downwardly facing surface 96 minimizes the stress concentrations created between the engagement surfaces 96, 132 when the lateral follower 80 is forced into contact with the piston 120, regardless of manufacturing variation that would cause the surfaces 96, 132 to contact in slightly different orientations.

[0064] Referring to Figs. 9 and 16, when the oil pressure is decreased to a pre-determined level, the spring 122 begins to expand to move the piston 120 back to the retracted or unlatch position (Fig. 16). Excess oil within the bore 128 of the piston 120 vents through the vent apertures 136 or through other passageways created between the latching mechanism 58 and the follower body 54. With the piston 120 in the retracted position, the lateral follower 80 pivots with respect to the follower body 54 and the engine valve 52 is returned to low lift operation.

[0065] Figs. 23-32 illustrate an alternative construction of the finger follower assembly 30 of Figs. 1-22. The finger follower assembly 230 of Figs. 23-32 is substantially the same as the finger follower assembly 30 of Fig. 1-22 and like components have been given like reference numbers plus 200 and only the general differences will be discussed below.

[0066] The illustrated latching mechanism 258 is of a slightly different construction from the latching mechanism 58 described above. The biasing member 322 is of a different configuration having a generally cylindrical coil diameter instead of the tapered diameter of the biasing member 122. Additionally, hooked ends 322a and 322b engage respective pins 379a and 379b that are coupled to the end cap 326 and the piston 320, respectively.

[0067] Referring to Figs. 26 and 27, the fmger follower assembly 230 includes a fluid venting system 380. The fluid venting system 380 includes a vent passageway 382, a secondary passageway 384, and a tertiary passageway 386 formed in the follower body 254.

[0068] The vent passageway 382 is in fluid communication with a fluid chamber 381 defined by the end cap or base 326, the bore 328 of the piston 320, and the bore 266 of the follower body 254 depending on the location of the piston 320. A plug 388 is located within the vent passageway 382 to substantially prevent fluid communication through the vent passageway 382 past the plug 388.

[0069] The secondary passageway 384 is adjacent the vent passageway 382. As best seen in Fig. 27, the secondary passageway 384 extends to the concave socket 264 such that the secondary passageway 384 is in fluid communication with the source of pressurized fluid supplied from the lash adjuster 50 of Fig. 1.

[0070] Referring to Fig. 26, a vent piston 390 is located within the secondary passageway 384. The vent piston

390 is biased in the direction of the arrow 392 by a biasing member 394 that acts against a plug 396.

[0071] In the illustrated construction, the tertiary passageway 386 is generally normal to the vent passageway 382 and the secondary passageway 384. The tertiary passageway 386 provides fluid communication between the vent passageway 382, the secondary passageway 384, and the outside of the finger follower 230.

[0072] Figs. 26 and 27 illustrate the piston 320 in the recessed or unlatched position such that the finger follower 230 is operating in the low valve lift mode of operation. As best seen in Fig. 26, the oil pressure is insufficient to move the vent piston 390 against the bias of the biasing member 394.

[0073] As illustrated in Figs. 28 and 29, as the oil pressure and oil flow from the lash adjuster 50 of Fig. 1 increases, the piston 320 begins to extend from the bore 266. In addition, the increased oil flow and pressure, generally indicated by the arrow 395, moves the vent piston 390 against the force of the biasing member 394 until the vent piston 390 contacts the plug 388. As the vent piston 390 moves from the position of Fig. 26 to the position of Fig. 28 air or fluid between the plug 396 and the vent piston 390 is allowed to escape through an aperture 397 defined by the plug 396. With the vent piston 390 in the position illustrated Fig. 28, fluid communication is inhibited through the vent passageway 382 and the secondary passageway 384 due to the blockage created by the vent piston 390.

[0074] As illustrated in Figs. 30 and 31, when the piston 320 moves to the fully extended position (i.e., high valve lift mode), the piston 320 uncovers the vent passageway 382 and oil flows into the vent passageway 382, generally indicated by the arrow 398. However, as best seen in Fig. 30, the vent piston 390 substantially prevents escape of oil from the vent passageway 382 through the tertiary passageway 386. Therefore, adequate oil pressure is maintained within the fluid chamber 381 to maintain the piston 320 in the extended or latched position, which allows the finger follower assembly 230 to operate the engine valve 52 (Fig. 1) in the high lift mode.

[0075] Referring to Fig. 23 and 25, during both the high lift and low lift modes of operation (i.e., piston 320 extended and retracted, respectfully) oil is allowed to escape from the fluid chamber 381 through the vent apertures 336 to provide lubrication to the lateral follower 280, central follower 282, and the cam lobes. During the high lift mode, the oil is supplied by the lash adjuster 50 (Fig. 1) at a sufficient quantity and pressure such that the oil that escapes through the vent apertures 336 does not substantially reduce the oil pressure in the fluid chamber 381 such that the piston biasing member 322 retracts the piston 320.

[0076] Referring to Figs. 32 and 33, when the finger follower assembly 230 returns to the low lift mode of operation, the oil pressure in the fluid chamber 381 decreases because of the lower pressure supplied by the lash adjuster 50 (Fig. 1). As the oil pressure decreases, the vent plug biasing member 394 overcomes the pressure of the oil to move the vent piston 390 back to the position illustrated in Fig. 32. Therefore, oil within the vent passageway 382 and the fluid chamber 381 flows, as generally indicated by the arrow 398, from the vent passageway 382 through the tertiary passageway 386 to the exterior of the finger follower assembly 320. Therefore, oil is quickly evacuated from the fluid chamber 381, allowing the piston biasing member 322 to return the piston 320 to the retracted position more rapidly than if the finger follower assembly included only the vent passageways 336 (Fig. 23). In an alternative embodiment, the vent apertures 336 can be eliminated and the finger follower assembly and cam assembly can be lubricated using oil from other passageways created in the finger follower assembly.

[0077] Various features and advantages are set forth in the following claims.

Claims

1. A finger follower assembly for variably activating a valve of an internal combustion engine, the finger follower assembly comprising:

   a follower body having a first end portion configured to couple to the engine, a second end portion configured to couple to the valve of the engine, and an aperture formed in the first end portion;
   a cam follower supported by the follower body; and
   a latching mechanism operable to selectively engage and disengage the cam follower to provide a first valve lift capability and a second valve lift capability, the latching mechanism including, a base portion, a piston movable relative to the base portion between an extended position and a retracted position, and a biasing member coupled between the base portion and the piston to bias the piston toward the retracted position, and wherein the base portion, the piston, and the biasing member are at least partially located within the aperture.

2. The finger follower assembly of claim 1, wherein the biasing member is a tapered spring.

3. The finger follower assembly of claim 1, wherein the aperture has a generally uniform inner dimension.

4. The finger follower assembly of claim 3, wherein the aperture is a cylindrical bore having a generally constant diameter.

5. The finger follower assembly of claim 1, wherein the base portion includes a tang, wherein the piston in-

cludes a slot, and wherein the tang is received within the slot of the piston to provide for a limited amount of rotation of the piston with respect to the follower body.

6. The finger follower assembly of claim 1, wherein a portion of the piston is located within the aperture, and wherein the portion of the piston has a generally constant outer dimension.

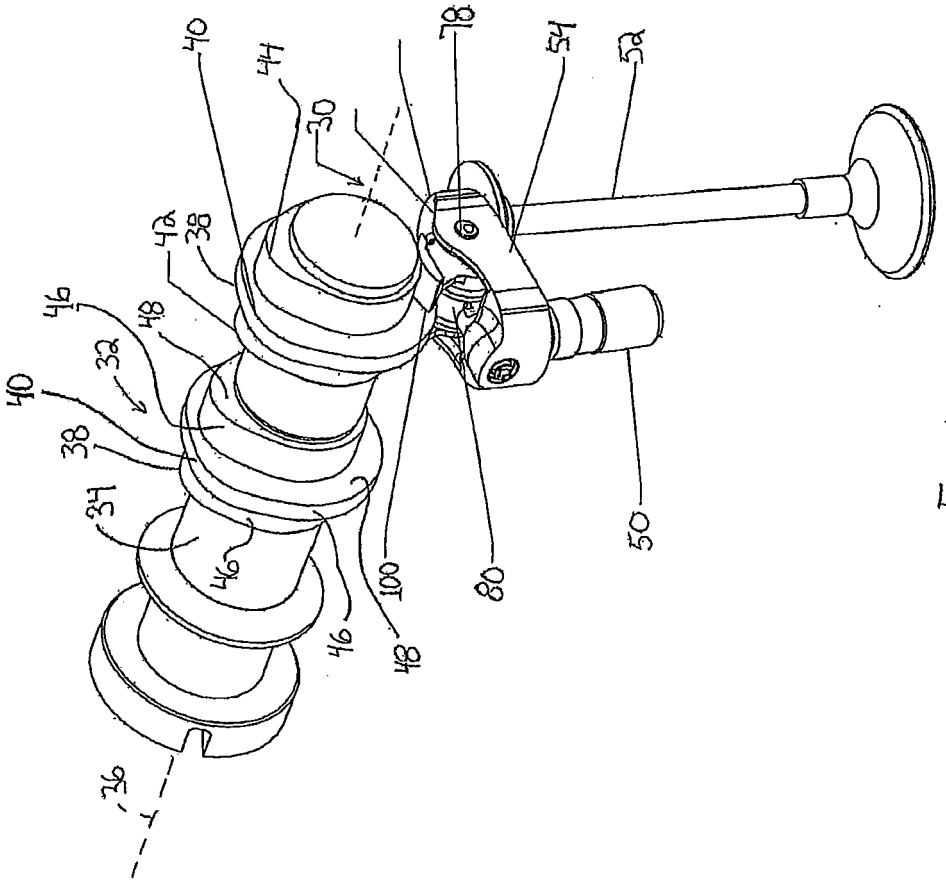


FIG. 1

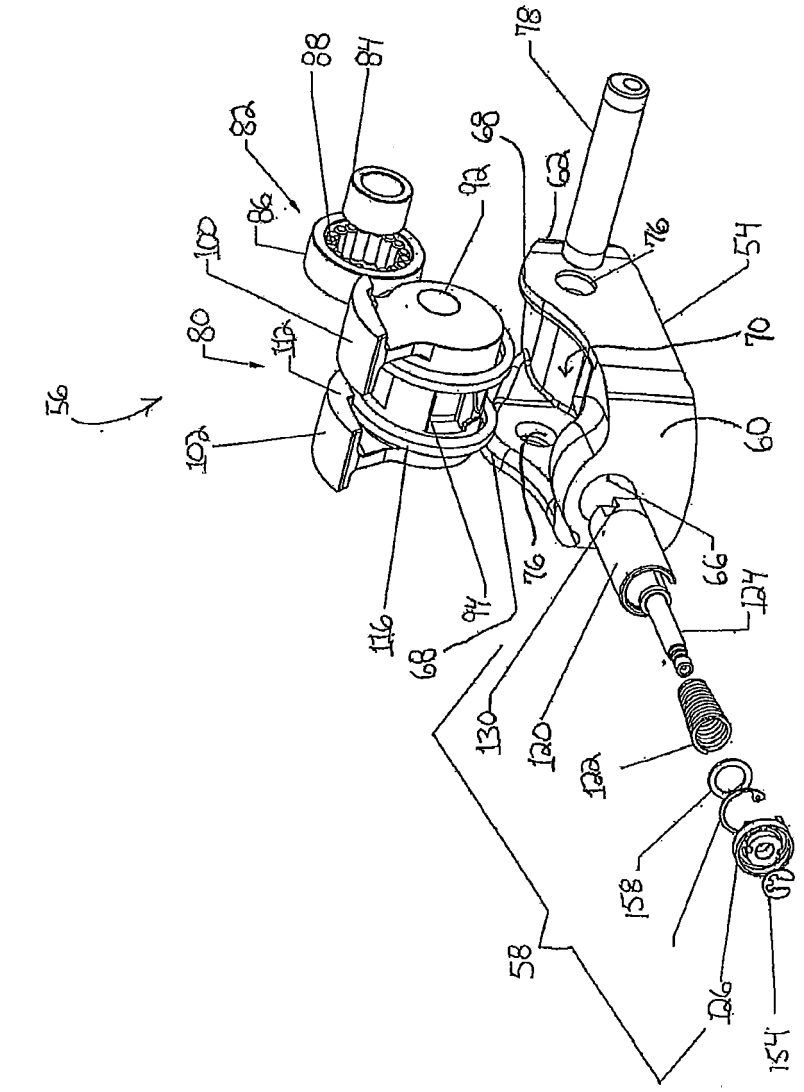

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FIG. 2

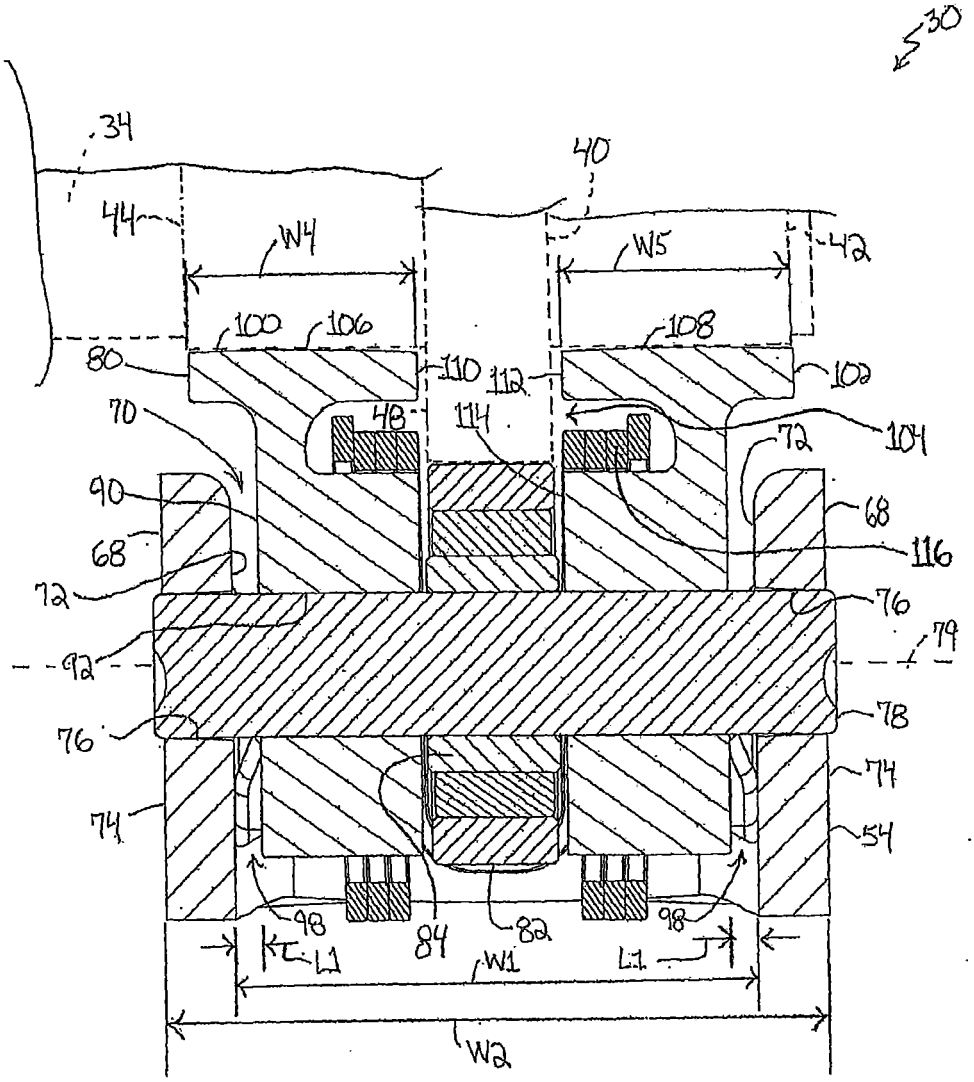

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FIG. 3

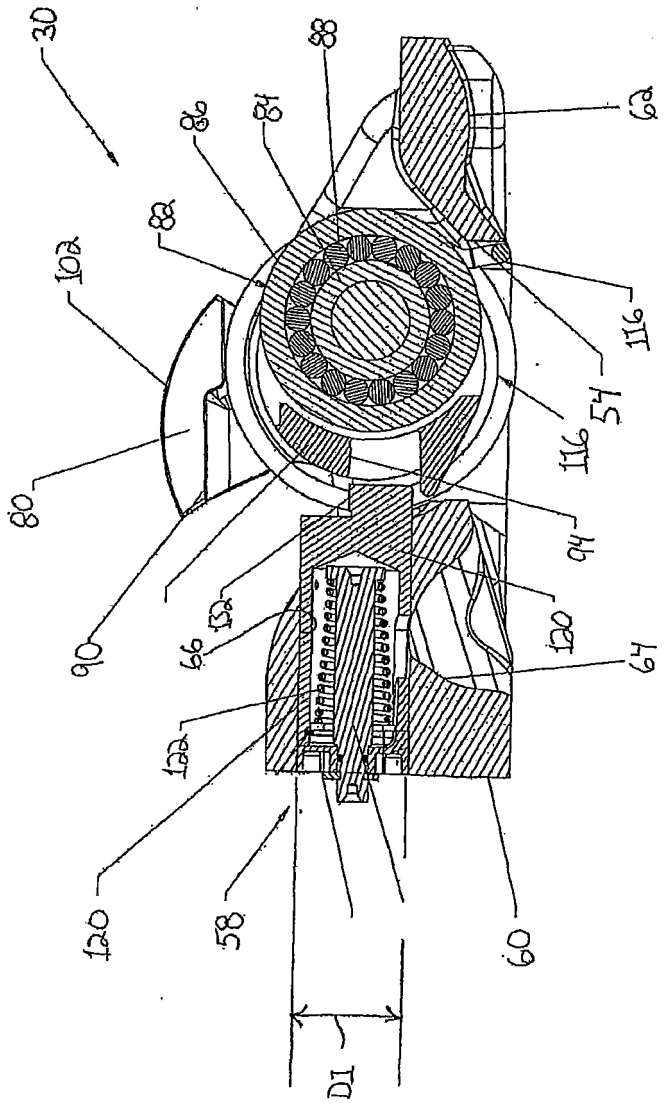


FIG. 4

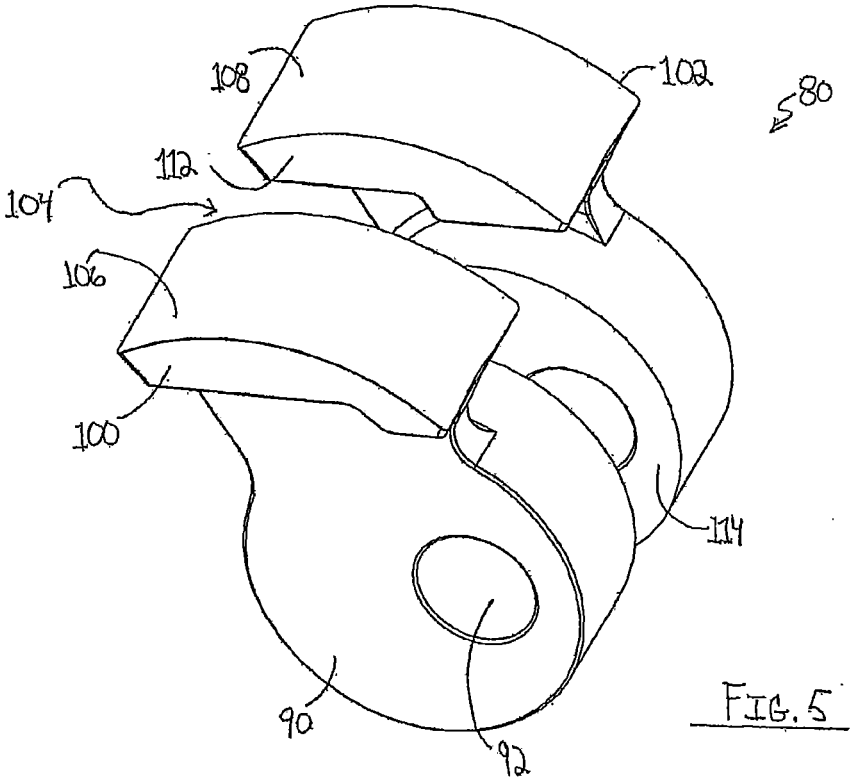

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FIG. 5

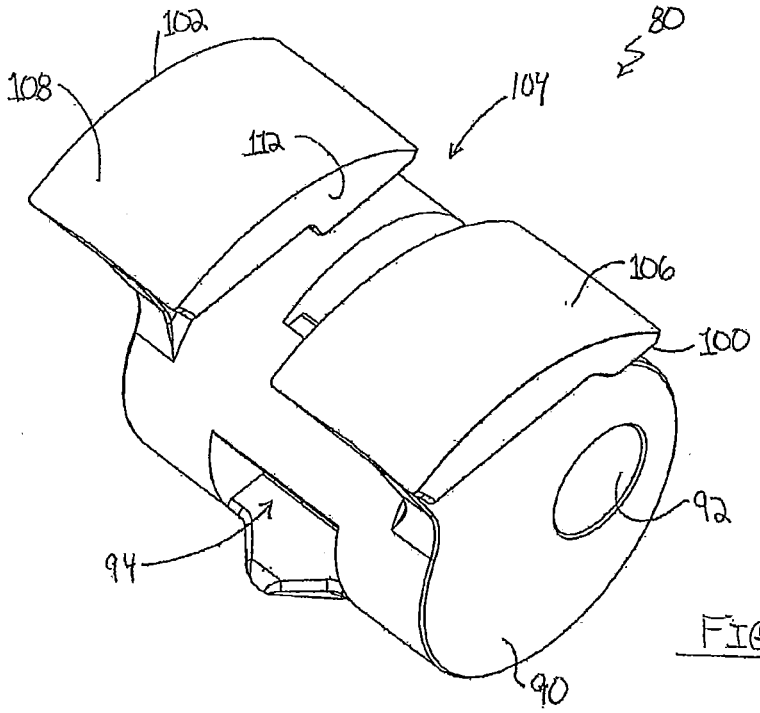

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FIG. 6

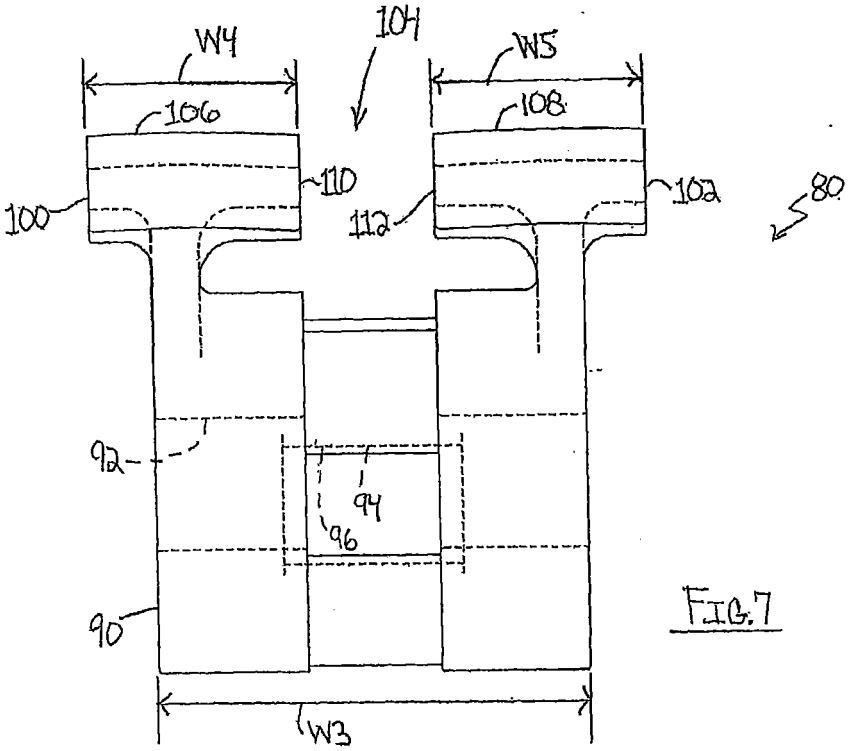


FIG. 7

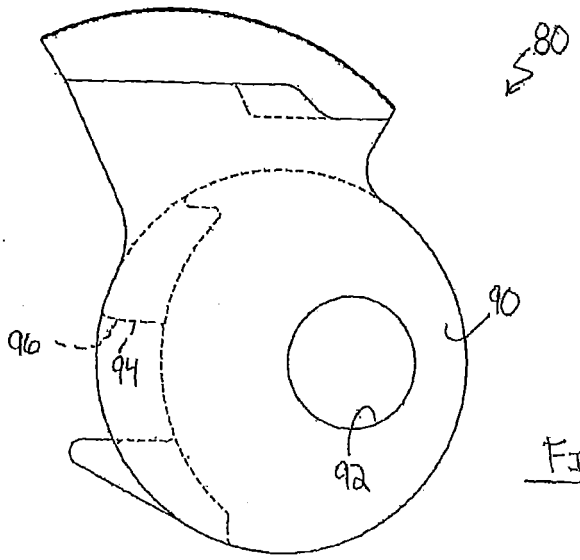


FIG. 8

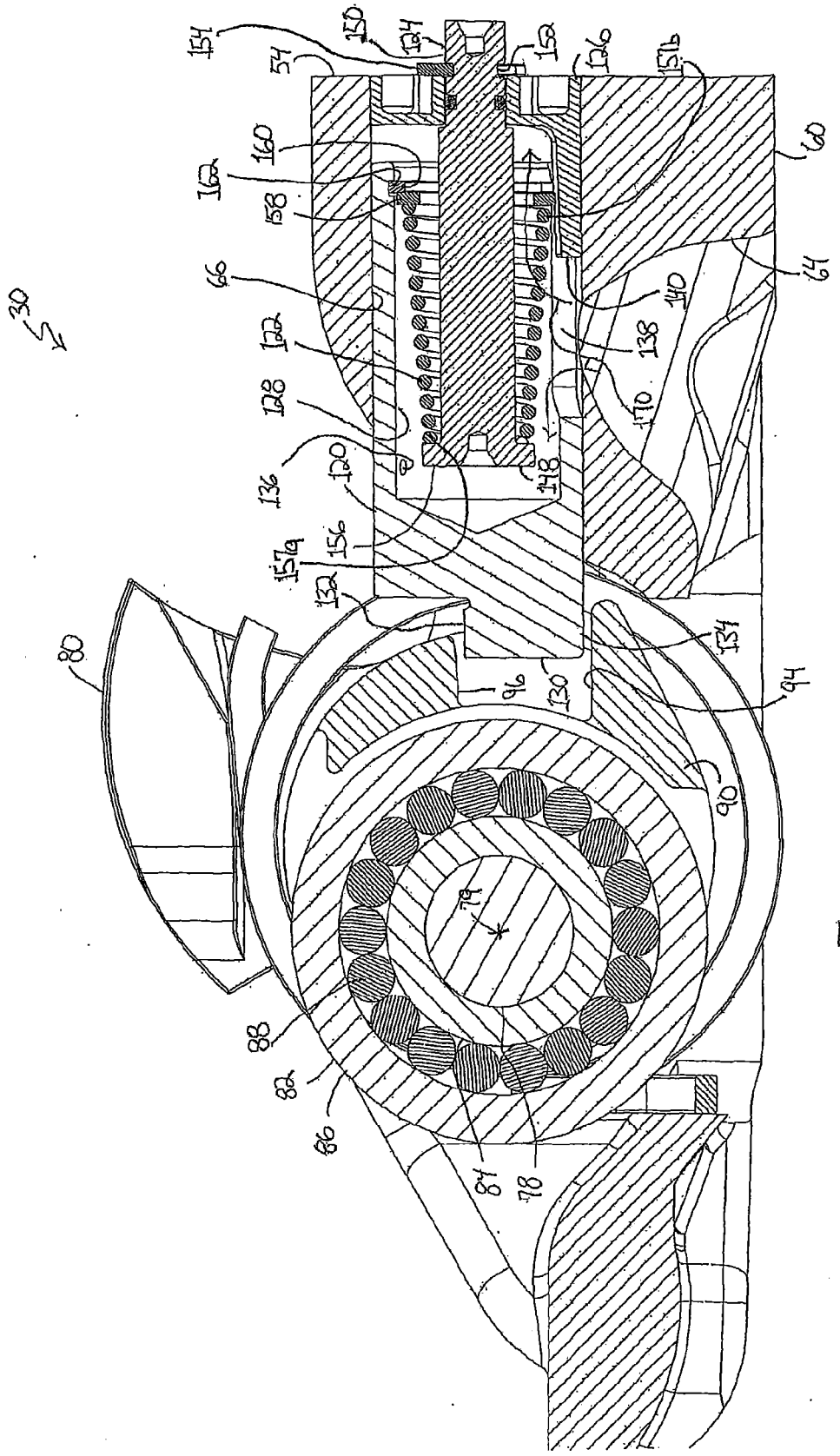

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FIG. 9

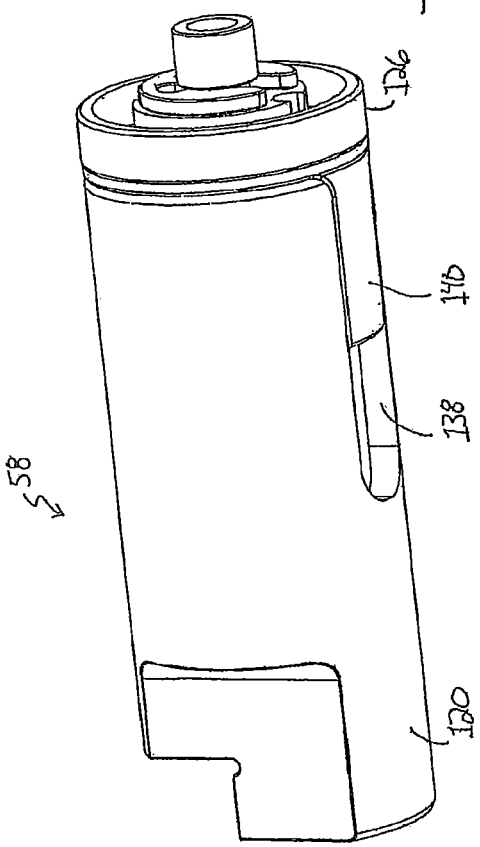


FIG. 10

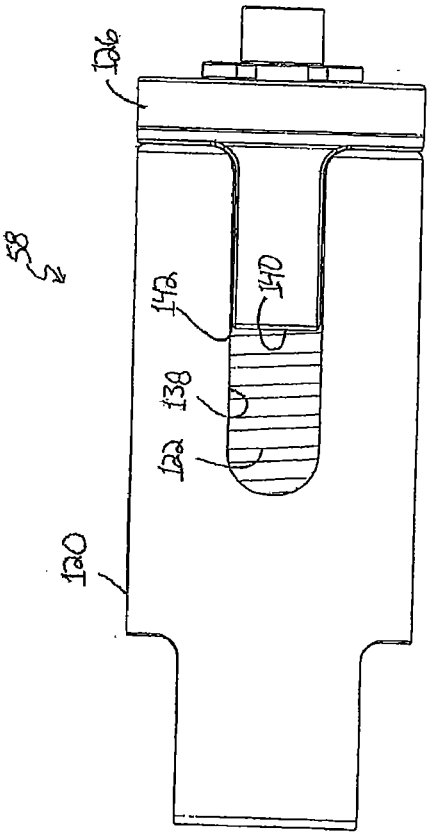


FIG. 11

FIG. 12

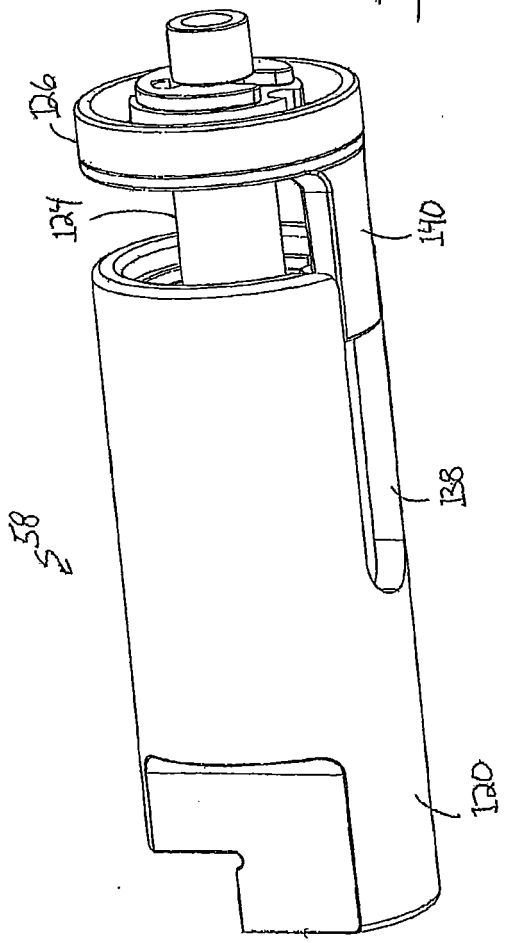
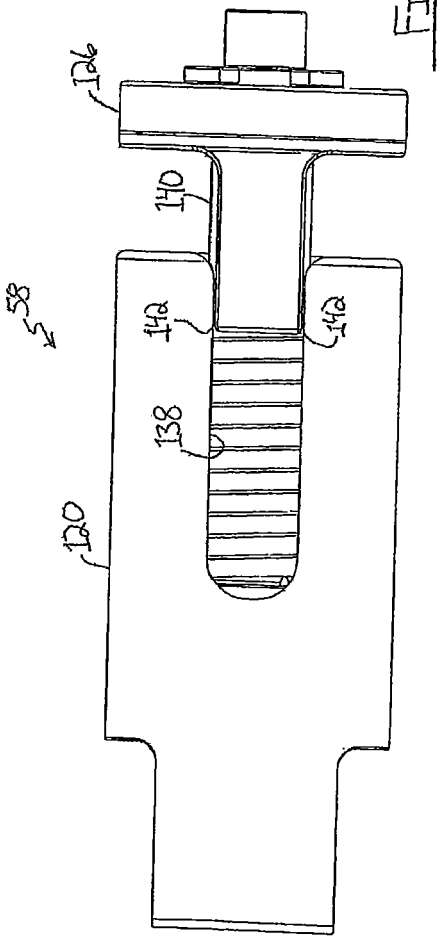


FIG. 13



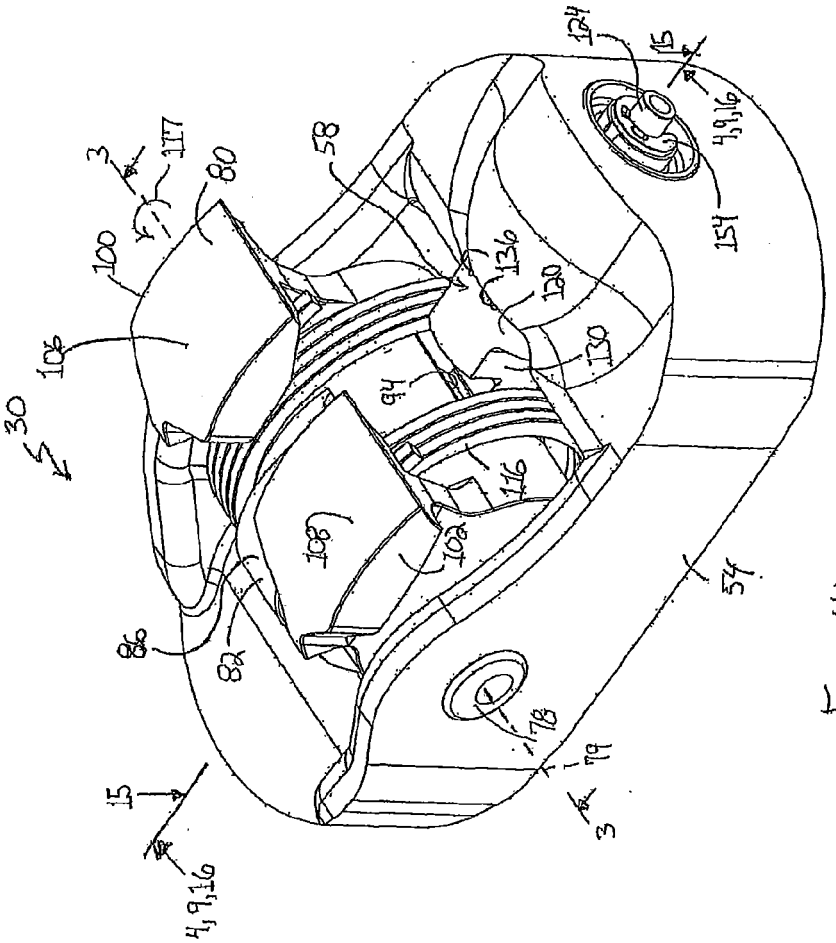


FIG. 14

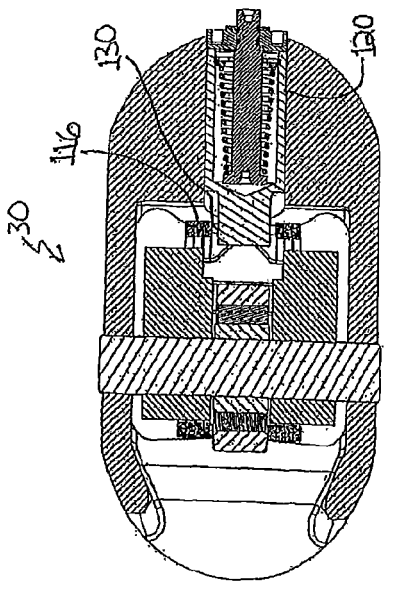


FIG. 15

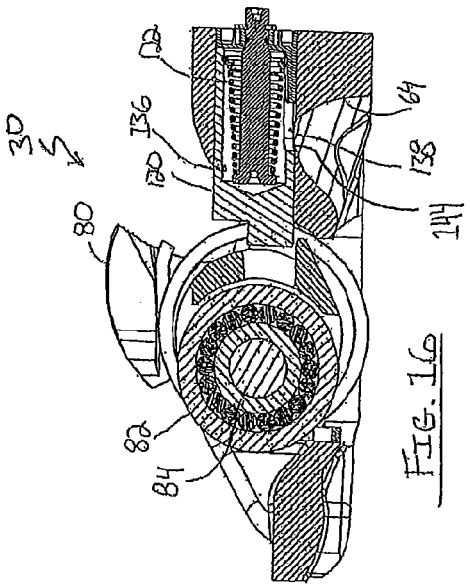


FIG. 16

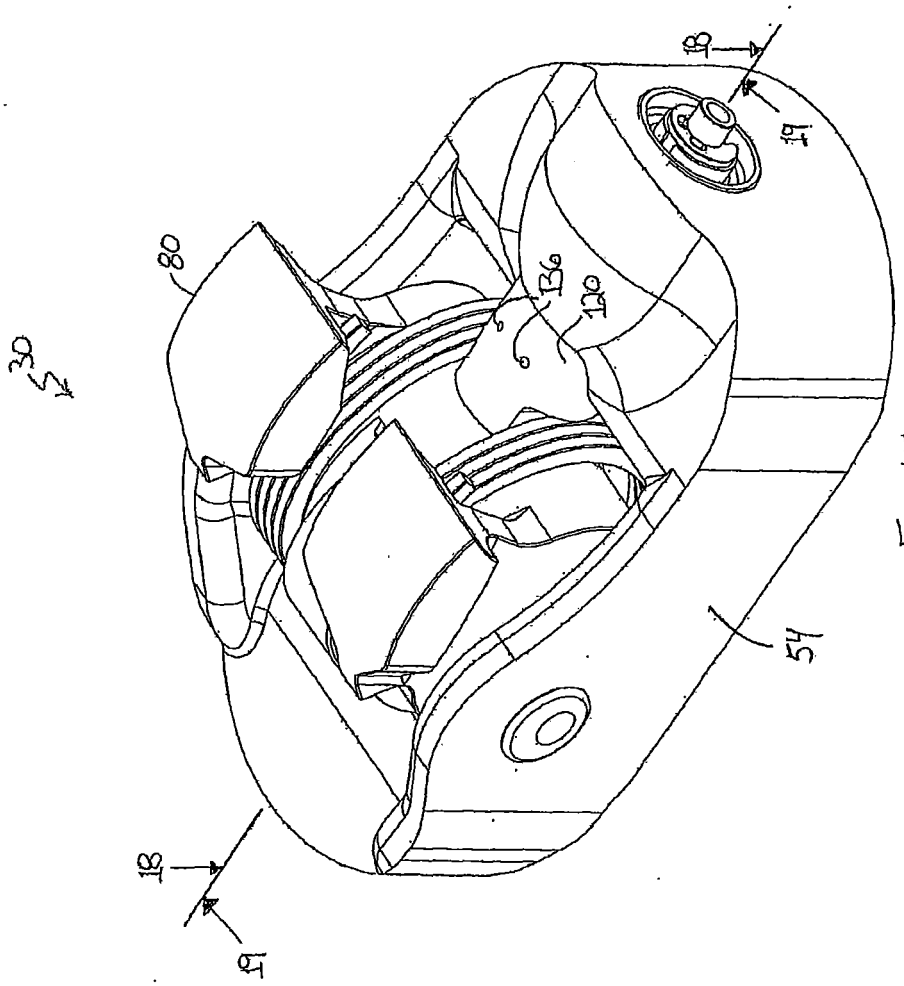


FIG. 17

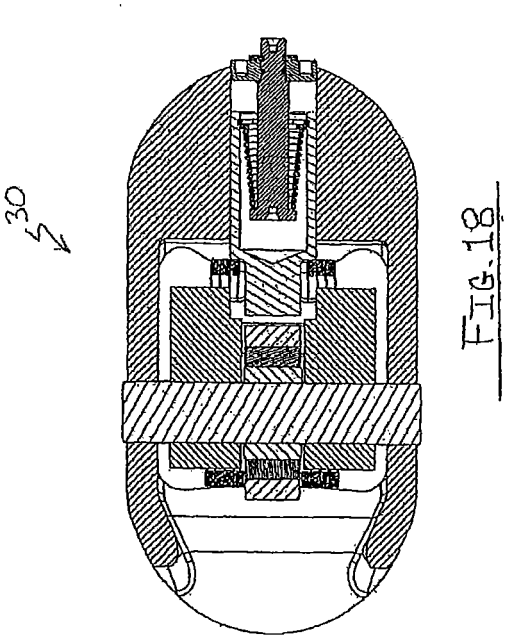


FIG. 18

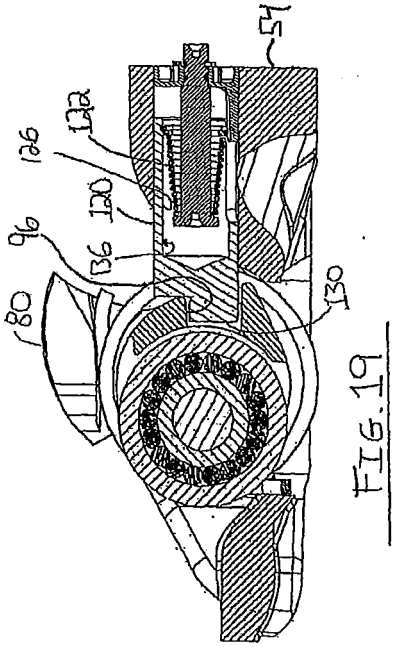


FIG. 19

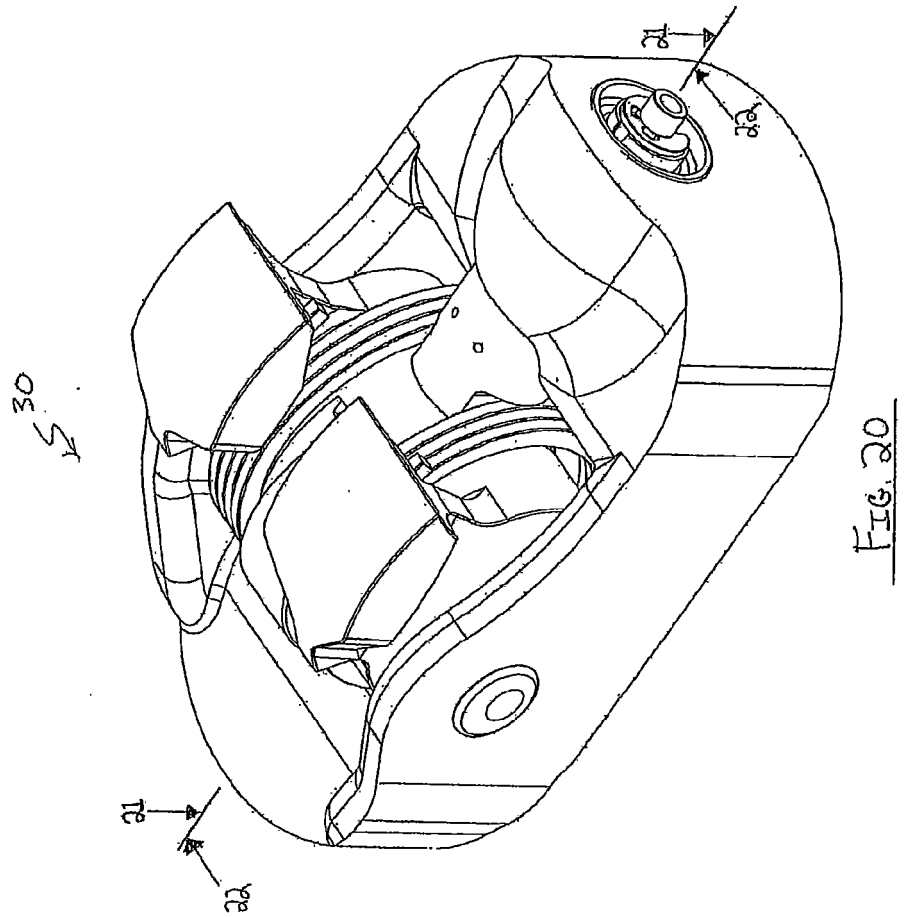


FIG. 20

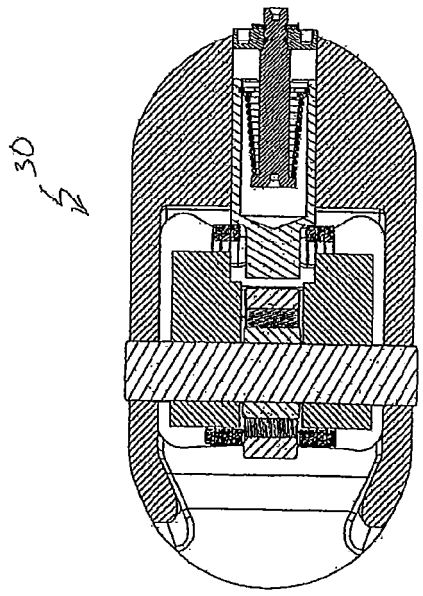


FIG. 21

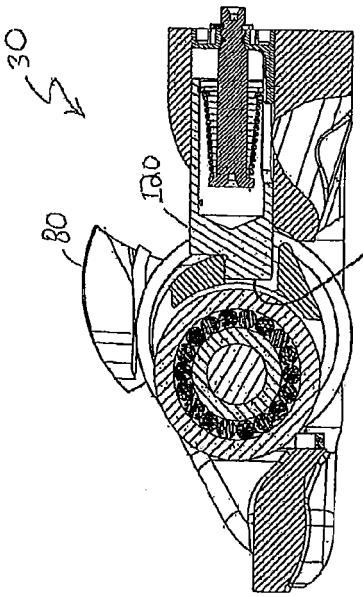


FIG. 22

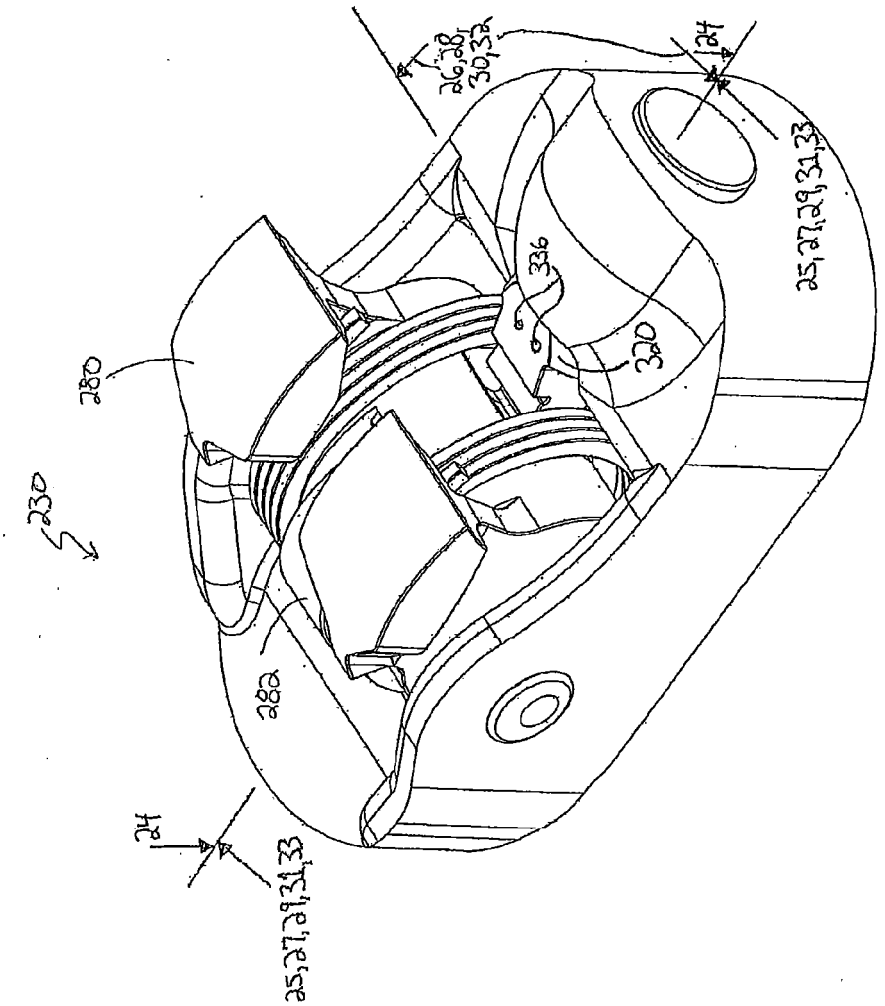


FIG. 23

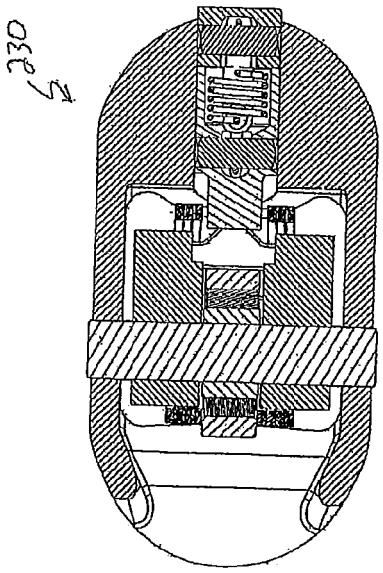


FIG. 24

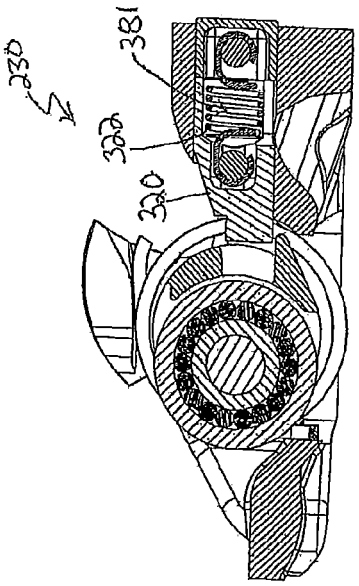


FIG. 25

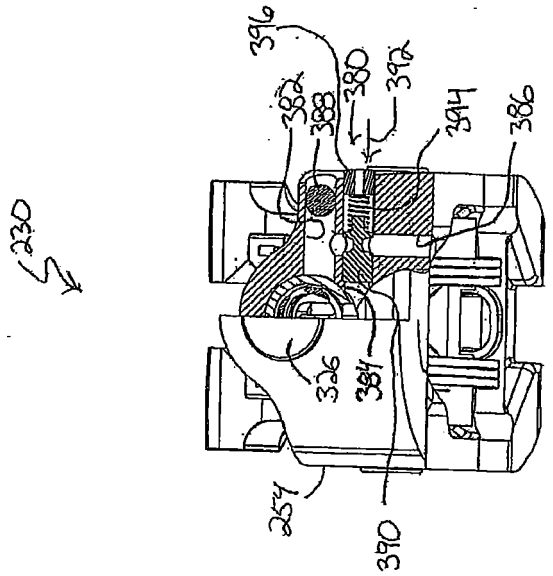

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FIG. 26

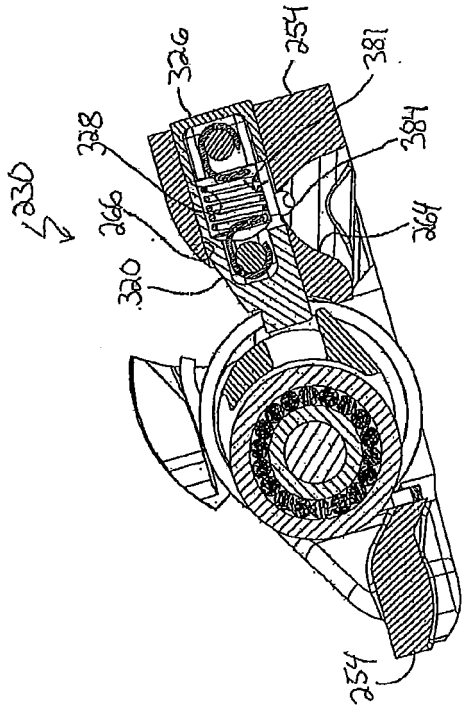

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FIG. 27

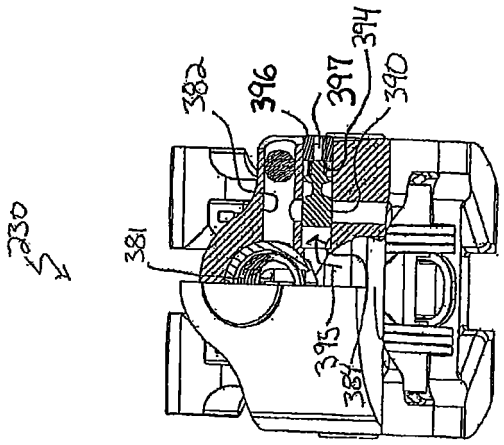


FIG. 28

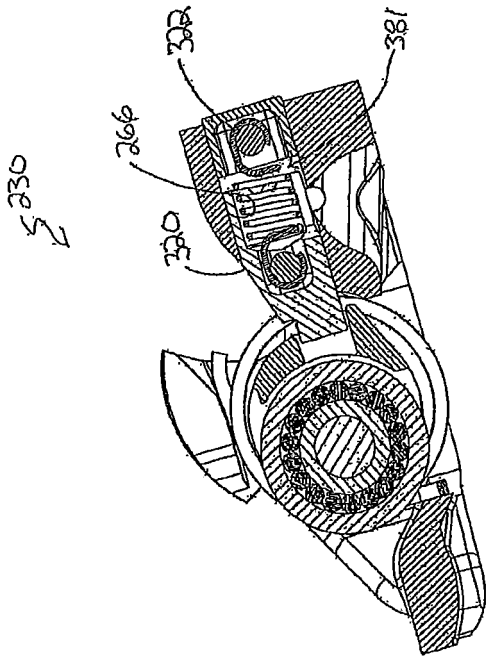


FIG. 29

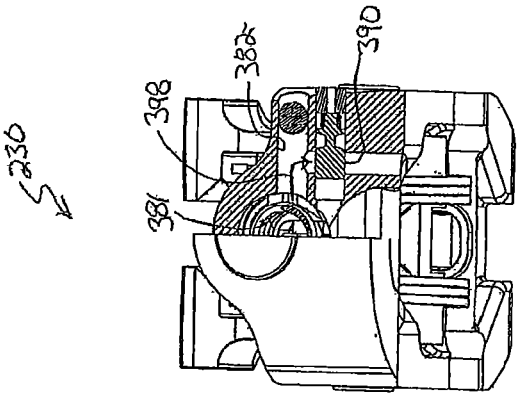


FIG. 30

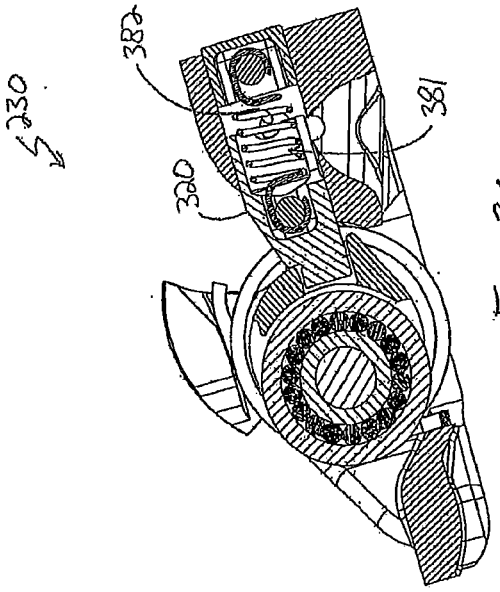


FIG. 31

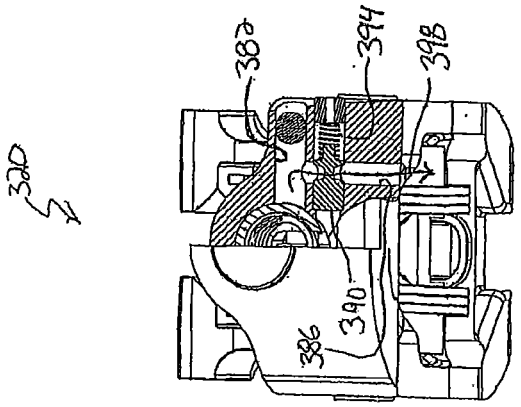


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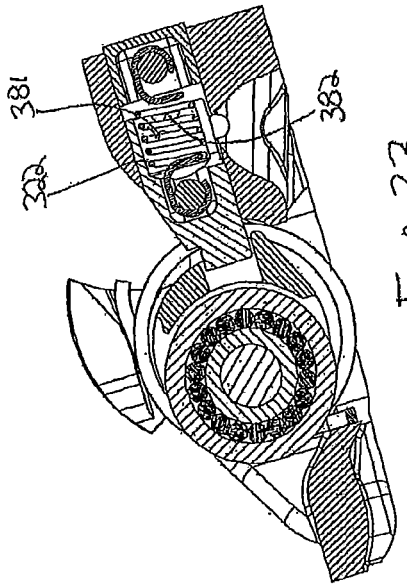


FIG. 33

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 10 18 6083

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	WO 2004/094791 A1 (INA SCHAEFFLER KG [DE]; SEITZ JOACHIM [DE]; ROERIG BODO [DE]; OPIPARI) 4 November 2004 (2004-11-04) * figure 2 *	1,3,4,6 2,5	INV. F01L1/18 F01L13/00
X	US 2003/209216 A1 (KREUTER PETER [DE]) 13 November 2003 (2003-11-13) * paragraph [0028] *	1,3,4,6	
X	DE 103 45 307 A1 (INA SCHAEFFLER KG [DE]) 14 April 2005 (2005-04-14) * figure 1 *	1	
Y	DE 196 06 796 A1 (AUDI NSU AUTO UNION AG [DE]) 7 November 1996 (1996-11-07) * figure 3 *	2	
Y	US 4 739 675 A (CONNELL CALVIN C [US]) 26 April 1988 (1988-04-26) * figure 1 *	5	

TECHNICAL FIELDS SEARCHED (IPC)

F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 February 2011	Clot, Pierre

CATEGORY OF CITED DOCUMENTS

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1

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16-02-2011

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82