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(54) **Variable valve timing mechanism**

Variable Ventilsteuervorrichtung

Commande de soupape à calage variable

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Description

[0001] This invention relates to an engine valve actuating system and more particularly to an improved arrangement for achieving variable valve actuation (timing and/or lift) in the operation of an engine valve comprising an improved lash adjustment arrangement.

[0002] As is well-known, many factors in an internal combustion engine represent a design compromise. Generally, the compromise is between achieving good low-speed performance and economy and high output and high power. There has been proposed a wide variety of devices, however, so as to permit the engine characteristics to be adjusted during its running, so as to obtain improved performance across the entire speed and load range. One of these features is variable valve actuation which includes both changing the valve timing and/or the valve lift. Obviously, these present substantial challenges to the engineer considering that the adjustment must be made when the engine is running.

[0003] A wide variety of mechanisms have been proposed for achieving either or both of the variable valve timing and variable valve lift. For the most part, however, they are fairly complex and add significantly to the complexity of the valve train.

[0004] EP-A-0 452 671 discloses a valve actuating mechanism comprising a rocker shaft rotatably supported to a cylinder head of an engine and having eccentric large-diameter portions formed as bushings on the way of the rocker shaft, rocker arms including a first rocker arm rotatably mounted directly on the rocker shaft and second and third rocker arms rotatably mounted on the bushings with the first rocker arm being interposed therebetween, and a cam assembly including first, second and third cam members which drive the first, second and third rocker arms, respectively. The second and third cams have the same cam profiles and the first cam has a cam profile different from those of the second and third cams. A driving mechanism for rotating the rocker shaft is connected to one end of the rocker shaft and comprises a hydraulic cylinder, a rack connected thereto and a pinion formed on the one end of the rocker shaft so as to be engaged with the rack from the upper side of the cylinder head. A stopper mechanism for controlling a sliding position of the rocker shaft is composed of a stopper groove formed to the cylinder head, a stopper screw engaged with the stopper groove and a stopper member disposed to the other end portion of the rocker shaft.

[0005] It was, therefore, a principal object of our earlier invention (see EP-A-834 647) to provide an improved variable valve actuating mechanism that was relatively simple in construction and which lent itself to incorporation in multi-valve engines.

[0006] This was achieved by providing a valve operating mechanism comprised of a single cam shaft having a pair of adjacent cams. A pair of adjacent, pivotally supported rocker arms, each cooperated with a respective one of the cams. A first of the rocker arms had an operating portion for direct cooperation with the valve stem for operating the valve. Means provided a selective coupling of the second rocker arm to the first rocker arm for effecting actuation of the valve through the first rocker arm. Thus, by providing different characteristics of the cam and rocker arms, varying lift and/or duration was achieved.

[0007] In order to provide the coupling between the first and second rocker arms and to adjust for wear and other conditions, a mechanism was provided for permitting adjustment in the relationship between the two rocker arms. This utilized a conventional type of adjusting screw.

[0008] The use of the adjusting screw somewhat complicates the overall valve mechanism and further requires sufficient clearances so that the screw can be adjusted and so that the relative movement between the rocker arms can be accommodated.

[0009] It is, therefore, a principal object of this invention to provide an improved construction of this type wherein the interrelationship between the two rocker arms is simplified while adjustment potential is still maintained. This object is achieved with the features of claim 1.

[0010] This invention is adapted to be embodied in the valve actuating mechanism for operating a single poppet valve of an engine through cooperation with the stem thereof. The valve operating mechanism is comprised of a single cam shaft having a pair of adjacent cams. A pair of adjacent, pivotally supported rocker arms, each cooperate with a respective one of the cams. A first of the rocker arms has an operating portion for direct cooperation with the valve stem for operating the valve. Means provide a selective, adjustable coupling of the second rocker arm to the first rocker arm for effecting actuation of the valve through the first rocker arm. This coupling includes a replaceable adjusting shim. Thus, by providing different characteristics of the cam and rocker arms, varying lift and/or duration can be achieved, adjustment is simplified and the construction can be more compact.

[0011] The invention is now described in detail in connection with the drawings.

Figure 1 is a top plan view looking at the valve actuating mechanism associated with a single cylinder of an internal combustion engine constructed in accordance with a first embodiment of the earlier invention (see EP-A-834 647), with the cam cover for the engine removed.

Figure 2 is an exploded view showing the same components illustrated in Figure 1 but illustrating only the cam shaft and the rocker arms associated therewith.

Figure 3 is a cross-sectional view taken along the line 3-3 of Figure 1 and illustrates one of the rocker arms and its association with the cam shaft.

Figure 4 is a cross-sectional view taken along the

line 4-4 of Figure 1 and shows the valve in its closed position.

Figure 5 is a cross-sectional view, in part similar to Figure 4, and shows the valve in its open position when opened by the first rocker arm.

Figure 6 is an enlarged cross-sectional view taken along the same plane as Figures 4 and 5, and shows the same condition in Figure 4, i.e., with the valve closed.

Figure 7 is a cross-sectional view taken along the line 7-7 of Figure 6.

Figure 8 is a cross-sectional view taken along the same plane as Figure 6 and shows the arrangement when the second rocker arm is coupled to the first rocker arm and is effective to operate the first rocker arm and the valve therethrough.

Figure 9 is a cross-sectional view taken along the line 9-9 of Figure 8.

Figure 10 is a cross-sectional view, in part similar to Figures 4 and 5, but shows the valve in its fully opened position when operated by the second rocker arm acting through the first rocker arm.

Figure 11 is a partially schematic view showing an induction system for the engine and an ancillary intake control system that may be utilized in conjunction with the various valve operating embodiments disclosed herein.

Figure 12 is a view, in part similar to Figure 1, and shows another embodiment of the prior invention where both valves of the same cylinder are operated by variable valve actuating mechanisms.

Figure 13 is a partially exploded view, in part similar to Figure 2, but shows the cam shaft and rocker arms of this embodiment.

Figure 14 is a cross-sectional view taken along the line 14-14 of Figure 12 and shows this intake valve in its opened position when opened by the first cam lobe.

Figure 15 is a cross-sectional view taken along the line 15-15 of Figure 12 and shows when the first intake valve is opened by the second cam lobe.

Figure 16 is an enlarged cross-sectional view taken along the same plane as Figure 14, but shows the operating mechanism when the valve is being opened by the first cam lobe.

Figure 17 is a cross-sectional view taken along the line 17-17 of Figure 16.

Figure 18 is a cross-sectional view taken along the line 18-18 of Figure 12 showing the second intake valve closed.

Figure 19 is an enlarged cross-sectional view taken along the same plane as Figure 18 and shows the valve actuating coupling arrangement between the second rocker arm and the valve.

Figure 20 is a cross-sectional view taken along the line 20-20 of Figure 19.

Figure 21 is a top plan view, in part similar to Figures 1 and 12, and shows yet another embodiment of the prior invention mechanism (see EP-A-834 647) employing variable valve actuating mechanism for both valves associated with a single cylinder of the engine.

Figure 22 is an exploded view, in part similar to Figures 2 and 13, but shows the cam shaft and rocker arms for this embodiment.

Figure 23 is a cross-sectional view, in part similar to Figure 3, but shows the other type of biasing arrangement for the second rocker arm used with this embodiment.

Figure 24 is a top plan view, in part similar to Figure 12, but shows an embodiment in accordance with this invention.

Figure 25 is an enlarged cross-sectional view taken along the line 25-25 of Figure 24.

[0012] Before describing in detail all of the embodiments, it should be noted that the embodiments of Figures 1-10, 11, 12-20, and 21-23 are substantially the same as embodiments shown and described in EP 0 834 647 A1. A description of these embodiments is incorporated herein, because the inventive structure, shown in detail in Figures 24 and 25 of the application, can be utilized with any of the types of structures shown in the prior application. That is, and as will become apparent, the adjusting mechanism for adjusting the interrelationship between the first and second rocker arms rather than using adjusting screws, as illustrated in the mentioned embodiments can be replaced by the shim type adjusting arrangement shown in Figures 24 and 25.

[0013] Referring now in detail to the drawings and initially to the embodiment of Figures 1-10, a portion of a cylinder head assembly of an internal combustion engine is illustrated and is identified generally by the reference numeral 31. Only a portion of the engine is illustrated and specifically the cylinder head thereof because the invention deals, as aforenoted, with a valve actuating mechanism for engines. Therefore, when any details of the construction of the engine are not illustrated, they may be considered to be conventional. Those skilled in the art will be able to determine from the following description how the invention can be utilized with a wide variety of engines.

[0014] In all of the embodiments illustrated, the depicted engine and cylinder head 31 are of the four valve cylinder type. This is because the invention has particular utility with multi-valve engines, for reasons which will become apparent. However, the invention can be utilized with engines having any number of valves including only two valves per cylinder or more than two valves in any number.

[0015] The cylinder head assembly 31 includes a main cylinder head member 32 which has an upper surface which carries a bearing and cam carrier 33 and which is closed by a cam cover 34.

[0016] As best seen in Figures 3-5 and 10, each cylinder of the engine is served by a pair of intake passages

35 that terminate in valve seats 36 which are valved by poppet-type intake valves, indicated generally by the reference numeral 37. These valves 37 have head portions 38 that cooperate with the valve seats 36 and stem portions 39 that are slidably supported in valve guides 41 affixed to the cylinder head member 32.

[0017] At their upper ends, keeper retainer assemblies 42 retain spring assemblies 43 that act between the keeper retainer assemblies 42 and the cylinder head for biasing the valves 37 to their closed positions, as is well-known in this art.

[0018] Referring now primarily to Figures 1 and 2, a cam shaft, indicated generally by the reference numeral 44, is journaled in the cam carrier 33 by bearing surfaces formed by it and bearing caps which are not illustrated. The cam shaft 44 has three lobes comprised of a first, center lobe 45, a second lobe 46, and a third lobe 47. Associated with these lobes 45-47 are first, second and third rocker arms, indicated generally by the reference numerals 48, 49 and 51. These rocker arms 48, 49 and 51 are all journaled on a common rocker arm shaft 52 that is carried by the cam carrier member 33 in any known manner.

[0019] As may be best seen from Figure 1, the cam lobes 45 and 46 and their cooperating rocker arms 48 and 49 are associated with one of the valves 37, the keeper retainer of which is indicated by the reference numeral 42-1. The remaining cam lobe 47 and rocker arm 51 are associated with and operate the remaining intake valve 37 and their association is indicated by the reference numeral 42-2, which identifies the keeper retainer of this remaining valve.

[0020] The first rocker arm 48 is a rocker arm which, under all conditions, operates the associated intake valve having a retainer 42-1. This rocker arm 48 has a follower portion 59 which is engaged with the cam lobe 45 and which is actuated by it. An actuating portion 61 extends integrally outwardly from the area adjacent the cam follower 59 and carries an adjusting screw 62 at its outer end which cooperates with the tip of the stem 39 of the associated valve. Thus, this rocker arm generally operates as a conventional rocker arm for the valve actuation during such time as the second rocker arm 49 is not coupled to it. This coupling method will be described later.

[0021] Referring now primarily to Figures 1-3, the second rocker arm 49 and its cooperation with the cam lobe 46 will be described. The rocker arm 49 has an outwardly extending arm which forms an integral follower 63 that is engaged by the cam lobe 46. At this point, it should be noted that the cam lobe 46 is of a larger lift and larger diameter than that of the cam lobe 45. This is readily apparent from Figure 10. In addition to providing a different lift, this cam lobe 46 may also be configured to provide slightly different timing through its cooperation with the first rocker arm 48.

[0022] Adjacent the follower surface 63, the rocker arm 49 is provided with a protrusion 64 that receives an adjusting screw 65. This adjusting screw 65 operates in conjunction with a coupling mechanism to, at times, control the operation of the first rocker arm 48. That mechanism will be described very shortly.

[0023] In order to maintain the rocker follower surface 63 in engagement with the cam lobe 46, a biasing arrangement shown in Figure 3 is provided. As seen in this Figure, a spring carrier 66 is affixed to the cam carrier 33 in a known manner. The spring carrier 66 is provided with a plurality of pockets, one for each rocker arm 49. A spring arrangement, indicated by the reference numeral 67, is supported in each of these pockets.

[0024] The spring arrangement includes an outer cylinder member 68 which defines a bore in which a sliding biasing member 69 is provided. The sliding biasing member 69 is biased by a coil compression spring 71 into engagement with a further follower surface 72 formed on a portion of the rocker arm 49 that extends in somewhat diametrical opposition to the portion that forms the follower surface 63. Thus, the spring 71 acting through the biasing member 69 and rocker arm surface 72 will maintain the rocker arm follower 63 in engagement with the cam lobe 46.

[0025] The mechanism for selectively coupling the rocker arm 49 to operate the rocker arm 48 will now be described by particular reference to Figures 4-10. Figures 4 through 7 show this coupling mechanism, which is indicated generally by the reference numeral 73, in the disengaged condition so that the first rocker arm 48 operates without any control or interference from the second rocker arm 43. Under this condition, the cam lobe 45 and first rocker arm 48 control the degree of maximum opening and timing of opening of the valve 37 with the fully-opened position being shown in Figure 5.

[0026] The rocker arm 48 has a boss portion 74 that is formed adjacent its follower surface 59 but below it. A cylindrical bore 75 is formed in this boss 74. A coupling plunger member, having a configuration shown in Figures 4-10 and indicated generally by the reference numeral 76, is slidably supported within this bore. This coupling plunger member 76 has a head or top portion 77 which is positioned to be and is engaged during the running of the engine by the screw 65.

[0027] As may be best seen in Figures 6 and 8, the lower end of the bore 74 is partially closed by a cap 78 which forms an engagement for a biasing spring 79 that acts on the lower end of the coupling plunger member 76. This spring 79 keeps the coupling plunger member 76 and specifically its surface 77 in constant engagement with the adjusting screw 65. It should be apparent, however, that if desired, some clearance may be maintained in this gap depending upon how the valve operation is to be accomplished. Also in some views the position of the plunger member 76 in the bore may not be the true position depending upon the lift characteristics of the respective cams 45 and 46 and specifically that of their lobes.

[0028] The coupling plunger member 76 is formed

with a bore 81 that extends from a flat surface 82 formed in a side thereof by a machined recess 83. Received within the bore 81 is a return spring arrangement that is comprised of a pair of end caps 85 and 86 that are urged apart by a coil compression spring 87.

[0029] In the uncoupled state when only the cam 45 is operating the valve 37, this compression spring 87 causes the retaining member 83 to be urged to a position where a flat surface of it is coextensive with the surface 82. Under this condition the surface 82 is engaged by a slidable locking member 88.

[0030] The locking member 88 is slidably supported within a bore 89 that extends through the rocker arm 48 below its journal on the rocker arm shaft 51. The outer end of this bore 89 is closed by a closure plug 91 and in the uncoupled state, the locking member 88 is abuttingly engaged with this closure plug 91.

[0031] The cooperation of the locking member 88 with the side of the surface 82 will permit reciprocation of the coupling plunger member 76 in the bore 75 between the position shown in Figure 4 which represents the closed condition and the position shown in Figure 6 which shows the condition when the intake valve 37 is opened to its maximum lift during the time when the cam lobe 45 is operating the rocker arm 48 so as to control the timing and lift of the valve 37. Rotation of the plunger member 76 in the bore 75 is, however, precluded by this co-action.

[0032] When the cam lobe 46 operates the rocker arm 49 to begin its lift, then the coupling plunger member 76 will be driven downwardly in the bore 75 as shown in Figure 6. Under this condition, no additional movement of the rocker arm 48 will occur and thus there is lost motion under this operation.

[0033] It should be noted that in the retracted position of the locking member 88, a gap 92 is provided between it and the end closure 91. This gap communicates with an oil control passage 93 that extends through the rocker arm shaft 51 and rocker arm 48. The rocker arm shaft 51 is hollow and hydraulic fluid pressure may be exerted selectively through this passage 73 to the area 92 in accordance with a desired control strategy. One such strategy will be described later by reference to the embodiment of Figure 11.

[0034] When this passage 93 is pressurized, as shown in Figures 8 and 9, the locking plunger 83, when it registers with the bore 81, will act on the retainer member 86 and force it inwardly and compress the spring 87. At this time, the rocker arms 48 and 49 will be coupled together and the rocker arm 49, because of its greater lift and timing, will actually control the opening degree of the valve so as to provide a greater lift under this coupled condition as clearly shown in Figure 10. By comparing Figure 10 with Figure 5, this greater lift condition can be readily appreciated.

[0035] When the hydraulic pressure in the passage 93 and area 92 is relieved, the spring 87 will urge the locking plunger 88 back to its disengaged position as shown in Figures 4-7.

[0036] Referring back to Figures 1 and 2, it will be seen that the rocker arm 51 and cam lobe 47 operate the remaining intake valve, which does not have its lift varied in this embodiment. The rocker arm 51 has a follower surface 94 that is engaged by the cam lobe 47. An aajusting screw 95 carried at the tip of this rocker arm cooperates with the stem of this valve to operate it in a normal manner. Varying types of lift arrangements may be employed and different lift ratios and/or valve timing between the non-variable actuated valve and the variable actuated valve. That is the lift and/or timing of the valve operated by the cam 47 may be the same as that provided by either of the cams 45 or 46 associated with the other valve or different from either of them.

[0037] Figure 11 is a view that shows one way in which this mechanism may operate. This view shows the induction system schematically and it now will be described by reference to that Figure. In this Figure, the normally or non-variably actuated valve is indicated by the reference numeral 37-2, while the variably actuated valve is indicated by the reference numeral 37-1. The intake passages 35 associated therewith have also been indicated by the same suffixes, i.e., 35-2 and 35-1.

[0038] In accordance with this embodiment, an air inlet device, indicated by the reference numeral 101, draws atmospheric air through an inlet opening 102 in which a manually actuated throttle control valve 103 is positioned. The air inlet device 101 forms a plenum chamber 104 that communicates with the runners 35-1 and 35-2 of each cylinder.

[0039] A control valve 105 is provided in the runner 35-2 and is operated by a servo motor 106 under the control of an ECU, indicated generally by the reference numeral 107.

[0040] In this embodiment, the intake valve 37-1 and its operation is adjusted to optimize primarily the low and mid-range performance of the engine. Thus, the cam lobe 45 and rocker arm 48 can be tailored for optimum performance under low-speed and low-mid range running. The cam lobe 46 and rocker arm 49 are coupled for a higher range of operation and may provide a substantially greater lift so as to improve the performance under higher speeds and loads.

[0041] Thus, the control strategy for the ECU is to sense throttle position or load and engine speed and be mapped so as to activate the servo motor 106 and maintain the throttle valve 105 in a closed position during low-speed and low-to-medium mid-range running.

[0042] As the speed and load increase, however, then the ECU effects opening of the control valve 105 by the servo motor 106. Thus, the engine can provide very good performance under a wide variety of speeds and loads due to the use of the variable valve actuating mechanism and the control valve 105.

[0043] The foregoing example is only one type of strategy that can be employed and the maximum lift for the valves 37-1 and 37-2 can be either the same or dif-

ferent depending upon the particular engine and tuning arrangement selected, as already noted.

[0044] Figures 12 and 20 show another embodiment wherein both of the intake valves 37-1 and 37-2 are provided with a variable valve actuating mechanism. In this particular embodiment, the cam shaft is provided with, in addition to, the lobes 45 and 46, for actuating the first intake valve 37-1, with additional lobes 151 and 152 for operating the rocker arms 48 and 49 associated with the remaining valve 37-2.

[0045] It should be noted that the rocker arms 48 and 49 associated with the second intake valve 37-2 are mirror images so as to permit the two rocker arms 48 to be positioned next to each other and the other two rocker arms to be spaced more widely. With this type of arrangement, as shown, the initial lift for the valve 37-2 is less than that of the valve 37-1 but the maximum lift provided by the cam lobes 46 and 152 can be the same.

[0046] In this embodiment, because the rocker arms associated with each of the valves 37-1 and 37-2 are the same as those associated with the primary valve of the embodiment of Figures 1-10, many of the figures showing this embodiment are the same as that previously described. Therefore, Figure 14 is basically the same as Figure 5; Figure 15 is basically the same as Figure 3; Figures 16 and 17 are basically the same as Figures 6 and 7 and Figures 19 and 20 are basically the same as Figures 8 and 9. Because of these similarities, it is believed that further description of this embodiment is not necessary to permit those skilled in the art to understand the construction and operation of this embodiment.

[0047] Figures 21 - 23 show yet another embodiment. In this embodiment, the rocker arms are reversed from the position utilized in Figures 12 through 21. That is, the direct actuating rocker arms 48 are disposed outwardly of the indirect acting rocker arms 49. Again, varying lift arrangements may be employed. As illustrated in this embodiment, the initial lift of the valve 37-1 is substantially greater than that of the remaining valve 37-2 while the maximum lift also is larger but only slightly larger as indicated by the respective cam lobe portions.

[0048] Figure 23 also shows a different biasing arrangement for the second rocker arms that is like that used in the embodiment of Figure 15. Since these are the only main differences from former embodiments, components which are the same or substantially the same have been identified by the same reference numerals.

[0049] In this embodiment, the second rocker arms 48 have, on the opposite side from their follower surfaces 59, a protruding portion 251 that is engaged by a spring return mechanism which is in essence the same as that employed in and shown in detail in Figure 3. However, this return mechanism 67 is mounted directly in the cylinder head member 32 rather than on the cam carrier 33. In all other regards, this embodiment is the same and thus, further description of it is not believed to be necessary to permit those skilled in the art to practice the invention.

[0050] In each of the embodiments described, in order to permit a compact assembly, obviously the adjusting screw 65 and its associated rocker arm must be configured in relation to the cam lobes and specifically the cam lobe 45, so as to not present any interference. This has some spatial disadvantages. It also dictates that the follower surfaces of the rocker arms 59 and 63 must be relatively narrow in order to permit a compact construction.

[0051] Next is described the added embodiment of this application, that of Figures 24 and 25 which avoids these disadvantages. Figures 24 and 25 show an embodiment which is generally the same as the embodiment of Figures 12-20 but also permits the use of the biasing arrangement as seen in Figures 15 and 23.

[0052] This embodiment differs from that earlier embodiment only in the way in which the two rocker arms 48 and 49 cooperate with each other so as to avoid the necessity of utilizing the adjusting screws 65. As may be seen in Figure 24, this permits the bearing area 63 of the second rocker arms to be substantially wider. Also the cam lobes 46 and 152 may be so widened. Thus, wear can be reduced and also the entire cylinder head construction can be made more compact.

[0053] In this embodiment, the portion of the rocker arm 63 which previously carried the adjusting screw 65 merely overlie an adjusting pad 201 (Figure 25) that is received in a complimentary recess formed in the upper portion of the plunger assembly 73 and specifically the member 76 thereof. The height or thickness of this shim 201 can be varied so as to provide the desired clearance and avoid the use of an adjusting screw. In addition, this arrangement provides a larger wear area between the two rocker arms 49 and 48 and thus also reduces wear. In all other regards, this construction is the same as that previously described.

[0054] It is also to be understood that this type of adjusting arrangement can be utilized in all of the embodiments of this application and those other embodiments of the prior application that are not carried through herewith.

[0055] From the foregoing description, it should be readily apparent to those skilled in the art that the various embodiments disclosed provide a very effective and compact arrangement for achieving variable valve actuation.

Claims

1. A valve operating mechanism for operating a single poppet valve (37) of an engine through cooperation with the stem (39) thereof, said valve operating mechanism being comprised of a single cam shaft (44) having a pair of adjacent cams (45, 46), a pair of adjacent pivotally supported rocker arms (48,

49), each of said rocker arms (48, 49) being operated by a respective one of said cams (45, 46), a first (48) of said rocker arms (48, 49) having an operating portion (61) for direct engagement with the valve stem (39) for operating the valve (37) directly, the valve operating mechanism being **characterized by** means (73) for selectively coupling a second (49) of said rocker arms (48, 49) to said first rocker arm (48) comprising a plunger (76) slidably supported within a bore (75) formed in said first rocker arm (48), a replaceable adjusting shim (201) engaged by actuating means (63) carried by said second rocker arm (49), said plunger (76) being engaged by said replaceable adjusting shim (201), and means for coupling said plunger (76) against movement relative to the first rocker arm (48) for effecting simultaneous movement of the rocker arms (48, 49) to actuate the valve (37), through said first rocker arm (48), by the cam (46) associated with said second rocker arm (49).

2. A valve operating mechanism as set forth in Claim 1, wherein both of the rocker arms (48, 49) are journaled on the same rocker arm shaft (52).

3. A valve operating mechanism as set forth in Claim 1 or 2, wherein the first and second cams (45, 46) and first and second rocker arms (48, 49) provide a different lift for the actuated valve (37).

4. A valve operating mechanism as set forth in Claim 3, wherein the lift provided by the second cam (46) and second rocker arm (49) is greater than that provided by the first cam (45) and the first rocker arm (48).

5. A valve operating mechanism as set forth in any of Claims 1 to 4, wherein the replaceable adjusting shim(201) is removabley supported in said plunger (76).

6. A valve operating mechanism set forth in Claim 5, wherein the coupling means comprises a pin (88) slidably supported in the first rocker arm (48) and engageable with a bore (81) formed in the plunger (76) for locking the plunger (76) against sliding movement in the bore (75).

7. A valve operating mechanism as set forth in any of Claims 1 to 6, wherein the valve (37) has a spring (43) that is associated with it for maintaining the first rocker arm (48) in engagement with the first cam (45) and further including a separate biasing spring (71) for urging the second rocker arm (49) into engagement with the second cam (46).

8. A valve operating mechanism as set forth in Claim 7, wherein the second spring (71) is engaged with an arm (72) of the second rocker arm (49) that is spaced from its actuating portion (63) and which spring (71) bears against the engine body.

9. A valve operating mechanism as set forth in any of Claims 1 to 8, wherein there is provided a second poppet valve (37) for serving the same combustion chamber of the engine and wherein the second poppet valve (37) is adjacent the first mentioned poppet valve (37).

10. A valve operating mechanism as set forth in Claim 9, wherein the second poppet valve (37) is operated by a third cam (47) though a third rocker arm (51).

11. A valve operating mechanism as set forth in Claim 10, wherein the all of the rocker arms (48, 49, 51) are supported on the same rocker arm shaft (52).

12. A valve operating mechanism as set forth in Claim 11, wherein the valves (37) are both intake valves.

13. A valve operating mechanism as set forth in Claim 12, wherein the first valve (37) is operated with a low lift by the first cam (45) and the first rocker arm (48) and a higher lift by the second cam (46) and the second rocker arm (49) acting through the first rocker arm (48) and wherein the third cam (47) and the third rocker arm (51) provide a lift for the second valve (37) that is higher than that of the first cam (45) and the first rocker arm (48) on the first valve (37).

14. A valve operating mechanism as set forth in Claim 13, wherein separate intake passages (35-1, 35-2) serve the intake valves (37-1, 37-2) and further including a control valve (105) in the intake passage (35-2) serving the second valve (37-2) controlled in response to engine running conditions and opened under only high speed, high load conditions.

15. A valve operating mechanism as set forth in any of Claims 10 to 14, wherein the second valve (37-2) is operated by first and second rocker arms (48, 49) each cooperating with a respective cam lobe (151, 152) to provide a different lift and further including means (73)for selectively coupling the first and second rocker arms (48, 49) associated with the second valve (37-2) with each other for varying the lift of the second valve (37-2).

16. A valve operating mechanism as set forth in Claim 15, wherein the first rocker arms (48) for the two valves (37-1, 37-2) are disposed adjacent each other on the rocker arm shaft (52).

17. A valve operating mechanism as set forth in Claim 16, wherein the lift provided by the first cam (45)

and first rocker arm (48) of one (37-1) of the valves is different from that provided by the first cam (151) and first rocker arm (48) of the other valve (37-2).

18. A valve operating mechanism as set forth in Claim 15, wherein the second rocker arms (49) are disposed adjacent each other on the same rocker arm shaft (52).

19. A valve operating mechanism as set forth in Claim 18, wherein the lift provided by the first cam (45) and first rocker arm (48) of one (37-1) of the valves is different from that provided by the first cam (151) and first rocker arm (48) of the other valve (37-2).

20. A valve operating mechanism as set forth in any of Claims 1 to 19, wherein the means (73) for selectively coupling the second rocker arm (49) to the first rocker arm (48) is hydraulically operated.

21. A valve operating mechanism as set forth in Claim 20, wherein the rocker arm shaft (52) is hollow and the hydraulic pressure is transmitted through the rocker arm shaft (52).

Patentansprüche

1. Ventilbetätigungsmechanismus zur Betätigung eines einzelnen Tellerventils (37) eines Motors durch Zusammenarbeit mit dessen Schaft (39), wobei der Ventilbetätigungsmechanismus eine einzelne Nokkenwelle (44), die ein Paar benachbarter Nocken (45, 46) aufweist, und ein Paar benachbarter schwenkbar gehaltener Kipphebel (48, 49) aufweist, wobei jeder der Kipphebel (48, 49) durch einen jeweiligen der Nocken (45, 46) betätigt wird, ein erster (48) der Kipphebel (48, 49) einen Betätigungsabschnitt (61) für einen direkten Eingriff mit dem Ventilschaft (39) zur direkten Betätigung des Ventils (37) aufweist, wobei der Ventilbetätigungsmechanismus **gekennzeichnet ist durch** eine Einrichtung (73) zur selektiven Kopplung eines zweiten (49) der Kipphebel (48, 49) mit dem ersten Kipphebel (48), die einen Kolben (76), der verschiebbar in einer Bohrung (75) gehalten ist, die in dem ersten Kipphebel (48) ausgebildet ist, ein austauschbares Einstellplättchen (201), das mit einer Betätigungseinrichtung (63) in Eingriff steht, die **durch** den zweiten Kipphebel (49) getragen ist, wobei der Kolben (76) mit dem austauschbaren Einstellplättchen (201) in Eingriff steht, und eine Einrichtung zur Kopplung des Kolbens (76) gegen eine Bewegung relativ zum ersten Kipphebel (48) zum Bewirken einer gleichzeitigen Bewegung der Kipphebel (48, 49) aufweist, um das Ventil (37) **durch** den ersten Kipphebel (48) mit Hilfe des Nockens (46), der mit dem zweiten Kipphebel (49) verbunden ist, zu betätigen.

2. Ventilbetätigungsmechanismus nach Anspruch 1, wobei beide Kipphebel (48, 49) auf derselben Kipphebelwelle (52) gelagert sind.

3. Ventilbetätigungsmechanismus nach Anspruch 1 oder 2, wobei die ersten und zweiten Nocken (45, 46) und ersten und zweiten Kipphebel (48, 49) einen unterschiedlichen Hub für das betätigte Ventil (37) bereitstellen.

4. Ventilbetätigungsmechanismus nach Anspruch 3, wobei der durch den zweiten Nocken (46) und zweiten Kipphebel (49) bereitgestellte Hub größer als jener ist, der durch den ersten Nocken (45) und den ersten Kipphebel (48) bereitgestellt wird.

5. Ventilbetätigungsmechanismus nach einem der Ansprüche 1 bis 4, wobei das austauschbare Einstellplättchen (201) entfernbar im Kolben (76) gehalten ist.

6. Ventilbetätigungsmechanismus nach Anspruch 5, wobei die Kopplungseinrichtung einen Stift (88) aufweist, der verschiebbar im ersten Kipphebel (48) gehalten ist und mit einer Bohrung (81) in Eingriff bringbar ist, die im Kolben (76) ausgebildet ist, um den Kolben (76) gegen eine gleitende Bewegung in der Bohrung (75) zu verriegeln.

7. Ventilbetätigungsmechanismus nach einem der Ansprüche 1 bis 6, wobei das Ventil (37) eine Feder (43) aufweist, die mit ihm in Verbindung steht, um den ersten Kipphebel (48) in Eingriff mit dem ersten Nocken (45) zu halten und ferner eine getrennte Vorspannungsfeder (71) vorgesehen ist, um den zweiten Kipphebel (49) in einen Eingriff mit dem zweiten Nocken (46) zu drücken.

8. Ventilbetätigungsmechanismus nach Anspruch 7, wobei die zweite Feder (71) mit einem Arm (72) des zweiten Kipphebels (49) in Eingriff steht, der von seinem Betätigungsabschnitt (63) beabstandet ist, und wobei die Feder (71) gegen den Motorkörper gelagert ist.

9. Ventilbetätigungsmechanismus nach einem der Ansprüche 1 bis 8, wobei ein zweites Tellerventil (37) vorgesehen ist, um dieselbe Verbrennungskammer des Motors zu bedienen und wobei das zweite Tellerventil (37) dem erstgenannten Tellerventil (37) benachbart ist.

10. Ventilbetätigungsmechanismus nach Anspruch 9, wobei das zweite Tellerventil (37) durch einen dritten Nocken (47) durch einen dritten Kipphebel (51) betätigt wird.

11. Ventilbetätigungsmechanismus nach Anspruch 10, wobei alle Kipphebel (48, 49, 51) auf derselben Kipphebelwelle (52) gehalten sind.

12. Ventilbetätigungsmechanismus nach Anspruch 11, wobei die Ventile (37) beide Einlaßventile sind.

13. Ventilbetätigungsmechanismus nach Anspruch 12, wobei das erste Ventil (37) mit einem niedrigen Hub durch den ersten Nocken (45) und den ersten Kipphebel (48) und einem höheren Hub durch den zweiten Nocken (46) und den zweiten Kipphebel (49) betätigt wird, der durch den ersten Kipphebel (48) wirkt, und wobei der dritte Nocken (47) und der dritte Kipphebel (51) einen Hub für das zweite Ventil (37) bereitstellen, der höher als jener des ersten Nockens (45) und des ersten Kipphebels (48) auf das erste Ventil (37) ist.

14. Ventilbetätigungsmechanismus nach Anspruch 13, wobei getrennte Einlaßkanäle (35-1, 35-2) die Einlaßventile (37-1, 37-2) bedienen und ferner ein Steuerventil (105) im Einlaßkanal (35-2) vorgesehen ist, der das zweite Ventil (37-2) bedient, das als Reaktion auf Motorbetriebsbedingungen gesteuert wird und nur unter Umständen einer hohen Drehzahl und hoher Belastung geöffnet wird.

15. Ventilbetätigungsmechanismus nach einem der Ansprüche 10 bis 14, wobei das zweite Ventil (37-2) durch erste und zweite Kipphebel (48,49) betätigt wird, die jeweils mit einer jeweiligen Nockennase (151, 152) zusammenarbeiten, um einen unterschiedlichen Hub bereitzustellen, und ferner eine Einrichtung (73) vorgesehen ist, um die ersten und zweiten Kipphebel (48, 49), die mit dem zweiten Ventil (37-2) in Verbindung stehen, miteinander selektiv zu koppeln, um den Hub des zweiten Ventils (37-2) zu variieren.

16. Ventilbetätigungsmechanismus nach Anspruch 15, wobei die ersten Kipphebel (48) für die beiden Ventile (37-1, 37-2) benachbart zueinander auf der Kipphebelwelle (52) angeordnet sind.

17. Ventilbetätigungsmechanismus nach Anspruch 16, wobei sich der Hub, der durch den ersten Nocken (45) und den ersten Kipphebel (48) eines der Ventile (37-1) bereitgestellt wird, von dem unterscheidet, der durch den ersten Nocken (151) und ersten Kipphebel (48) des anderen Ventils (37-2) bereitgestellt wird.

18. Ventilbetätigungsmechanismus nach Anspruch 15, wobei die zweiten Kipphebel (49) benachbart zueinander auf derselben Kipphebelwelle (52) angeordnet sind.

19. Ventilbetätigungsmechanismus nach Anspruch 18, wobei sich der Hub, der durch den ersten Nocken (45) und ersten Kipphebel (48) eines der Ventile (37-1) bereitgestellt wird, von dem unterscheidet, der durch den ersten Nocken (151) und ersten Kipphebel (48) des anderen Ventils (37-2) bereitgestellt wird.

20. Ventilbetätigungsmechanismus nach einem der Ansprüche 1 bis 19, wobei die Einrichtung (73) zur selektiven Kopplung des zweiten Kipphebels (49) mit dem ersten Kipphebel (48) hydraulisch betätigbar ist.

21. Ventilbetätigungsmechanismus nach Anspruch 20, wobei die Kipphebelwelle (52) hohl ist und der Hydraulikdruck durch die Kipphebelwelle (52) übertragen wird.

Revendications

1. Un mécanisme d'actionnement de soupape pour actionner une soupape en champignon (37) unique d'un moteur à combustion par coopération avec sa tige (39), ledit mécanisme d'actionnement de soupape étant constitué d'un arbre à cames unique (44) ayant une paire de cames (45, 46) adjacentes, une paire de culbuteurs (48, 49) supportés à pivotement adjacents, chacun desdits culbuteurs (48, 49) étant actionné par l'une respective desdites cames (45, 46), un premier (48) desdits culbuteurs (48, 49) ayant une partie d'actionnement (61) devant venir en contact direct avec la tige de soupape (39) pour actionner directement la soupape (37), le mécanisme d'actionnement de soupape étant **caractérisé par** des moyens (73) pour coupler sélectivement un deuxième (49) desdits culbuteurs (48, 49) audit premier culbuteur (48), comprenant un piston (76) monté à coulissement dans un alésage (75) formé dans ledit premier culbuteur (48), une cale d'ajustement (201) remplaçable mise en prise par des moyens d'actionnement (63) portés par ledit deuxième culbuteurs (49), ledit piston (76) étant mis en prise par ladite cale d'ajustement (201) remplaçable et des moyens pour coupler ledit piston (76) contre tout déplacement par rapport audit premier culbuteur (48) pour effectuer un déplacement simultané des culbuteurs (48, 49) afin d'actionner la soupape (37), par l'intermédiaire dudit premier culbuteur (48), par la came (46) associée audit deuxième culbuteur (49).

2. Un mécanisme d'actionnement de soupape selon la revendication 1, dans lequel les deux culbuteurs (48, 49) tourillonnent sur la même tige de culbuteur (52).

3. Un mécanisme d'actionnement de soupape selon la revendication 1 ou 2, dans lequel la première et deuxième cames (45, 46) et les premier et deuxième culbuteur (48, 49) produisent une levée différente pour la soupape (37) actionnée.

4. Un mécanisme d'actionnement de soupape selon la revendication 3, dans lequel la levée produite par la deuxième came (46) et le deuxième culbuteur (49) est supérieure à celle produite par la première came (45) et le premier culbuteur (48).

5. Un mécanisme d'actionnement de soupape selon l'une quelconque des revendications 1 à 4, dans lequel la cale d'ajustement (201) remplaçable est supportée de façon amovible dans ledit piston (76).

6. Un mécanisme d'actionnement de soupape selon la revendication 5, dans lequel les moyens de couplage comprennent une tige (88) supportée à coulissement dans le premier culbuteur (48) et susceptible de venir en prise avec un alésage (81) formé dans le piston (76) pour verrouiller le piston (76) contre tout déplacement coulissant à l'intérieur de l'alésage (75).

7. Un mécanisme d'actionnement de soupape selon l'une quelconque des revendication 1 à 6, dans lequel la soupape (37) a un ressort (43) qui est associé à elle pour maintenir le premier culbuteur (48) en prise avec la première came (45) et comprenant en outre un ressort de déplacement (71) séparé devant placer le deuxième culbuteur (49) en contact avec la deuxième came (46).

8. Un mécanisme d'actionnement de soupape selon la revendication 7, dans lequel le deuxième ressort (71) est mis en prise avec un bras (72) du deuxième culbuteur (49) espacé de sa partie d'actionnement (63) et le ressort (71) portant contre le bloc moteur.

9. Un mécanisme d'actionnement de soupape selon l'une quelconque des revendications 1 à 8, dans lequel est prévue une deuxième soupape en champignon (37) pour servir la même chambre de combustion du moteur à combustion et dans lequel la deuxième soupape en champignon (37) est montée de façon adjacente à la première soupape en champignon (37) mentionnée.

10. Un mécanisme d'actionnement de soupape selon la revendication 9, dans lequel la deuxième soupape en champignon (37) est actionnée par une troisième came (47) par l'intermédiaire d'un troisième culbuteur (51).

11. Un mécanisme d'actionnement de soupape selon la revendication 10, dans lequel la totalité des culbuteurs (48, 49, 51) sont supportés sur le même arbre de bras de culbuteur (52).

12. Un mécanisme d'actionnement de soupape selon la revendication 11, dans lequel les soupapes (37) sont les deux des soupapes d'admission.

13. Un mécanisme d'actionnement de soupape selon la revendication 12, dans lequel la première soupape (37) est actionnée avec une faible levée par la première came (45) et le premier culbuteur (48) et avec une plus grande levée par la deuxième came (46) et le deuxième culbuteur (49) agissant par l'intermédiaire du premier culbuteur (48) et dans lequel la troisième came (47) et le troisième culbuteur (51) produisent une levée pour la deuxième soupape (37) qui est supérieure à celle de la première came (45) et du premier culbuteur (48) sur la première soupape (37).

14. Mécanisme d'actionnement de soupape selon la revendication 13, dans lequel des passages d'admission (35-1, 35-2) séparés desservent des soupapes d'admission (37-1, 37-2) et en outre incluant une soupape de commande (105) placée dans le passage d'admission (35-2) desservant la deuxième soupape (37-2) commandée en réponse aux conditions de fonctionnement du moteur à combustion et ouverte uniquement dans des conditions de haute vitesse et de forte charge.

15. Un mécanisme d'actionnement de soupape selon l'une quelconque des revendications 10 à 14, dans lequel la deuxième soupape (37-2) est actionnée par les premier et deuxième culbuteurs (48, 49), chacun coopérant avec un lobe de came (151, 152) respectif pour produire une levée différente et incluant en outre des moyens (73) pour coupler sélectivement les premier et deuxième culbuteurs (48, 49) associés à la deuxième soupape (37-2) l'un avec l'autre pour faire varier la levée de la deuxième soupape (37-2).

16. Un mécanisme d'actionnement de soupape selon la revendication 15, dans lequel les premiers culbuteurs (48) des deux soupapes (37-1, 37-2) sont disposés de façon adjacente l'un à l'autre sur l'arbre à culbuteur (52).

17. Un mécanisme d'actionnement de soupape selon la revendication 16, dans lequel la levée produite dans la première came (45) et le premier culbuteur (48) d'une (37-1) des soupapes est différente de celle produite par la première came (151) et le premier culbuteur (48) de l'autre soupape (37-2).

18. Un mécanisme d'actionnement de soupape selon la revendication 15, dans lequel les deuxièmes cul-

buteurs (49) sont disposés de façon adjacente l'un à l'autre sur le même arbre de culbuteur (52).

19. Un mécanisme d'actionnement de soupape selon la revendication 18, dans lequel la levée produite par la première came (45) et le premier culbuteur (48) d'une (37-1) des soupapes est différente de celle produite par la première came (151) et le premier culbuteur (48) de l'autre soupape (37-2).

20. Un mécanisme d'actionnement de soupape selon l'une quelconque des revendications 1 à 19, dans lequel les moyens (73) pour coupler sélectivement le deuxième culbuteur (49) sur le premier culbuteur (48) sont à actionnement hydraulique.

21. Un mécanisme d'actionnement de soupape selon la revendication 20, dans lequel l'arbre à culbuteur (52) est creux et la pression hydraulique est transmise à travers l'arbre à culbuteur (52).

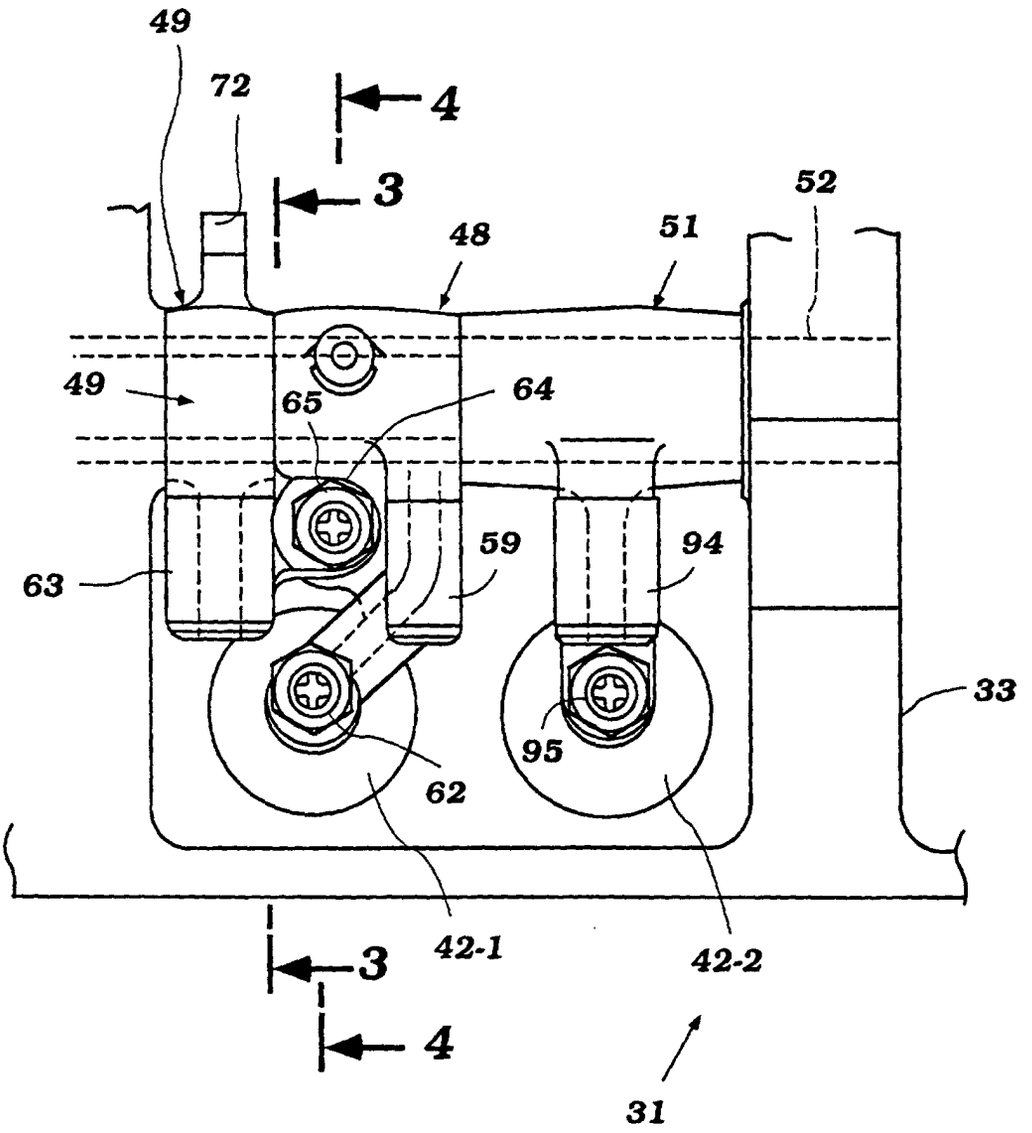

Figure 1

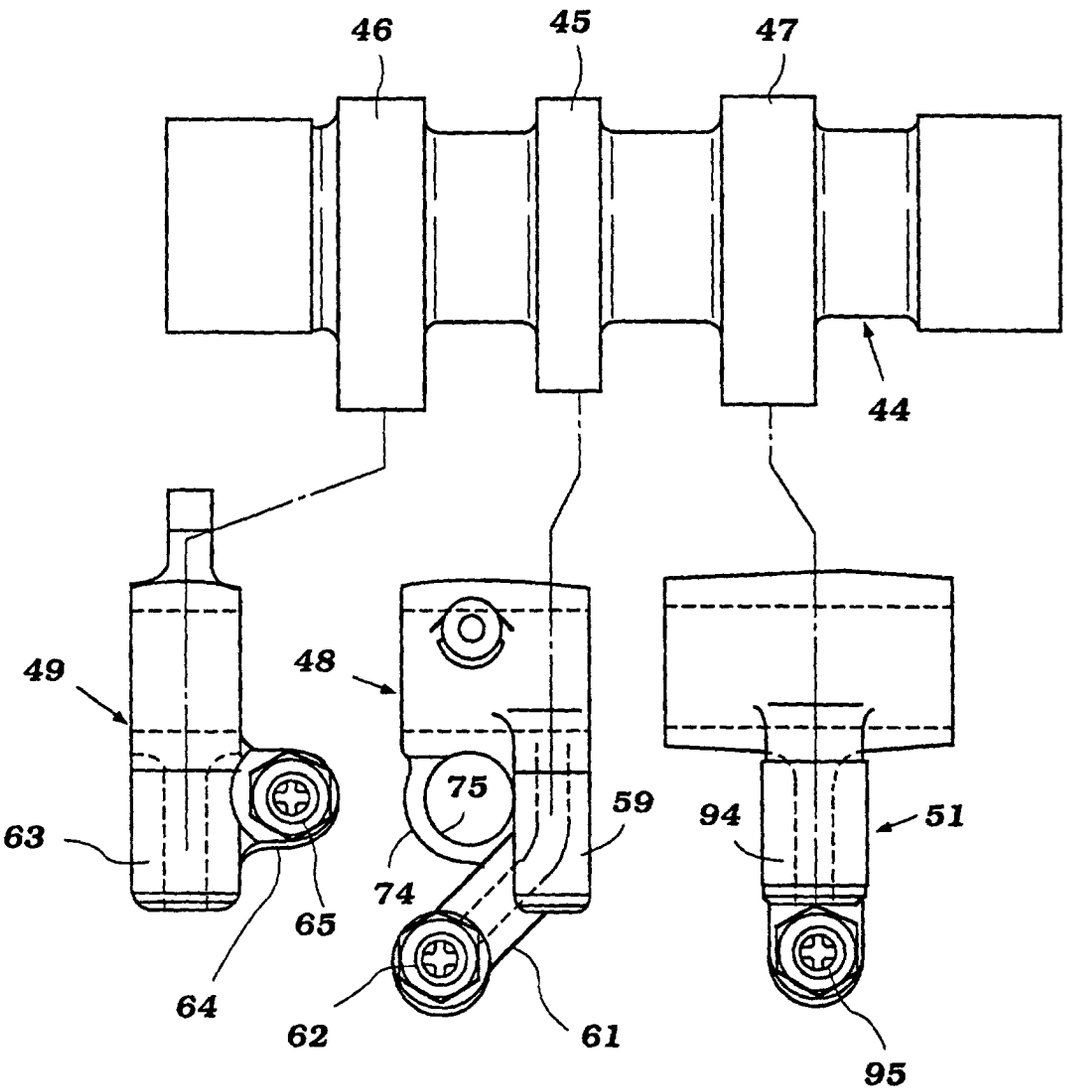

Figure 2

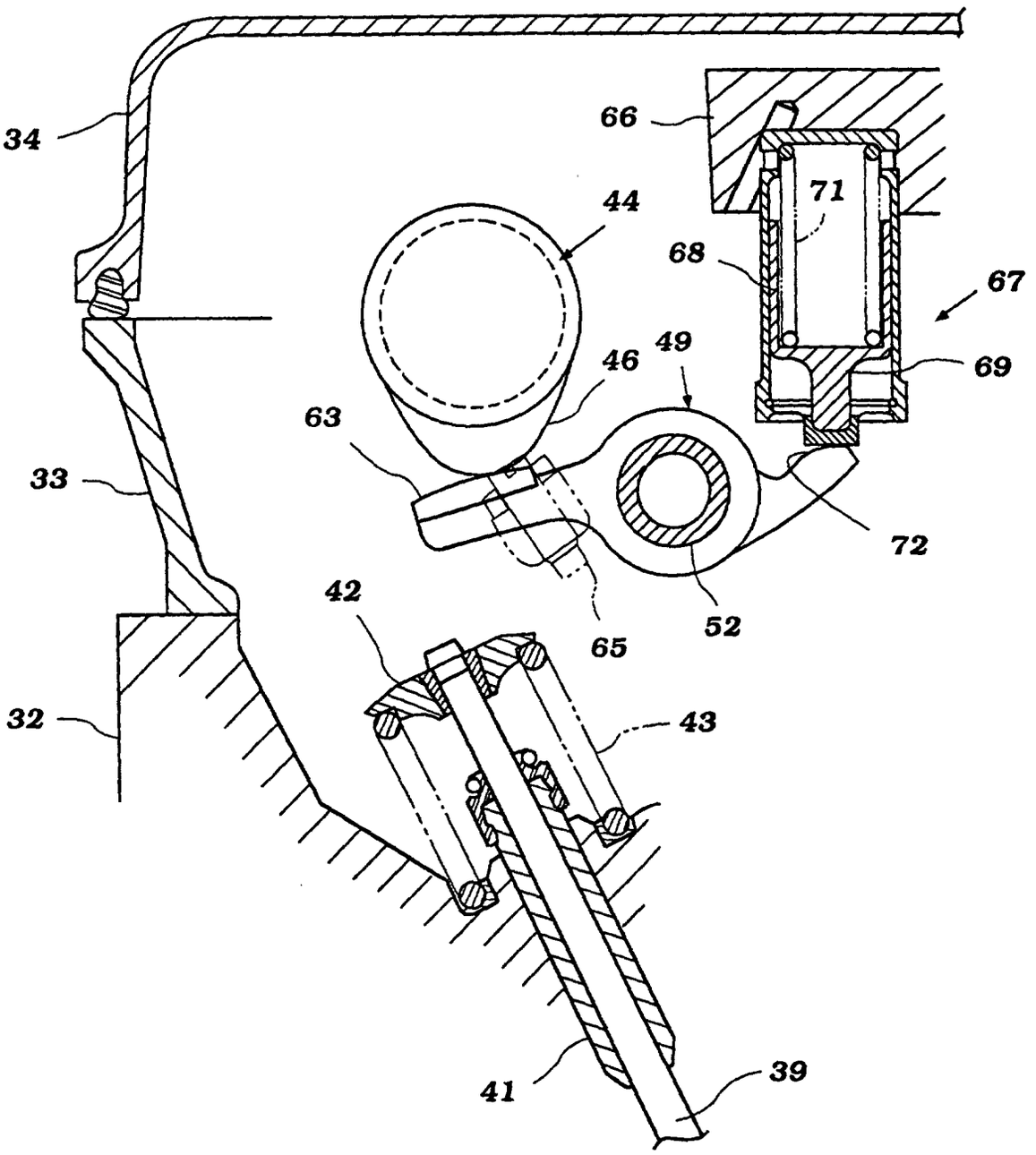

Figure 3

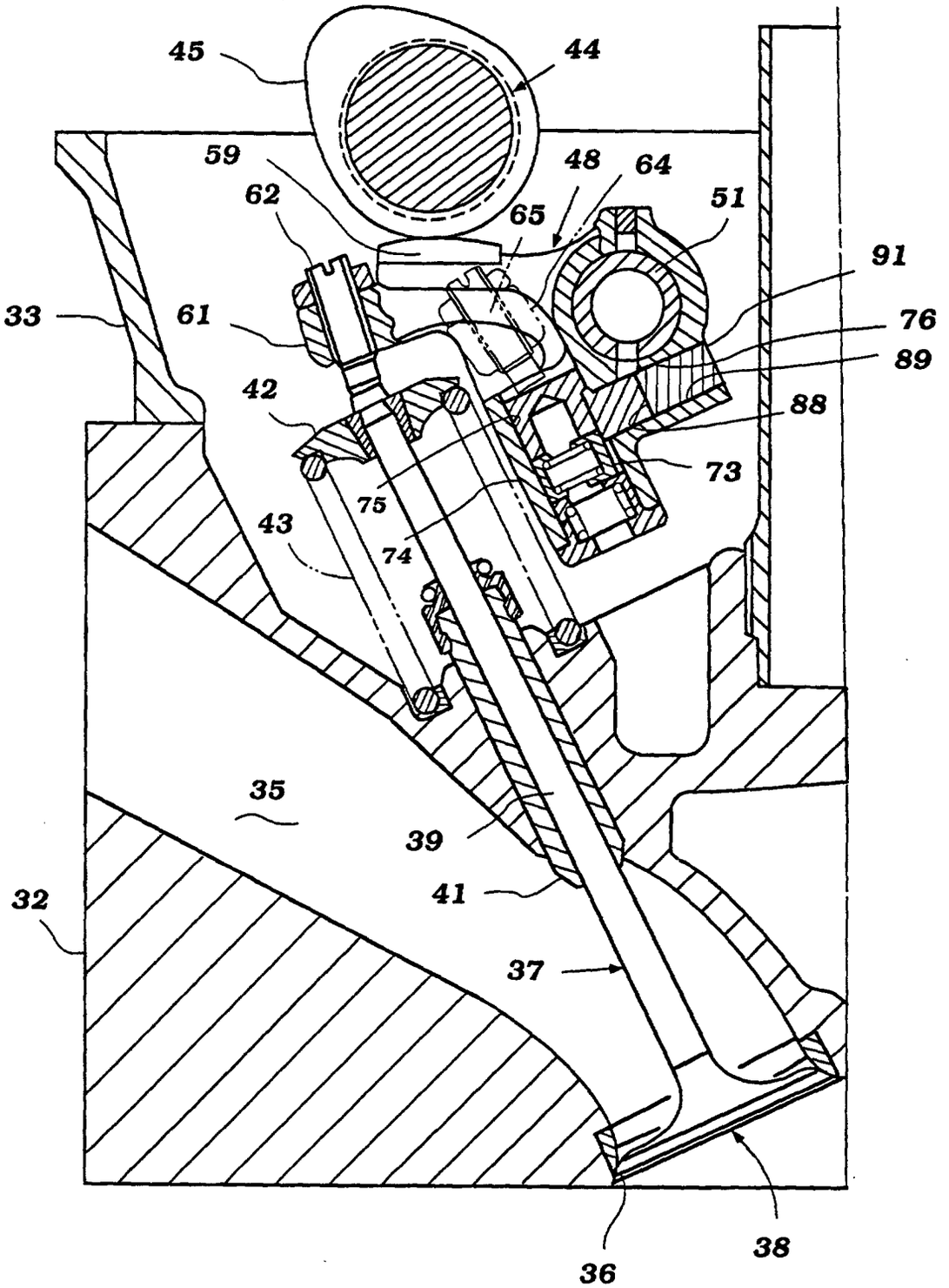
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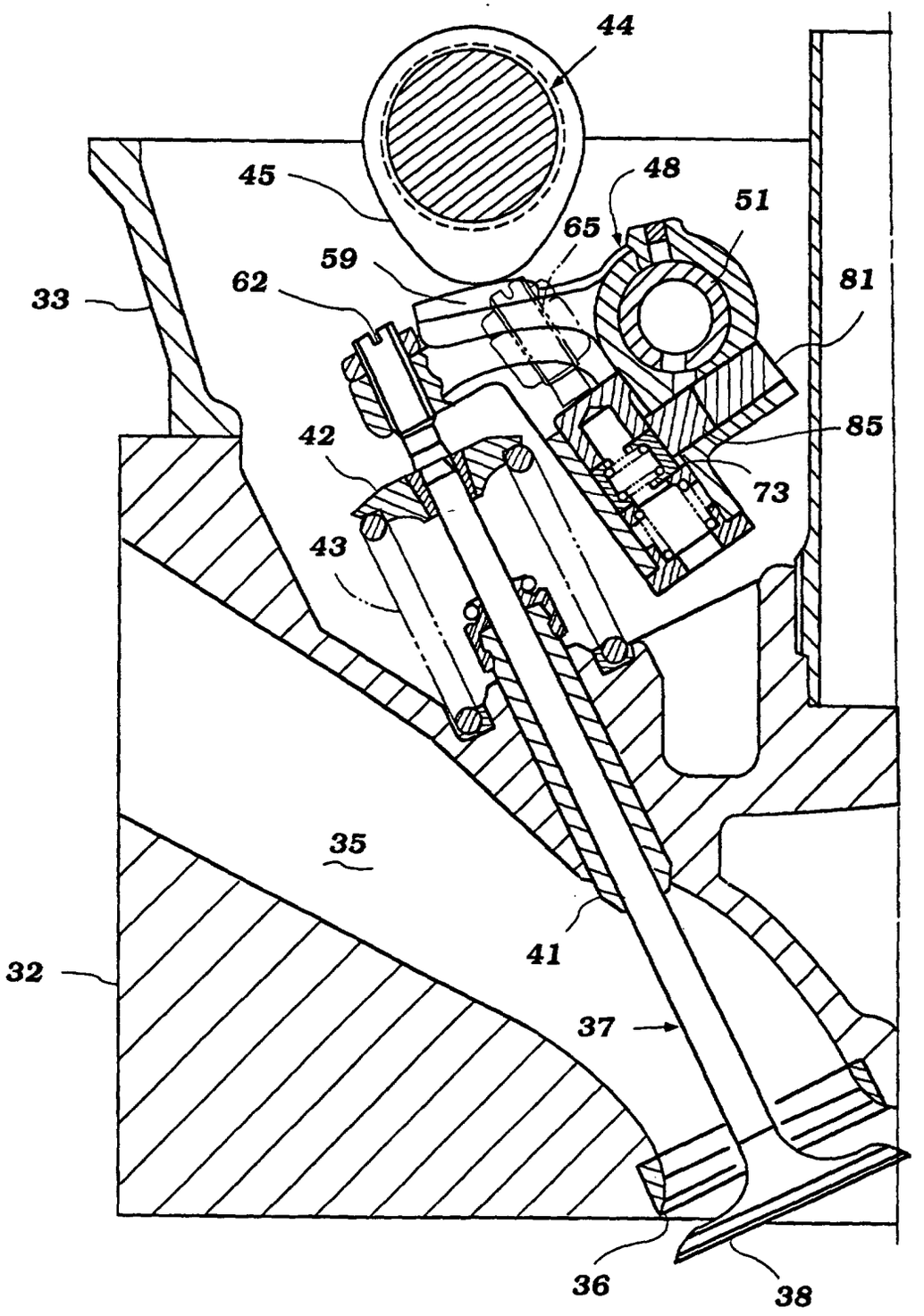
Figure 4



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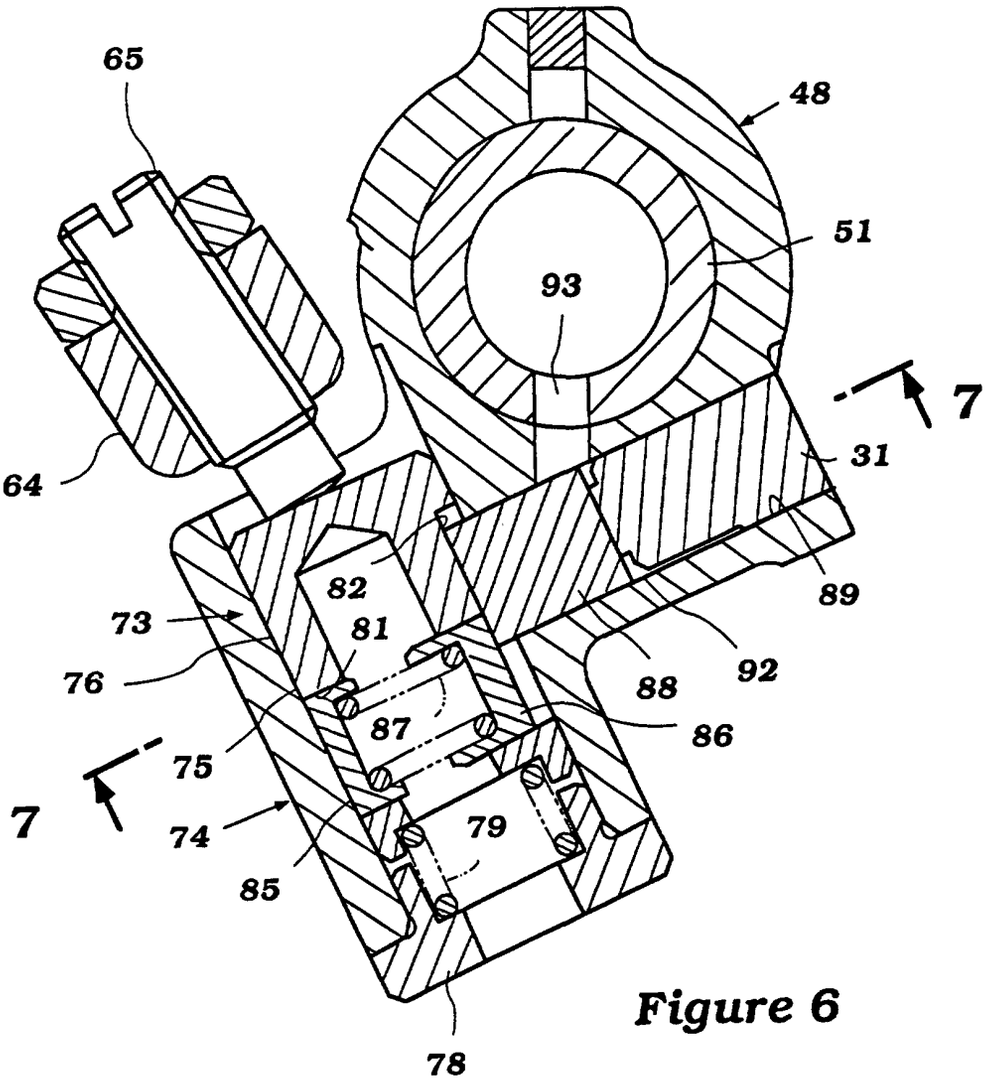


Figure 6

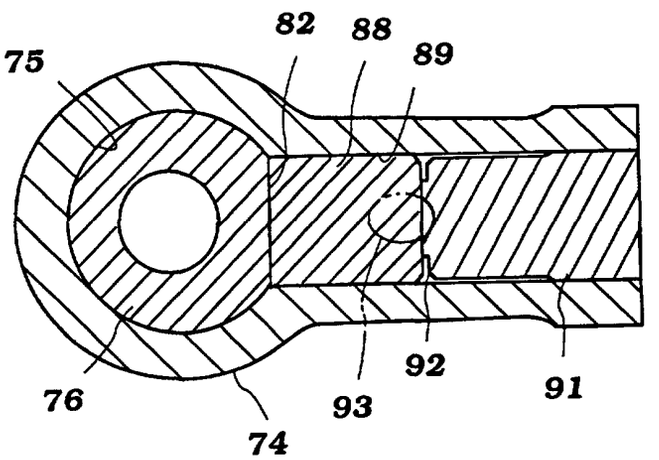
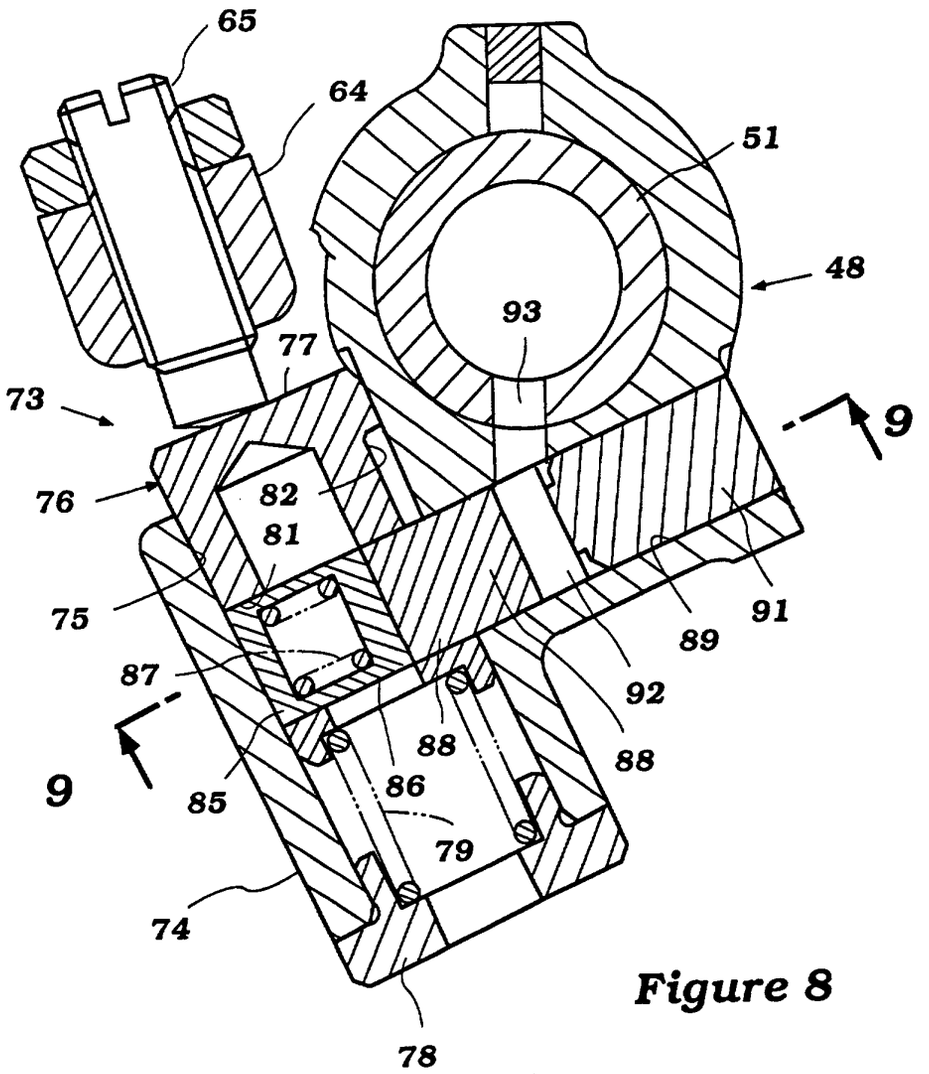


Figure 7



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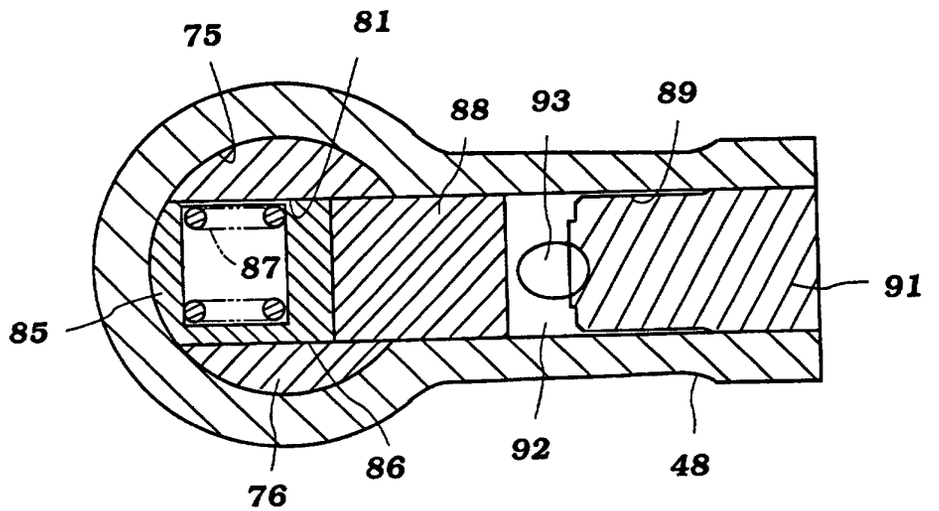


Figure 9

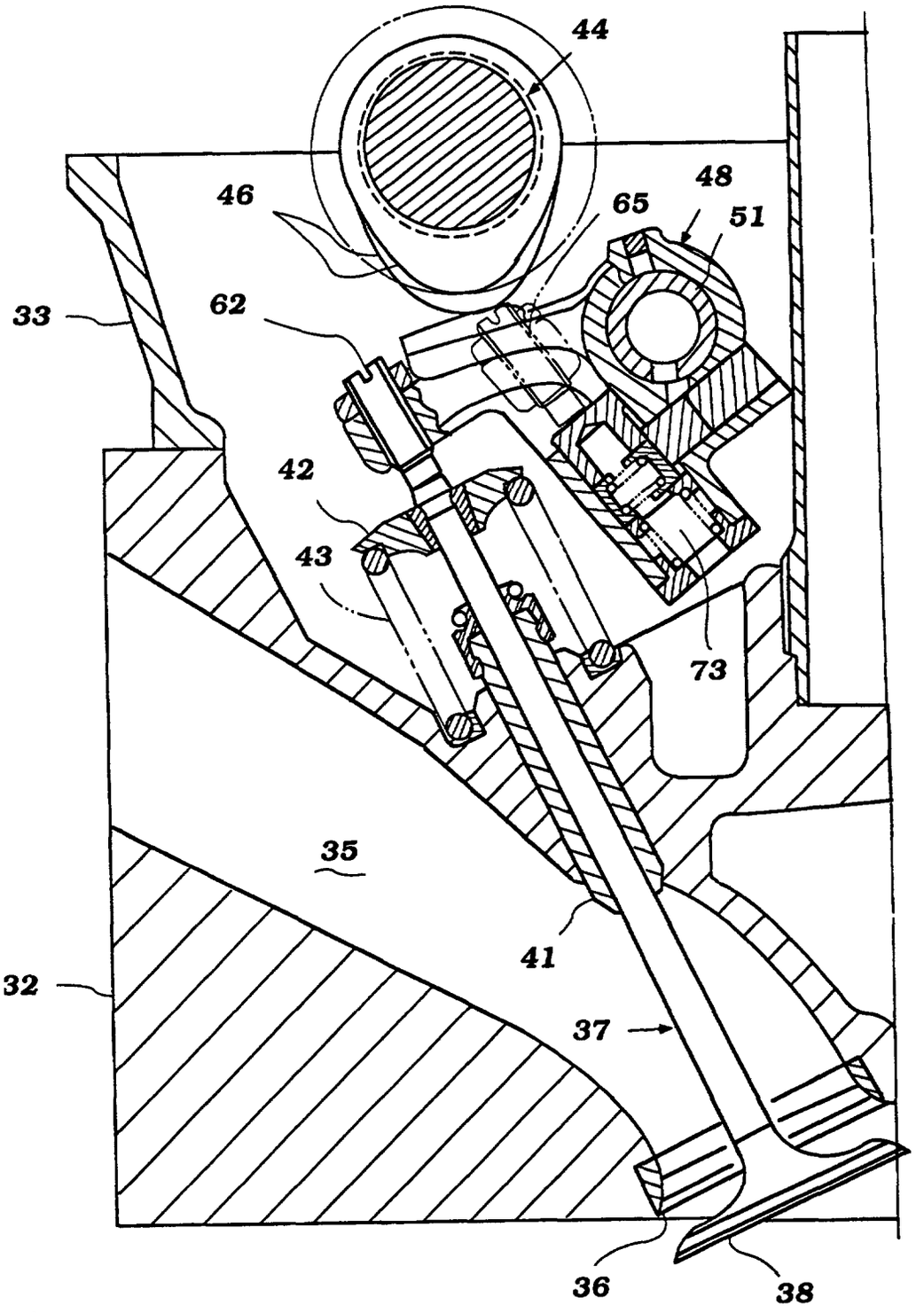


Figure 10

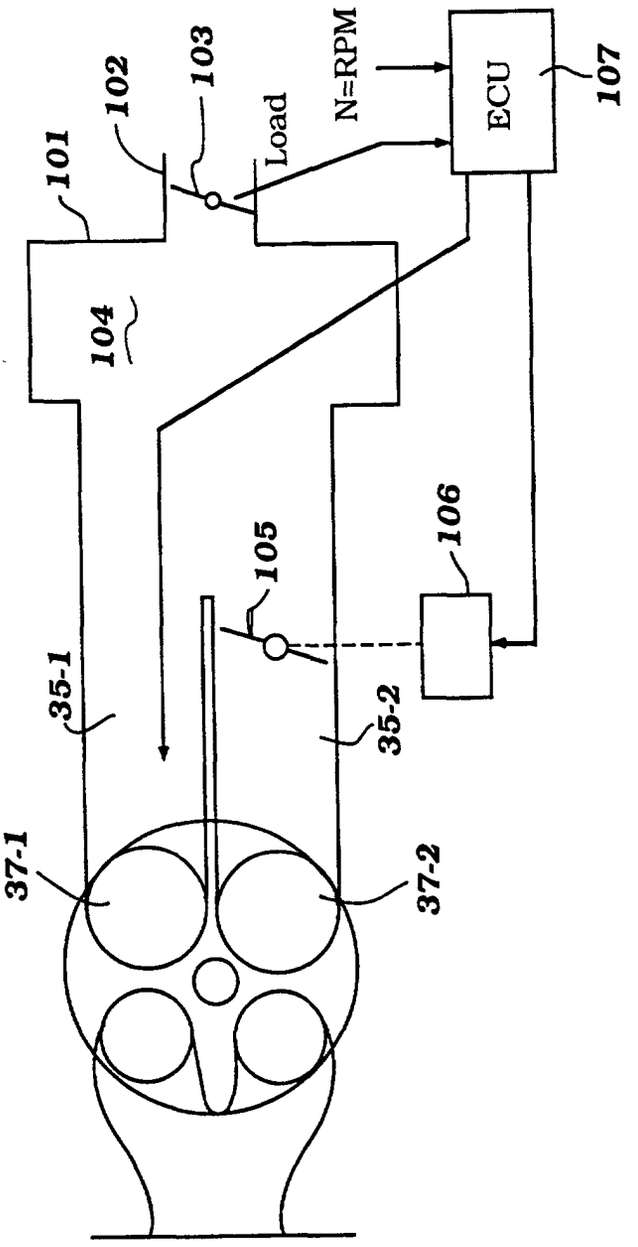
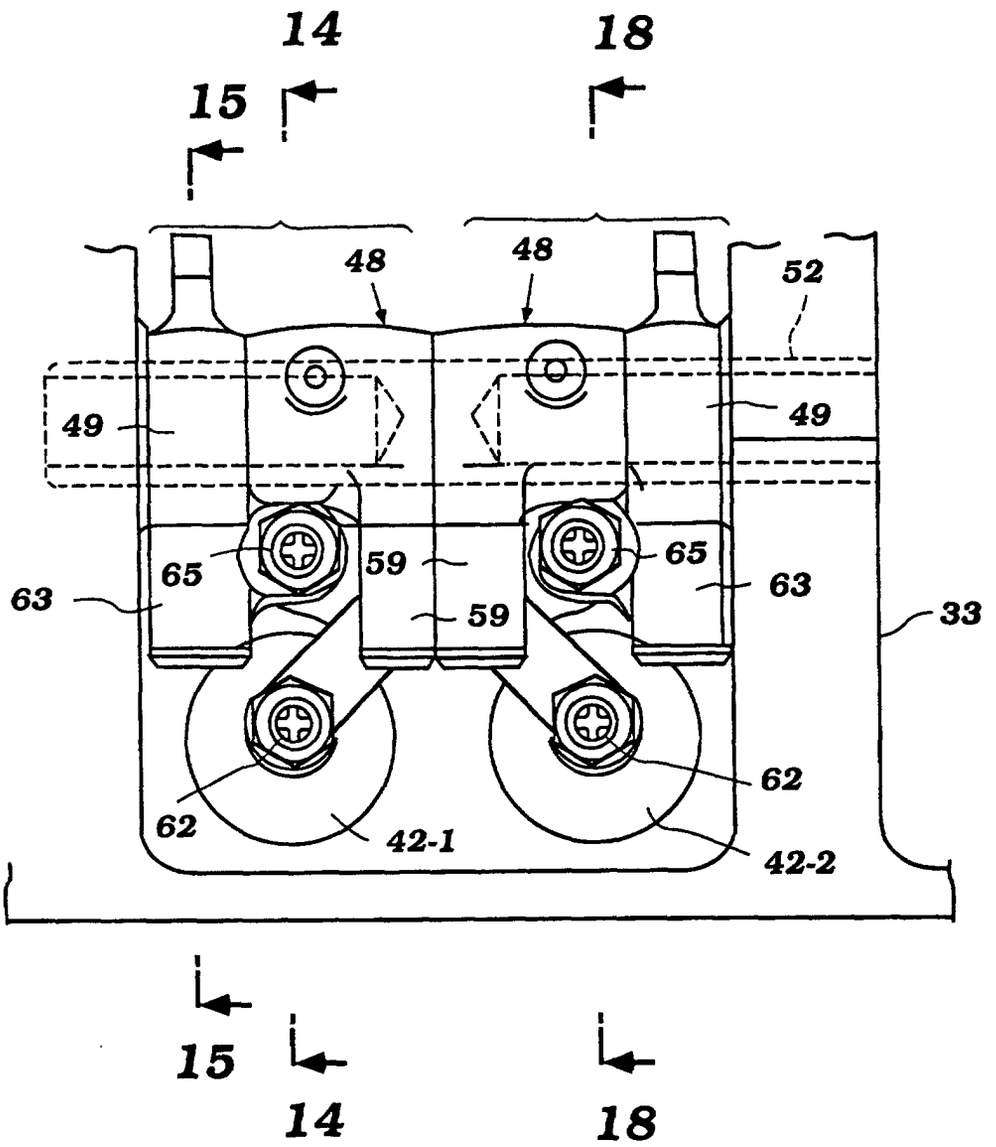


Figure 11



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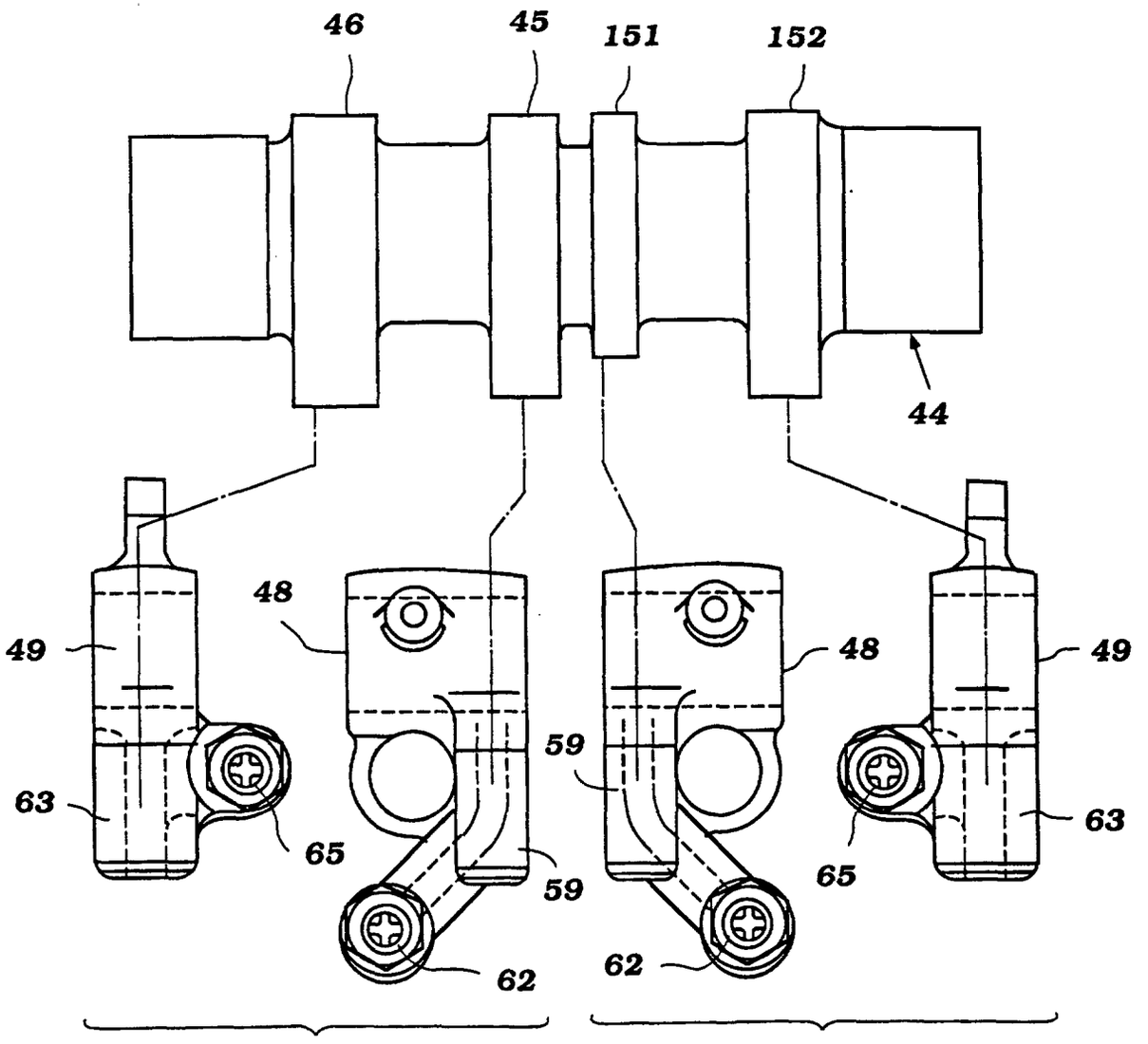

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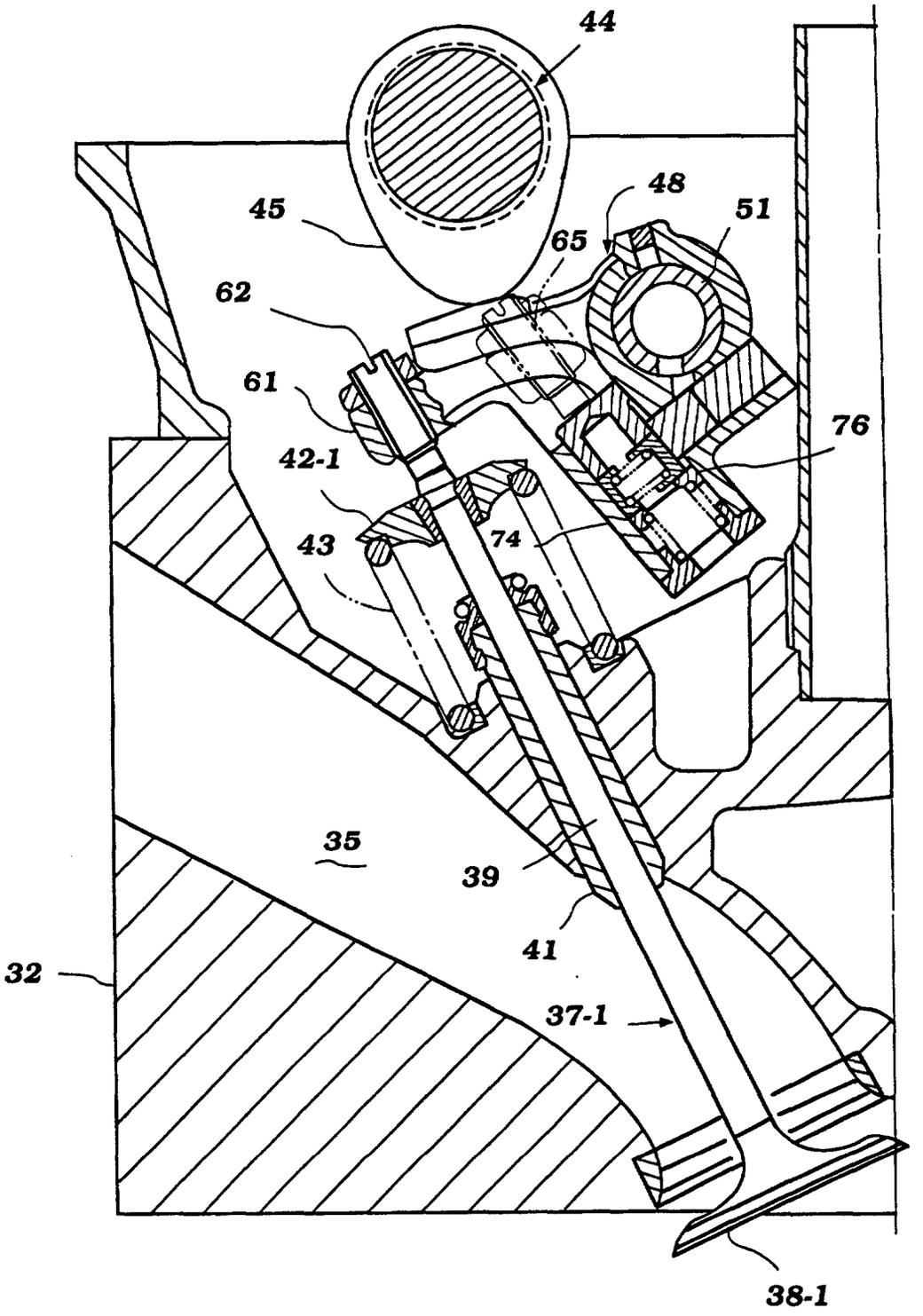


Figure 14

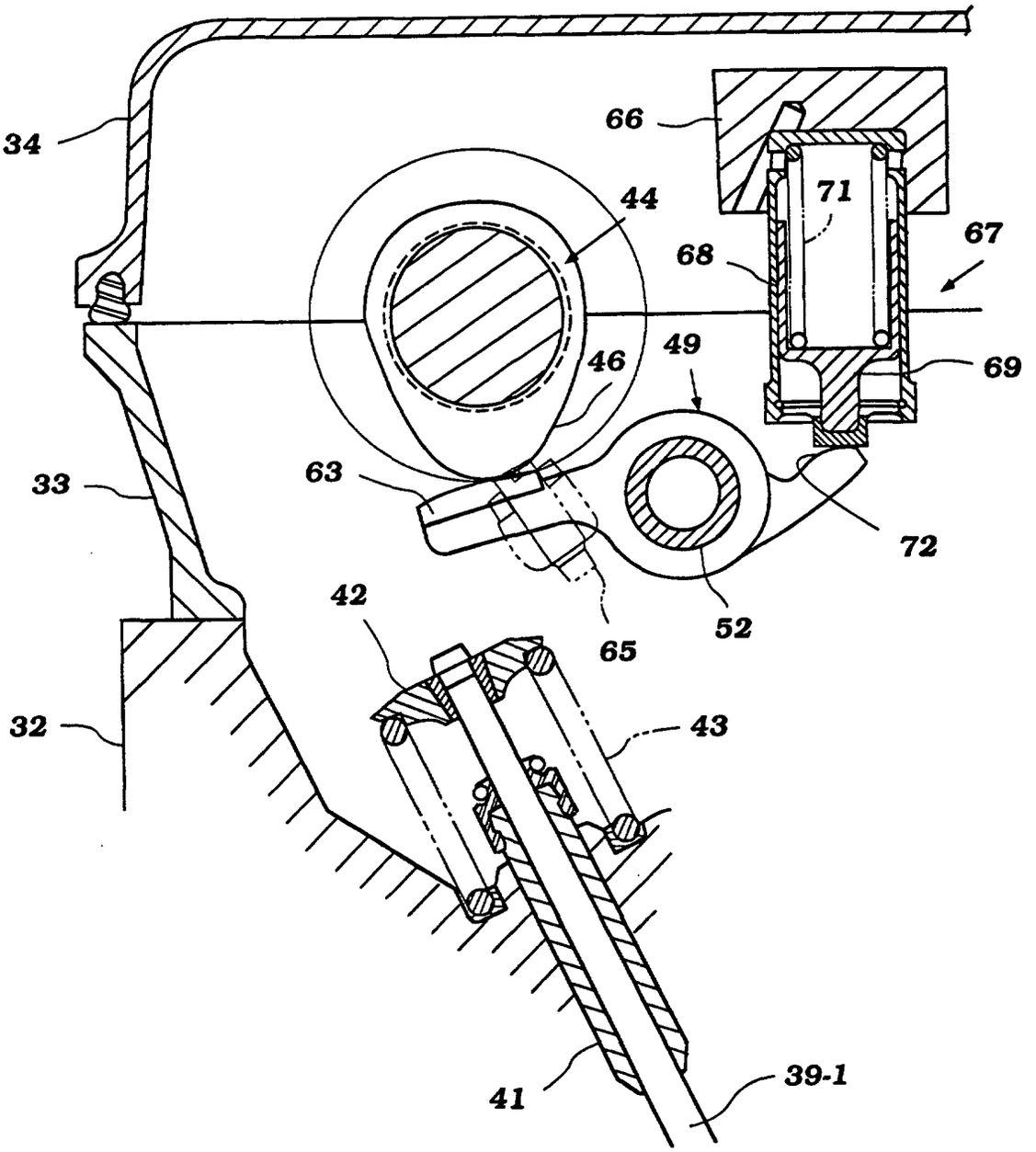


Figure 15

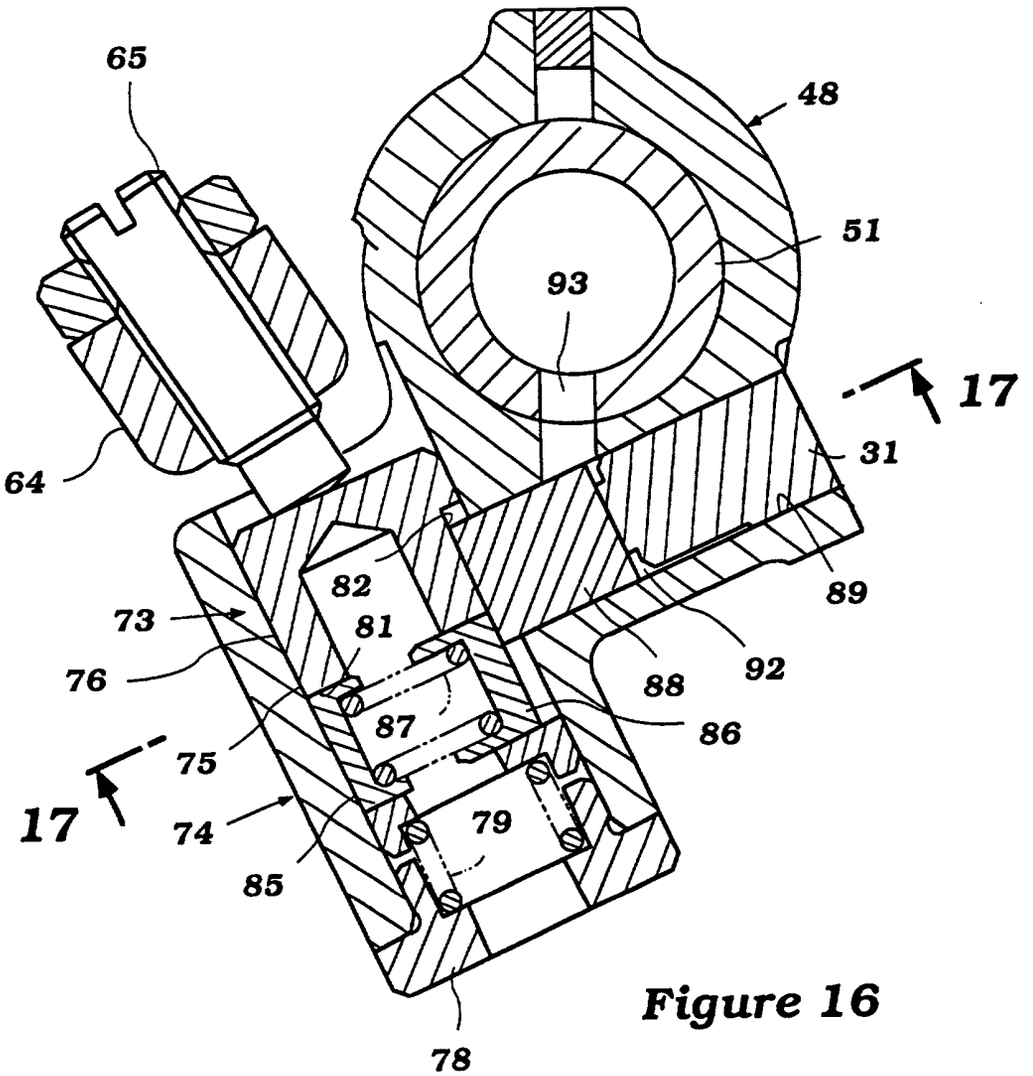


Figure 16

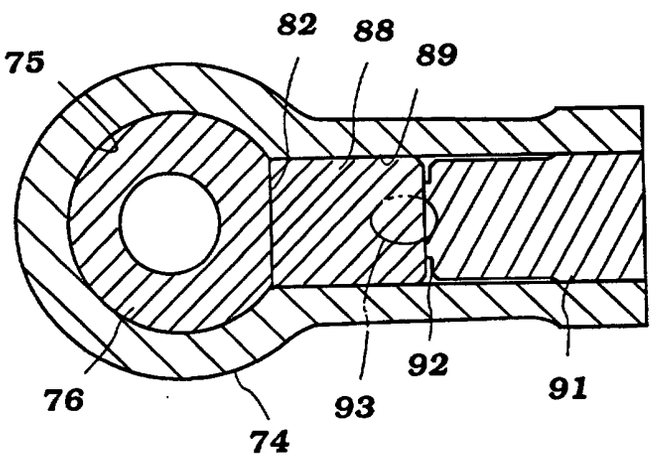


Figure 17

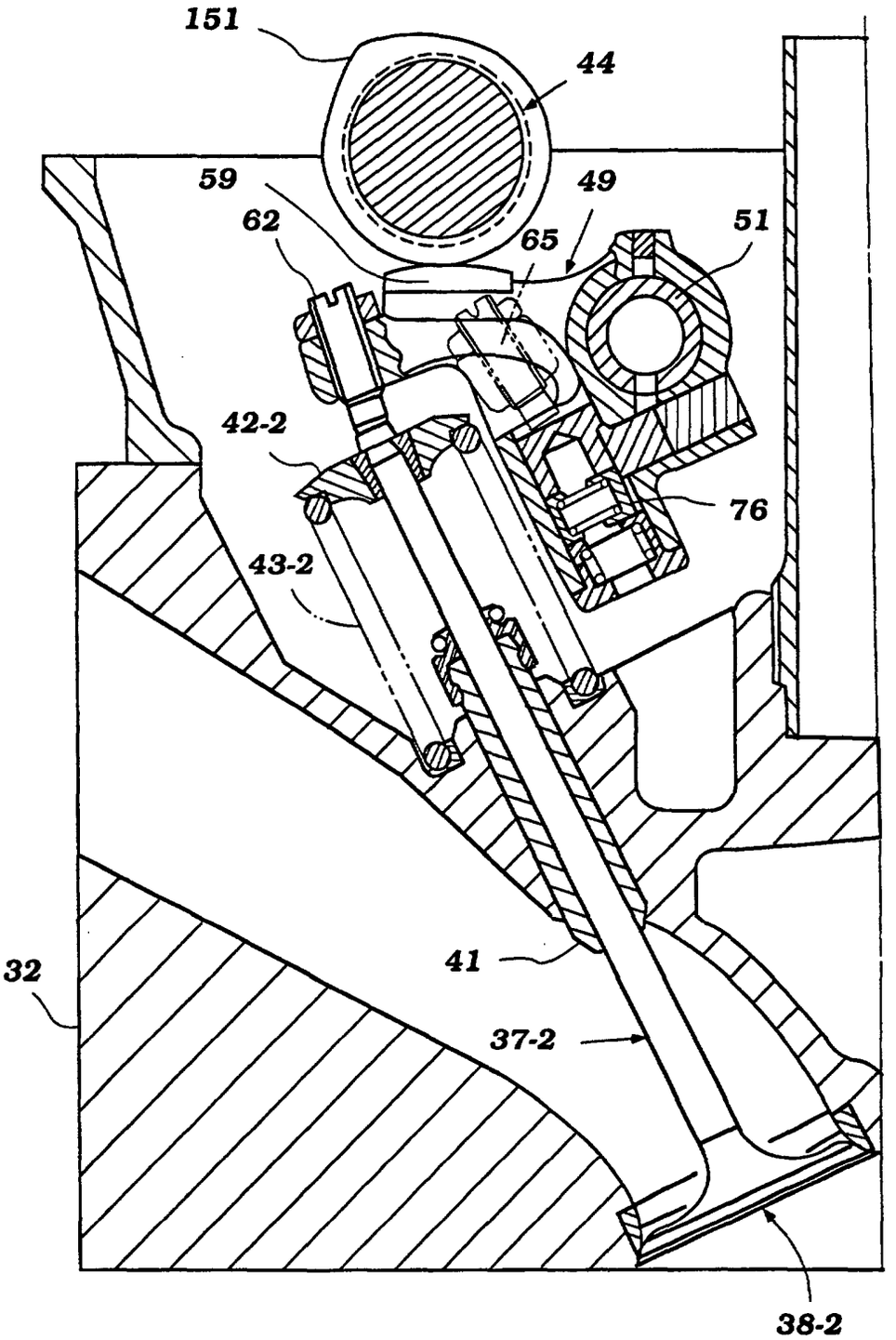


Figure 18

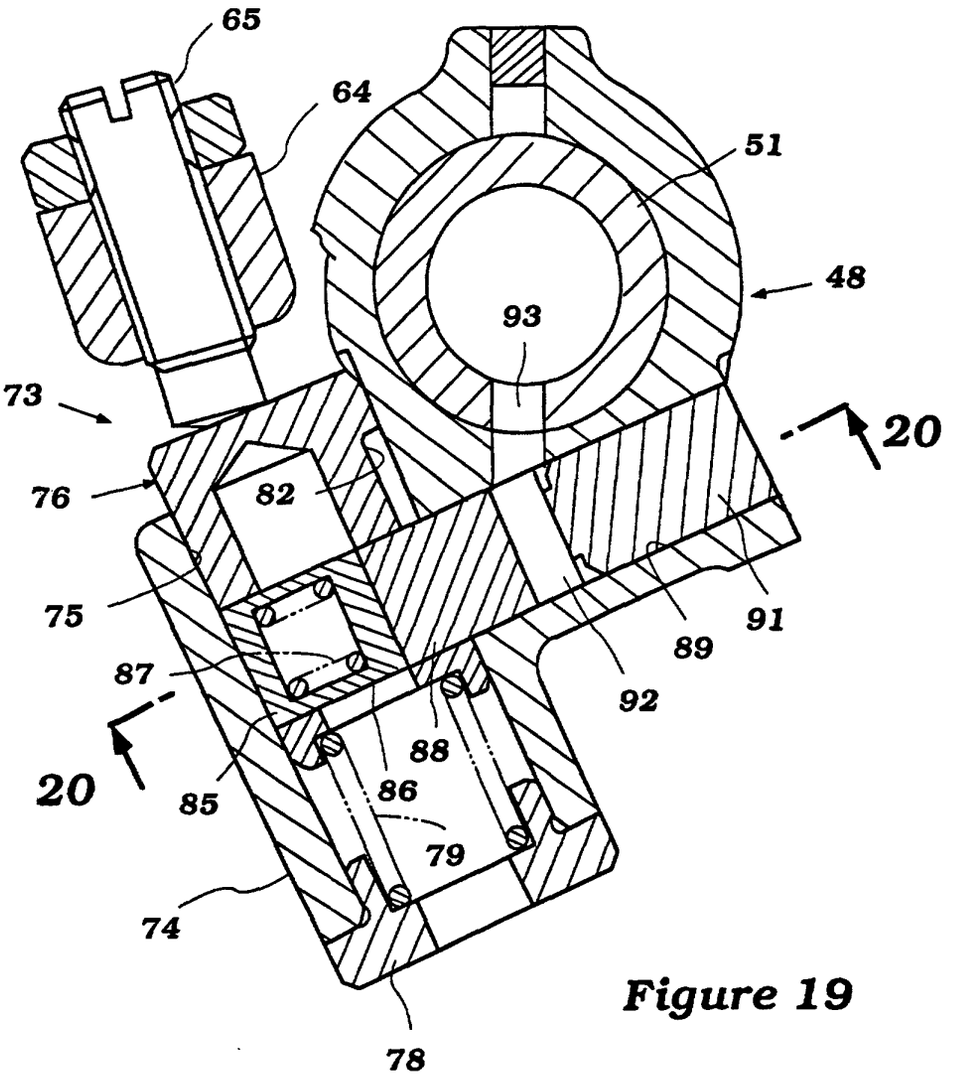


Figure 19

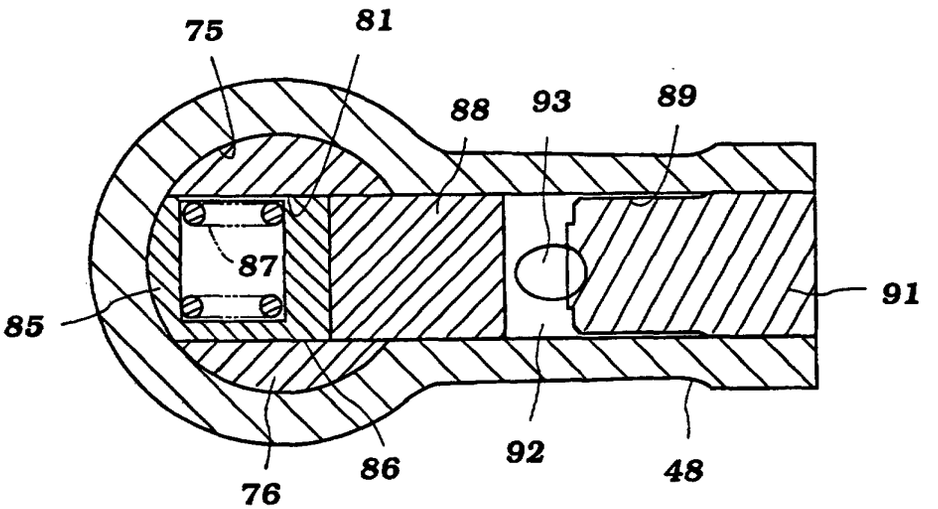


Figure 20

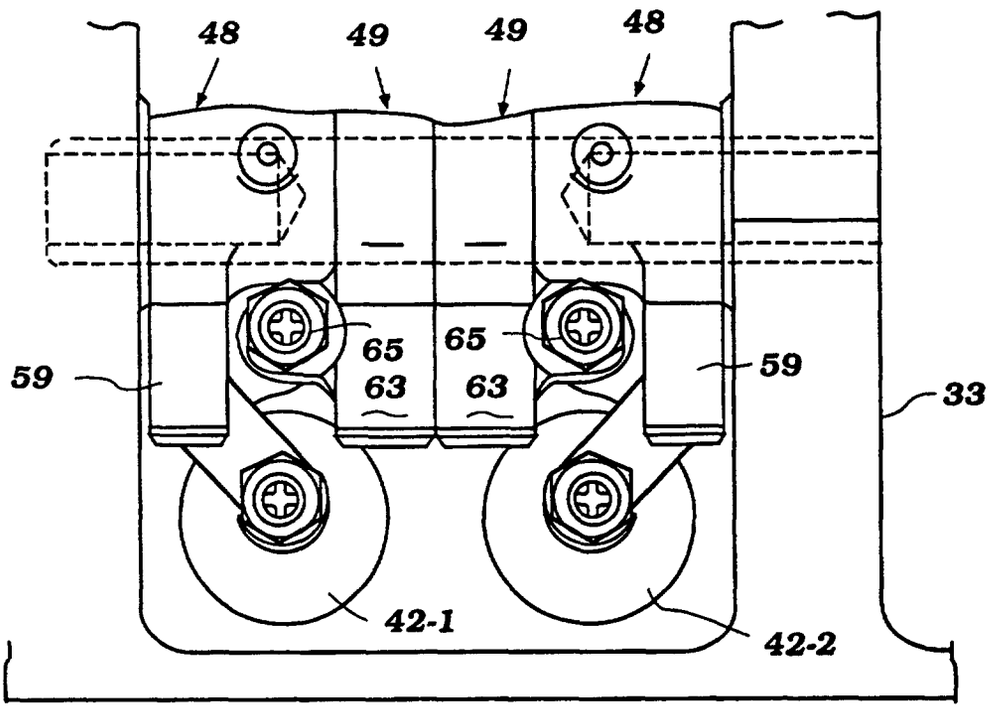
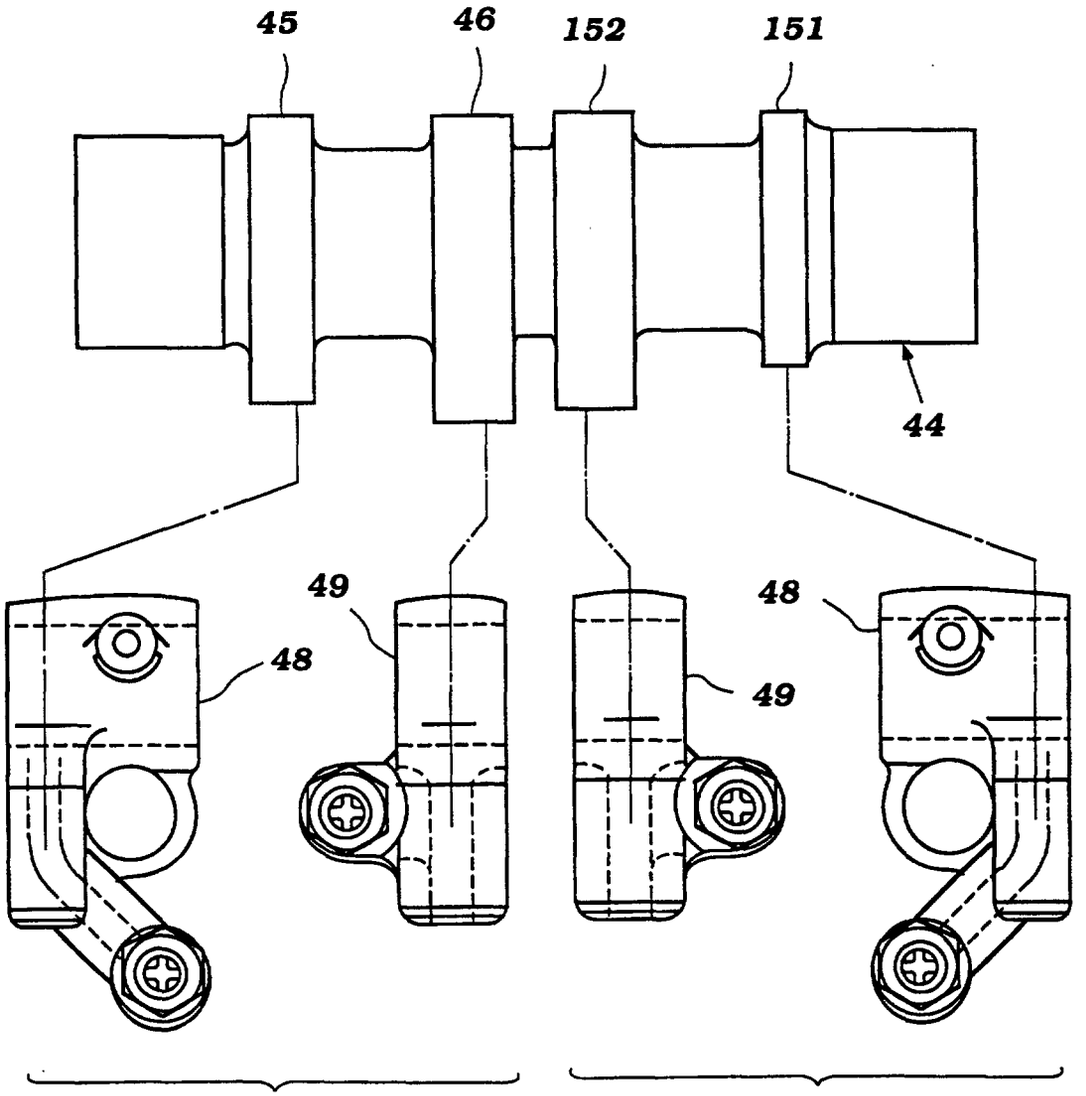


Figure 21



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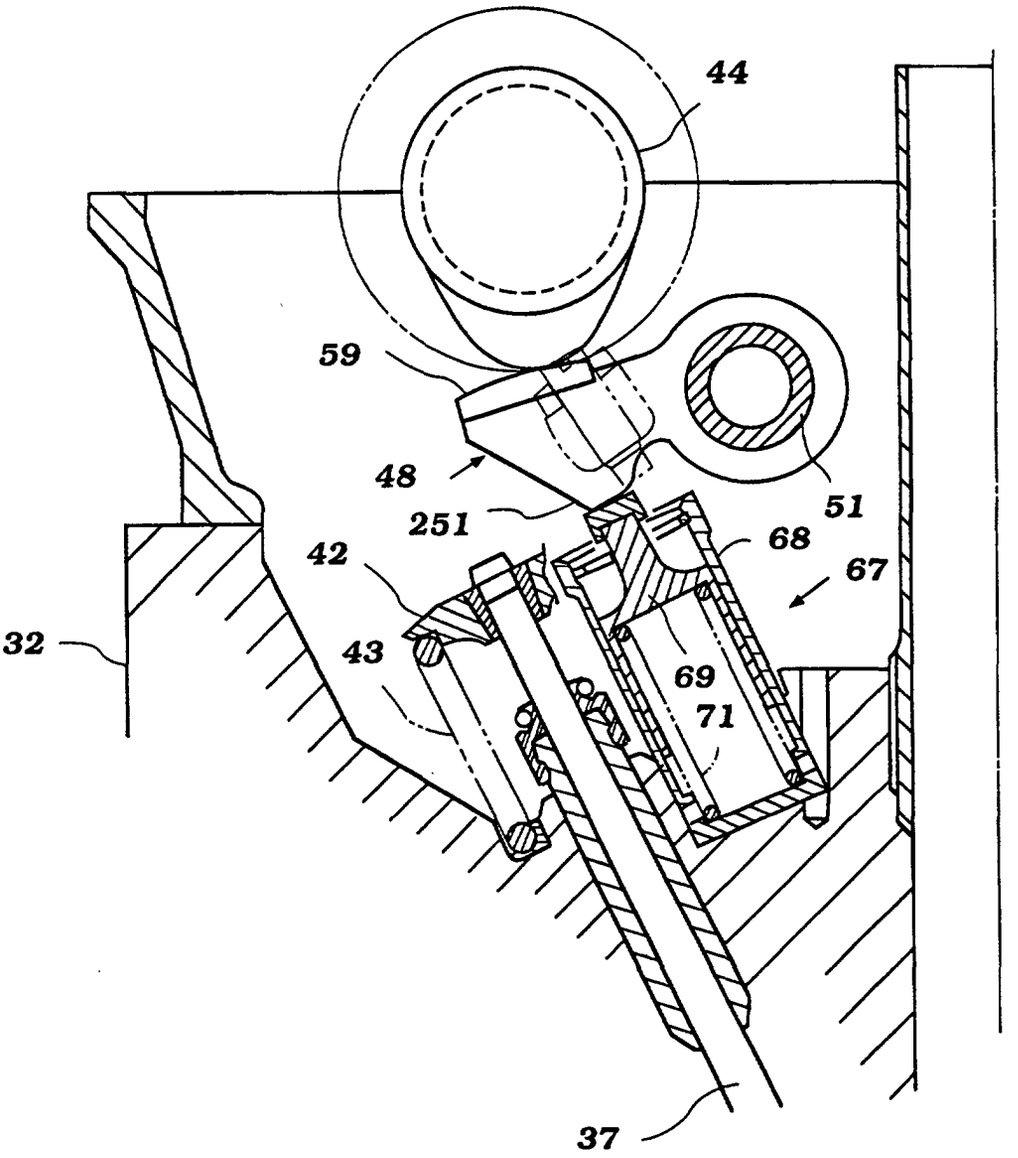

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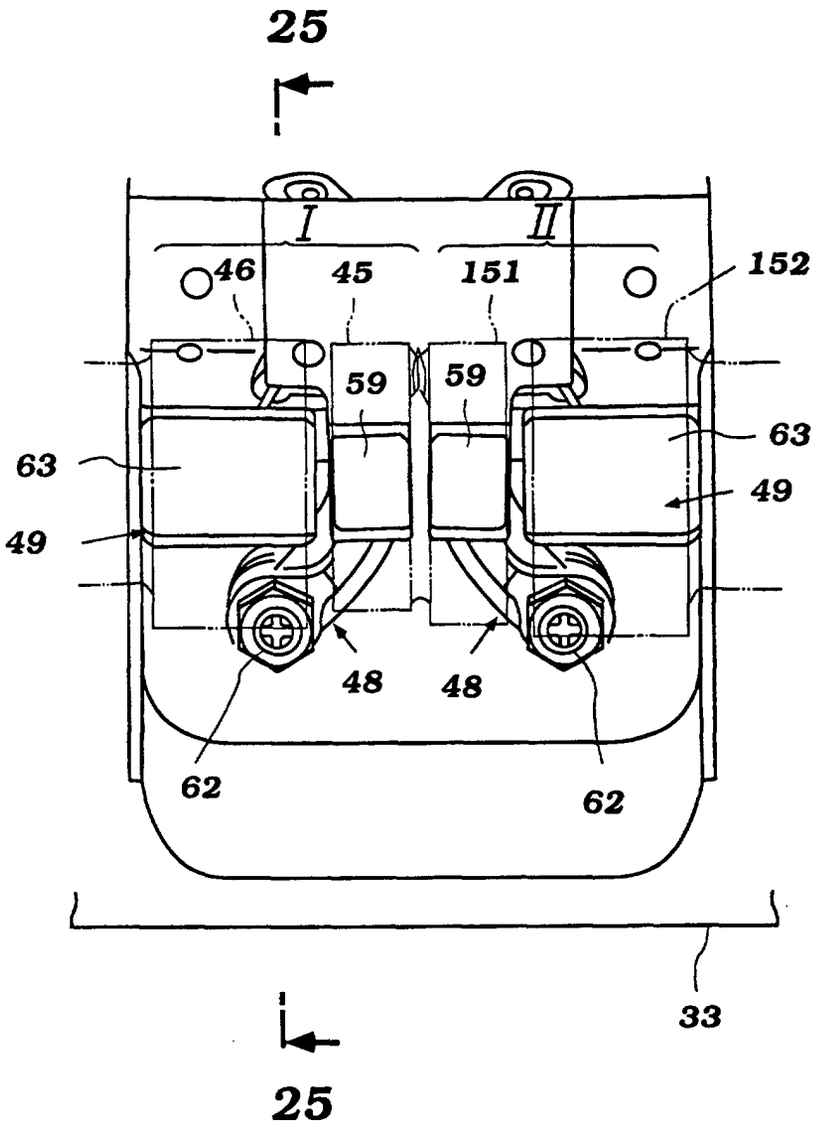

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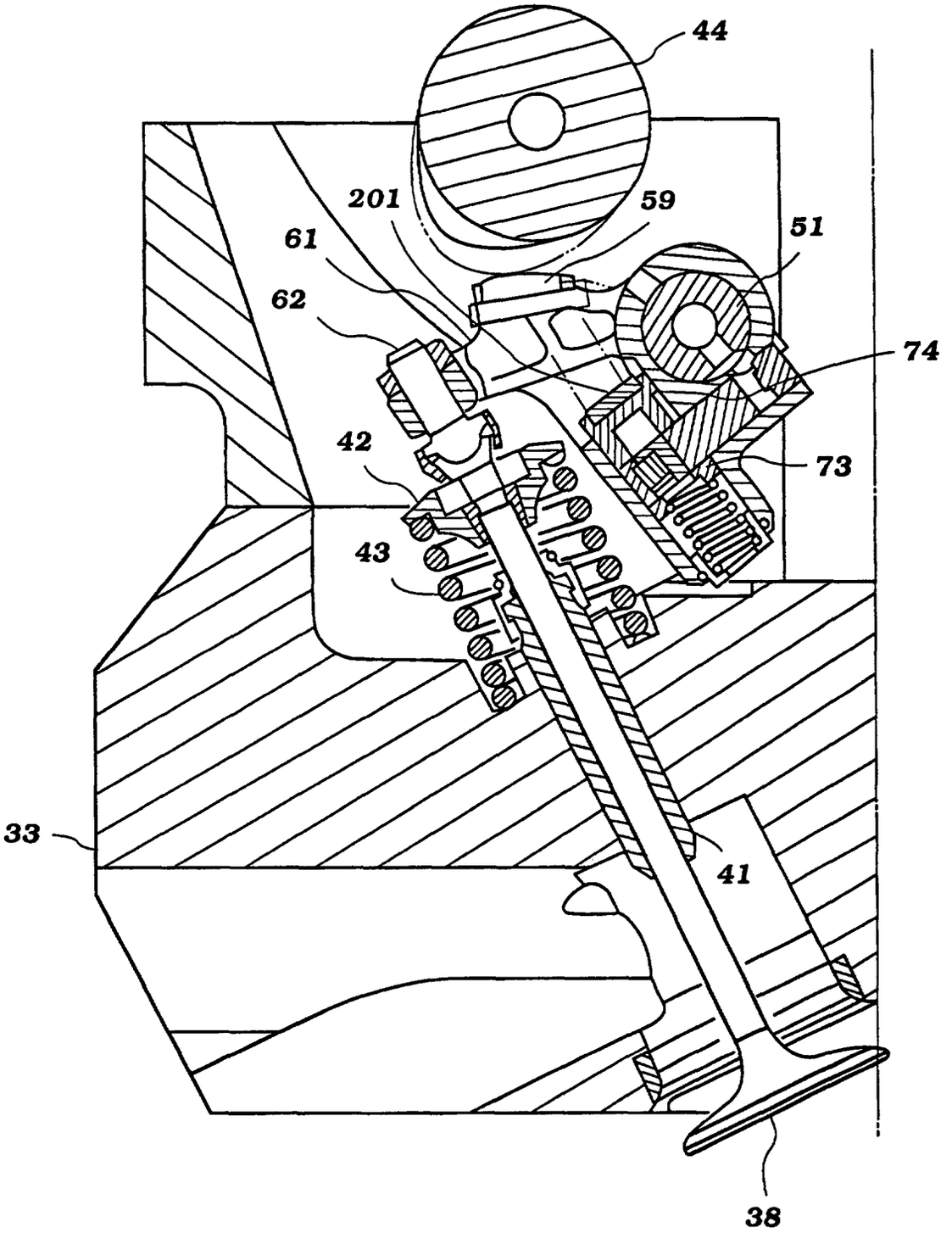

Figure 25