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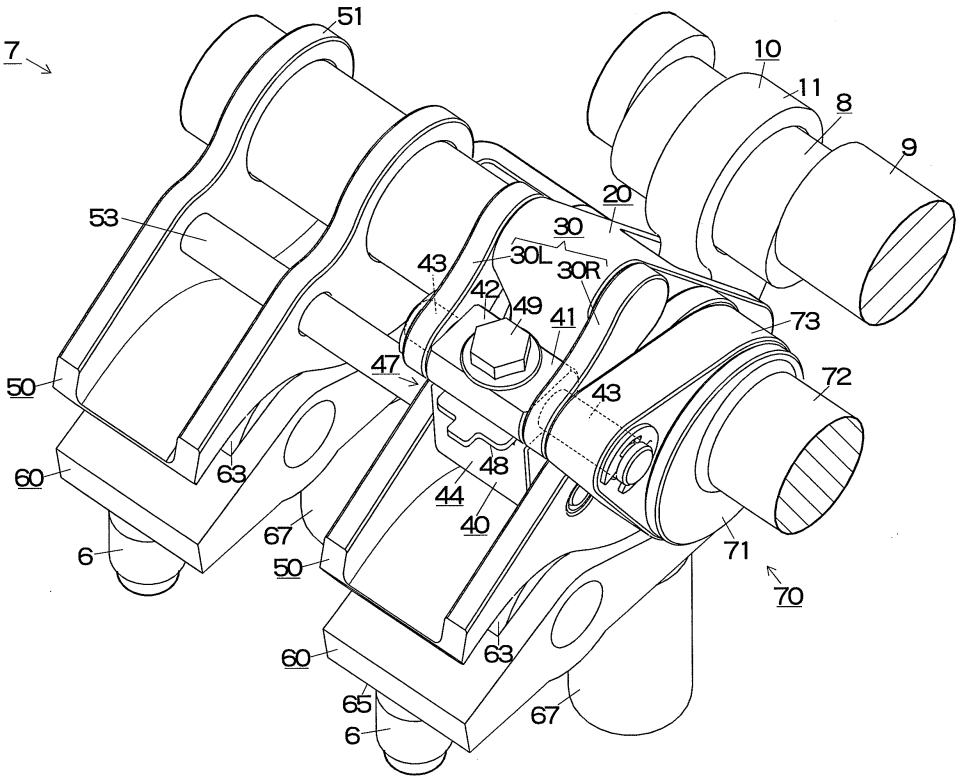
(54) **Variable valve mechanism**

(57) The present invention provides a variable valve mechanism that includes a drive cam for supplying a driving force, a link mechanism that opens and closes a valve by transmitting the driving force to the valve and has a plurality of rocking levers connected in sequence by respective joints so as to be relatively rotatable, and a variable mechanism that changes an opening and closing amount of the valve by displacing the link mechanism. One of the rocking levers of the link mechanism is provided with a length adjustment mechanism for adjusting a length of the one rocking lever in which the length adjustment mechanism is provided, and the opening and closing amount of the valve can be adjusted by adjusting the length using the length adjustment mechanism.

F I G. 1



EP 2 299 070 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a variable valve mechanism that changes an opening and closing amount of a valve in accordance with an operating condition of an internal combustion engine.

BACKGROUND ART

[0002] A variable valve mechanism may have a constitution such as that of a conventional variable valve mechanism 90 shown in FIG. 6, which includes a drive cam 91 that supplies a driving force, a link mechanism that opens and closes a valve 6 by transmitting the driving force to the valve 6 and has a plurality of rocking levers 92 to 95 connected in sequence by respective joints so as to be relatively rotatable, and a variable mechanism 97 that changes an opening and closing amount of the valve 6 by displacing the link mechanism.

CITATION LIST

[0003]

Patent Literature: Japanese Patent Application Publication H11-324625

SUMMARY OF INVENTION

Technical Problem

[0004] However, in the conventional variable valve mechanism 90 described above, the opening and closing amount of the valve 6 may deviate from a desired opening and closing amount due to variation in the dimensions of the rocking levers 92 to 95 and so on, and as a result, an engine performance may deteriorate.

[0005] It is therefore an object of the present invention to enable adjustment of an opening and closing amount of a valve even when the opening and closing amount deviates from a desired opening and closing amount due to variation in the dimensions of respective rocking levers and so on.

Solution to Problem

[0006] In order to achieve the above object, a variable valve mechanism according to the present invention includes a drive cam for supplying a driving force, a link mechanism that opens and closes a valve by transmitting the driving force to the valve and has a plurality of rocking levers connected in sequence by respective joints so as to be relatively rotatable, and a variable mechanism that changes an opening and closing amount of the valve by displacing the link mechanism. The variable valve mechanism is **characterized in that** at least one of the rocking levers of the link mechanism is provided with a length adjustment mechanism for adjusting a length of the one rocking lever in which the length adjustment mechanism is provided, and the opening and closing amount of the valve can be adjusted by adjusting the length using the length adjustment mechanism.

[0007] There is no particular limit on the length adjustment mechanism. However, it is preferred that the length adjustment mechanism includes the one rocking lever which is divided into two members in a length direction, a spacer inserted between the two members replaceably, and a coupling member that couples the two members releaseably with the spacer inserted, and the length of the one rocking lever can be adjusted by replacing the spacer with a spacer having a different thickness.

[0008] Further, there is no particular limit on the one of the two members. However, it is preferred that the one of the two members includes a coupled portion that is coupled to the other member by the coupling member, and a connecting shaft that extends from the coupled portion in a width direction of the one rocking lever and is connected to another rocking lever adjacent to the one member by one of the joints so as to be capable of rotating relative to the other rocking lever, and that the coupled portion is formed to be larger than the connecting shaft in a radial direction of the connecting shaft, and is provided with a planar contact surface that contacts the spacer. Accordingly, the contact surface can be formed without reducing a section modulus (strength relative to flexing) of the one member.

[0009] Further, there is no particular limit on the one member and the other rocking lever. However, it is preferred that the connecting shaft is provided on each side of the coupled portion in the width direction of the one rocking lever, and the other rocking lever is divided into a member that is connected to one of the two connecting shafts and a member that is connected to the other of the two connecting shafts. By dividing the adjacent other rocking lever in this manner, the variable valve mechanism can be assembled easily even when the coupled portion is larger than the connecting shafts on each side thereof in the radial direction, as described above.

Advantageous Effects of Invention

[0010] According to the present invention, as described above, at least one of the rocking levers is provided with the length adjustment mechanism, and by adjusting the length of the rocking lever using the length adjustment mechanism, the opening and closing amount of the valve can be adjusted.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

FIG. 1 is a perspective view showing a variable valve mechanism according to an embodiment of the

present invention;
FIG. 2 is an exploded perspective view showing the variable valve mechanism according to the embodiment;
FIG. 3A is a side view showing the variable valve mechanism according to the embodiment, and FIG. 3B is a side view showing the variable valve mechanism in an operative state;
FIG. 4A is a side view showing a state in which an opening and closing amount of a valve is reduced by a variable mechanism of the variable valve mechanism according to the embodiment, and FIG. 4B is a side view showing a state in which the opening and closing amount of the valve is increased;
FIG. 5A is a side view showing a state in which the opening and closing amount of the valve is reduced by a length adjustment mechanism of the variable valve mechanism according to the embodiment, and FIG. 5B is a side view showing a state in which the opening and closing amount of the valve is increased; and
FIG. 6 is a side view showing a conventional variable valve mechanism.

DESCRIPTION OF EMBODIMENTS

[0012] A variable valve mechanism 7 according to an embodiment shown in FIGS. 1 to 5 is provided relative to two intake or exhaust valves 6, 6 provided relative to a single cylinder so as to change an opening and closing amount L of the two valves 6, 6 continuously. The variable valve mechanism 7 includes a drive cam 8, first to fifth rocking levers 10, 20, 30, 40, 50, 50, rocker arms 60, 60, and a variable mechanism 70, to be described below. Here, the first to fifth rocking levers 10, 20, 30, 40, 50, 50 extend respectively in orthogonal directions to a left-right direction to be capable of rocking in orthogonal planes to the left-right direction. The first to fifth rocking levers 10, 20, 30, 40, 50, 50 constitute a link mechanism that opens and closes the valves 6, 6 by transmitting a driving force of the drive cam 8 to the rocker arms 60, 60.

[Drive cam 8]

[0013] The drive cam 8 is provided on a camshaft 9 that extends in the left-right direction, and rotate together with rotation of the camshaft 9. The drive cam 8 has a perfectly circular sectional shape and a center A of the perfect circle is offset from an axial center Ao of the camshaft 9. The camshaft 9 is shared by a plurality of the variable valve mechanisms 7, 7... and rotates in accordance with rotation of an internal combustion engine.

[First rocking lever 10]

[0014] The first rocking lever 10 includes a ring-shaped ring portion 11 on a rear end portion thereof and is externally fitted to the drive cam 8 by the ring portion 11 to be capable of rotating relative to the drive cam 8. Further, a connection hole (not shown) enabling connection to a rear end portion of the second rocking lever 20 is formed through a tip end portion of the first rocking lever 10.

[Second rocking lever 20]

[0015] The second rocking lever 20 includes a ring-shaped ring portion (not shown) in a length direction intermediate portion thereof, and is externally fitted to a support shaft 72, to be described below, by the ring portion to be capable of rotating relative to the support shaft 72. Further, a connection hole 22 is formed in a rear end portion of the second rocking lever 20, and by inserting a single connecting pin 23 into the connection hole 22 and the connection hole (not shown) in the tip end portion of the first rocking lever 10, the rear end portion of the second rocking lever 20 is connected to the tip end portion of the first rocking lever 10 to be capable of rotating relative thereto. Furthermore, a connection hole 25 enabling connection to a rear end portion of the third rocking lever 30 is formed through a tip end portion of the second rocking lever 20.

[Third rocking lever 30]

[0016] The third rocking lever 30 is divided into a lever left side member 30L and a lever right side member 30R in the left-right direction. A connecting shaft 33 that extends rightward projects from a right side surface of a rear end portion of the lever left side member 30L, and a connecting shaft 33 that extends leftward projects from a left side surface of a rear end portion of the lever right side member 30R. When the two connecting shafts 33, 33 are inserted into the connection hole 25 in the tip end portion of the second rocking lever 20 from the left and right sides, respectively, the rear end portion of the third rocking lever 30 is connected to the tip end portion of the second rocking lever 20 to be capable of rotating relative thereto. Further, connection holes 35, 35 enabling connection to a rear end portion of the fourth rocking lever 40 are formed through respective tip end portions of the lever left side member 30L and the lever right side member 30R.

[Fourth rocking lever 40]

[0017] The fourth rocking lever 40 is divided into a lever rear side member 41 and a lever front side member 44 in a length direction thereof. Further, the fourth rocking lever 40 is provided with a length adjustment mechanism 47 for adjusting a length thereof.

[0018] The lever rear side member 41 constitutes a rear end portion of the fourth rocking lever 40. The lever rear side member 41 includes a coupled portion 42 coupled to the lever front side member 44, and left and right connecting shafts 43, 43 extending respectively leftward from a left side surface of the coupled portion 42 and

rightward from a right side surface of the coupled member 42. The coupled portion 42 takes a columnar shape formed to be larger than (substantially twice as large as) the connecting shafts 43, 43 in a radial direction of the connecting shafts 43, 43, from which parts on both length direction sides of the fourth rocking lever 40 are cut into a planar shape. A lever front side member 44 side plane of the coupled portion 42 constitutes a contact surface 42b that contacts a spacer 48 to be described below. Further, a bolt through hole 42a for coupling the coupled portion 42 to the lever front side member 44 is formed through the coupled portion 42 in the length direction of the fourth rocking lever 40. The lever rear side member 41 is connected to the tip end portion of the third rocking lever 30 to be capable of rotating relative thereto by inserting the left side connecting shaft 43 into the connection hole 35 in the tip end portion of the lever left side member 30L of the third rocking lever 30 and inserting the right side connecting shaft 43 into the connection hole 35 in the tip end portion of the lever right side member 30R of the third rocking lever 30. Furthermore, one of the connecting shafts 43 of the lever rear side member 41 is also connected to a tip end portion of a variable lever 73, to be described below, of the variable mechanism 70 such that a displacement direction of the connecting shaft 43 is restricted in a circumferential direction.

[0019] The lever front side member 44 constitutes the part of the fourth rocking lever 40 other than the rear end portion. The lever front side member 44 includes, on a rear end portion thereof, a female screw-shaped bolt hole 44a extending in the length direction of the fourth rocking lever 40 to enable coupling to the lever rear side member 41, a planar contact surface 44b that contacts the spacer 48, and projections 44c, 44c that prevent the spacer 48 from shifting. Further, a connection hole (not shown) enabling connection to the fifth rocking levers 50, 50 is formed through a tip end portion of the lever front side member 44.

[0020] The length adjustment mechanism 47 includes the lever rear side member 41 and lever front side member 44 described above, the spacer 48, which is inserted between the lever rear side member 41 and the lever front side member 44 replaceably, and a bolt 49 serving as a coupling member that couples the lever rear side member 41 and the lever front side member 44 releaseably with the spacer 48 inserted. Here, the spacer 48 is a plate-shaped member (a shim) in which a notch 48a is provided from one side thereof to a central portion. The bolt 49 is inserted into the bolt through hole 42a in the lever rear side member 41 and the notch 48a in the spacer 48 and then screwed into the bolt hole 44a in the lever front side member 44.

[Fifth rocking lever 50]

[0021] The fifth rocking levers 50, 50 are a pair of levers, each of which is provided for each of the valves 6, 6. Ring portions 51, 51 are provided on respective rear end portions of the fifth rocking levers 50, 50, and the respective fifth rocking levers 50, 50 are externally fitted to the support shaft 72 by the ring portions 51, 51 such that the fifth rocking levers 50, 50 are supported on the support shaft 72 to be capable of rotating relative thereto. Further, connection holes 52, 52 are provided in respective length direction intermediate portions of the fifth rocking levers 50, 50, and by inserting a single connecting pin 53 into the connection holes 52, 52 and the connection hole (not shown) in the tip end portion of the fourth rocking lever 40, the respective length direction intermediate portions of the fifth rocking levers 50, 50 are connected to the tip end portion of the fourth rocking lever 40 to be capable of rotating relative thereto. Furthermore, pressing surfaces 55, 55 for pressing the pair of rocker arms 60, 60 are formed on lower surfaces of respective tip end portions of the fifth rocking levers 50, 50.

[Rocker arms 60, 60]

[0022] Each of the rocker arms 60, 60 is provided for each of the valves 6, 6. Each rocker arm 60 extends in an orthogonal direction to the left-right direction such that a rear end portion thereof is supported by a lash adjuster 67 to be capable of rocking. A roller 63 that contacts the pressing surface 55 of the fifth rocking lever 50 and a pressing surface 65 that presses a stem end of the valve 6 are provided respectively in a length direction intermediate portion and a tip end portion of each rocker arm 60.

[0023] Further, valve springs (not shown) for closing the valves 6, 6 when the pressing surfaces 65, 65 of the rocker arms 60, 60 displace in a direction heading away from the stem ends of the valves 6, 6 are attached to the valves 6, 6.

[0024] Hence, when the camshaft 9 rotates, the drive cam 8 rotates together with the rotation of the camshaft 9, as shown in FIG. 3B, whereby a resulting driving force is transmitted to the first rocking lever 10, the second rocking lever 20, the third rocking lever 30, the fourth rocking lever 40, the pair of fifth rocking levers 50, 50, and the pair of rocker arms 60, 60 in sequence. As a result, the pair of rocker arms 60, 60 rock, thereby opening and closing the pair of valves 6, 6 by a fixed opening and closing amount L.

[Variable mechanism 70]

[0025] The variable mechanism 70 changes the opening and closing amount of the valves 6, 6 by displacing the connecting shaft 43 on the lever rear side member 41 of the fourth rocking lever 40. The variable mechanism 70 includes a variable cam 71 and a variable lever 73, to be described below.

[0026] The variable cam 71 is provided on the support shaft 72, which supports the second rocking lever 20 and the fifth rocking levers 50, 50 to be capable of relative rotation, and rotates together with the rotation of the support shaft 72. The variable cam 71 has a perfectly circular

sectional shape and a center B of the perfect circle is offset from an axial center Bo of the support shaft 72. The support shaft 72 is driven to rotate by a rotation device (not shown).

[0027] The variable lever 73 extends in an orthogonal direction to the left-right direction, and a ring-shaped ring portion 74 is provided in a rear end portion thereof. The variable lever 73 is externally fitted to the variable cam 71 by the ring portion 74 to be capable of rotating. Further, a connection hole 75 is formed through a tip end portion of the variable lever 73, and by inserting one of the connecting shafts 43 of the lever rear side member 41 of the fourth rocking lever 40 into the connection hole 75, the tip end portion of the variable lever 73 is connected to the rear end portion of the fourth rocking lever 40 to be capable of rotating. Furthermore, a stopper 76 for preventing the variable lever 73 from falling out of the connecting shaft 43 of the fourth rocking lever 40 is attached to the connecting shaft 43.

[0028] Hence, when the support shaft 72 is driven by the rotation device (not shown) to rotate in one circumferential direction, as shown in FIG. 4A, the variable cam 71 rotates together with the rotation of the support shaft 72, whereby a resulting driving force is transmitted to the fourth rocking lever 40 and the pair of fifth rocking levers 50, 50 in sequence. As a result, the pair of fifth rocking levers 50, 50 rock about the central axis Bo of the support shaft 72 while a rocking range thereof shifts in its entirety in the one circumferential direction of the central axis Bo. Thus, the opening and closing amount L of the valves 6, 6 is reduced.

[0029] Further, when the support shaft 72 is driven by the rotation device (not shown) to rotate in the other circumferential direction, as shown in FIG. 4B, the variable cam 71 rotates together with the rotation of the support shaft 72, whereby a resulting driving force is transmitted to the fourth rocking lever 40 and the pair of fifth rocking levers 50, 50 in sequence. As a result, the pair of fifth rocking levers 50, 50 rock about the central axis Bo of the support shaft 72 while a rocking range thereof shifts in its entirety in the other circumferential direction of the central axis Bo. Thus, the opening and closing amount L of the valves 6, 6 is increased.

[0030] Next, the manner in which the opening and closing amount L (and a timing) of the valves 6, 6 is adjusted using the length adjustment mechanism 47 will be described in relation to a case where a reduction adjustment is performed to reduce the opening and closing amount L and a case where an increase adjustment is performed to increase the opening and closing amount L.

[Reduction adjustment]]

[0031] As shown in FIG. 5A, by loosening the bolt 49, removing the spacer 48, inserting a thinner spacer 48P than the spacer 48 in place of the spacer 48, and then retightening the bolt 49, the spacer 48 is replaced by the thinner spacer 48P. As a result, the length of the fourth rocking lever 40 is slightly reduced, and accordingly, the pair of fifth rocking levers 50, 50 shift slightly in the one rotation direction centering on the axial center Bo of the support shaft 72, thereby slightly reducing the opening and closing amount L of the valves 6, 6.

[Increase adjustment]

[0032] As shown in FIG. 5B, by loosening the bolt 49, removing the spacer 48, inserting a thicker spacer 48Q than the spacer 48 in place of the spacer 48, and then retightening the bolt 49, the spacer 48 is replaced by the thicker spacer 48Q. As a result, the length of the fourth rocking lever 40 is slightly increased, and accordingly, the pair of fifth rocking levers 50, 50 shift slightly in the other rotation direction centering on the axial center Bo of the support shaft 72, thereby slightly increasing the opening and closing amount L of the valves 6, 6.

[0033] Note that a rank interval and a rank number of the spacers 48P, 48, 48Q may be set as desired, and by changing the rank interval and rank number, an adjustment precision and an adjustable range can be determined as desired.

[0034] According to this embodiment, by replacing the spacer 48 inserted between the lever rear side member 41 and the lever front side member 44 of the fourth rocking lever with the spacers 48P, 48Q having different thicknesses, as described above, the opening and closing amount (and timing) of the valves 6, 6 can be adjusted. Hence, valve timing synchronization can be realized more accurately, which contributes to an improvement in engine performance. Furthermore, the dimensional precision of components such as the respective rocking levers 10, 20, 30, 40, 50 can be relaxed, making manufacture easier.

[0035] Moreover, by forming the coupled portion 42 of the lever rear side member 41 to be larger than the connecting shafts 43, 43 on each side thereof in the radial direction and providing the coupled portion 42 with the planar contact surface 42b that contacts the spacer 48, a contact surface area of the lever rear side member 41 relative to the spacer 48 can be enlarged without reducing a section modulus (strength relative to flexing) thereof. Furthermore, assembly problems caused by the thick intermediate portion of the lever rear side member 41 can be solved by dividing the third rocking lever 30 into the lever left side member 30L and the lever right side member 30R in the left-right direction, as described above. Hence, by changing the shape of the lever rear side member 41 of the fourth rocking lever 40 and the shape of the third rocking lever 30 in this manner, the principal parts of the length adjustment mechanism 47 can be housed in a small space without a reduction in strength.

[0036] Note that the present invention is not limited to the constitution of the embodiment described above, and may be subjected to modifications within a scope that does not depart from the spirit of the invention.

REFERENCE SIGNS LIST

[0037]

6	valve
7	variable valve mechanism
8	drive cam
10	first rocking lever
20	second rocking lever
30	third rocking lever (the other rocking lever)
30L	lever left side member
30R	lever right side member
40	forth rocking lever (one of the rocking levers)
41	lever rear side member (the one member)
42	coupled portion
42b	contact surface
43	connecting shaft
44	lever front side member (the other member)
47	length adjustment mechanism
48	spacer
49	bolt serving as coupling member
50	fifth rocking lever
70	variable mechanism
L	opening and closing amount of valve

[0038] The present invention provides a variable valve mechanism that includes a drive cam for supplying a driving force, a link mechanism that opens and closes a valve by transmitting the driving force to the valve and has a plurality of rocking levers connected in sequence by respective joints so as to be relatively rotatable, and a variable mechanism that changes an opening and closing amount of the valve by displacing the link mechanism. One of the rocking levers of the link mechanism is provided with a length adjustment mechanism for adjusting a length of the one rocking lever in which the length adjustment mechanism is provided, and the opening and closing amount of the valve can be adjusted by adjusting the length using the length adjustment mechanism.

Claims

1. A variable valve mechanism including: a drive cam (8) for supplying a driving force; a link mechanism that opens and closes a valve (6) by transmitting the driving force to the valve (6) and has a plurality of rocking levers (10, 20, 30, 40, 50) connected in sequence by respective joints so as to be relatively rotatable; and a variable mechanism (70) that changes an opening and closing amount (L) of the valve (6) by displacing the link mechanism, the variable valve mechanism **characterized in that**
at least one (40) of the rocking levers of the link mechanism is provided with a length adjustment mechanism (47) for adjusting a length of the one rocking lever (40) in which the length adjustment mechanism (47) is provided, and
the opening and closing amount (L) of the valve (6) can be adjusted by adjusting the length using the length adjustment mechanism (47).

2. The variable valve mechanism according to claim 1, wherein the length adjustment mechanism (47) comprises:

the one rocking lever (40) which is divided into two members (41,44) in a length direction;
a spacer (48) inserted between the two members (41,44) replaceably; and
a coupling member (49) that couples the two members (41,44) releaseably with the spacer (48) inserted, and
the length of the one rocking lever (40) can be adjusted by replacing the spacer (48) with a spacer (48P, 48Q) having a different thickness.

3. The variable valve mechanism according to claim 2, wherein the one (41) of the two members (41,44) comprises:

a coupled portion (42) that is coupled to the other member (44) by the coupling member (49); and
a connecting shaft (43) that extends from the coupled portion (42) in a width direction of the one rocking lever (40) and is connected to another rocking lever (30) adjacent to the one member (41) by one of the joints so as to be capable of rotating relative to the other rocking lever (30), and
the coupled portion (42) is formed to be larger than the connecting shaft (43) in a radial direction of the connecting shaft (43), and is provided with a planar contact surface that contacts the spacer (48).

4. The variable valve mechanism according to claim 3, wherein the connecting shaft (43) is provided on each side of the coupled portion (42) in the width direction of the one rocking lever (40), and
the other rocking lever (30) is divided into a member (30L) that is connected to one of the two connecting shafts (43,43) and a member (30R) that is connected to the other of the two connecting shafts (43,43).

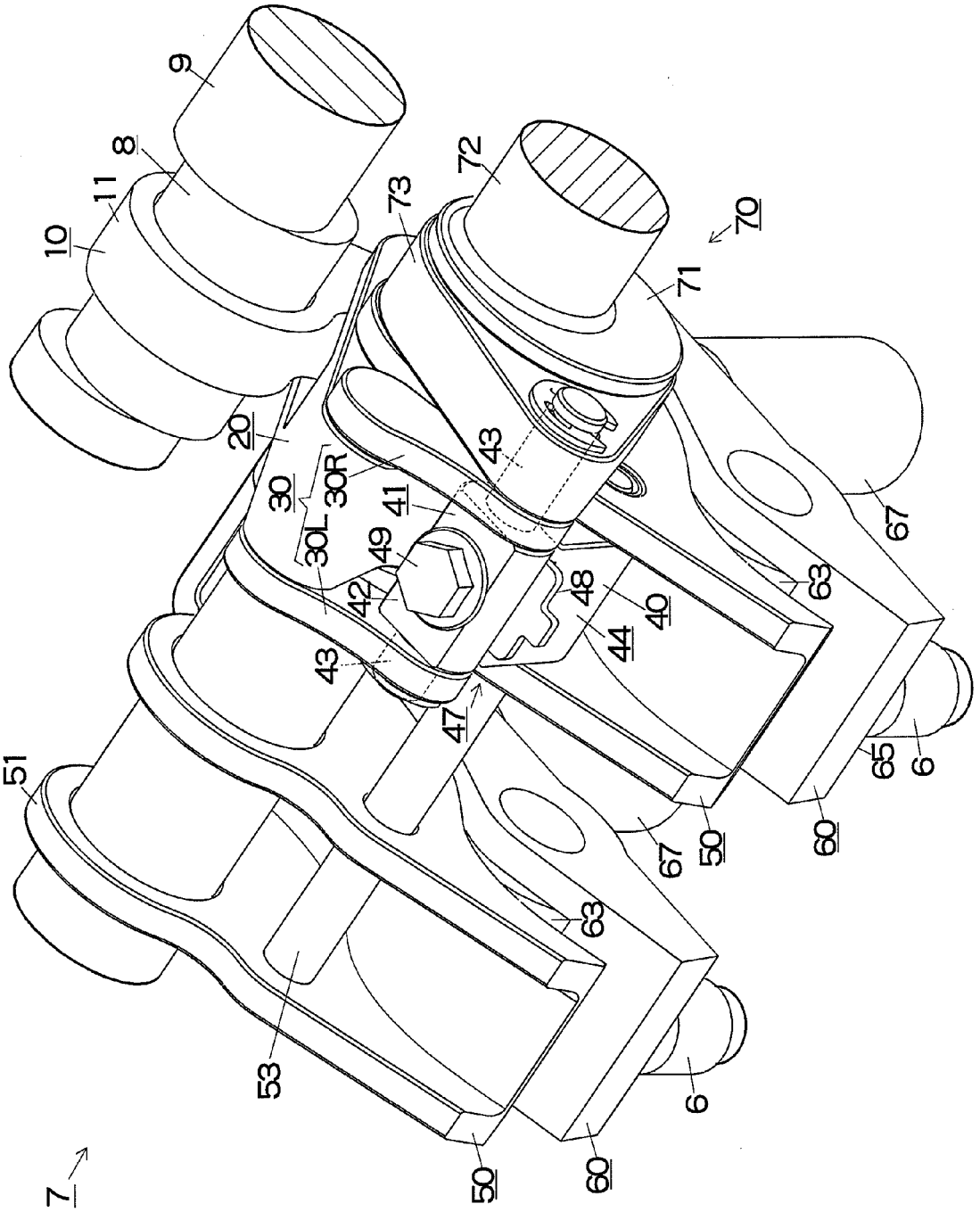

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FIG. 1

FIG. 2

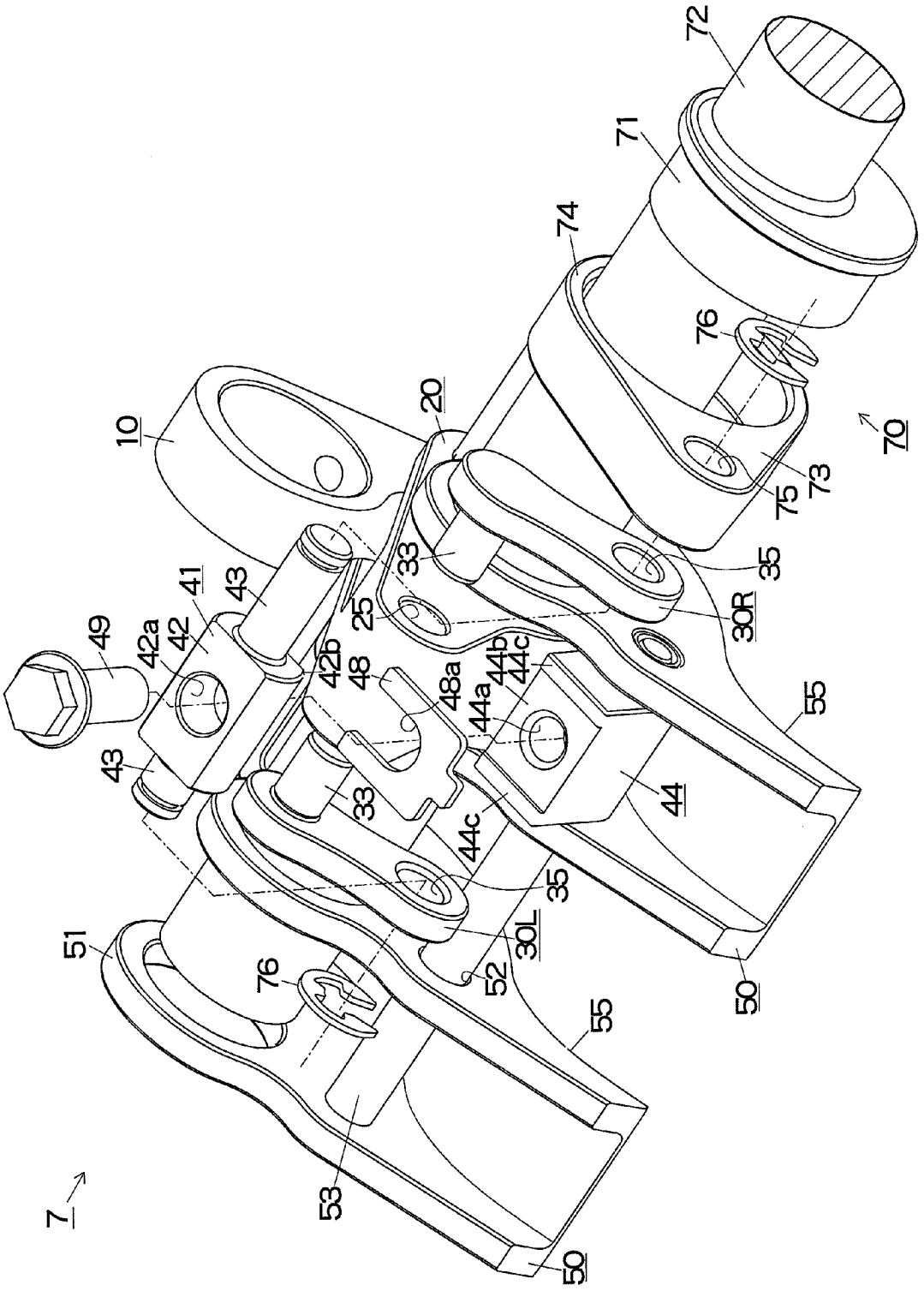
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FIG. 3B

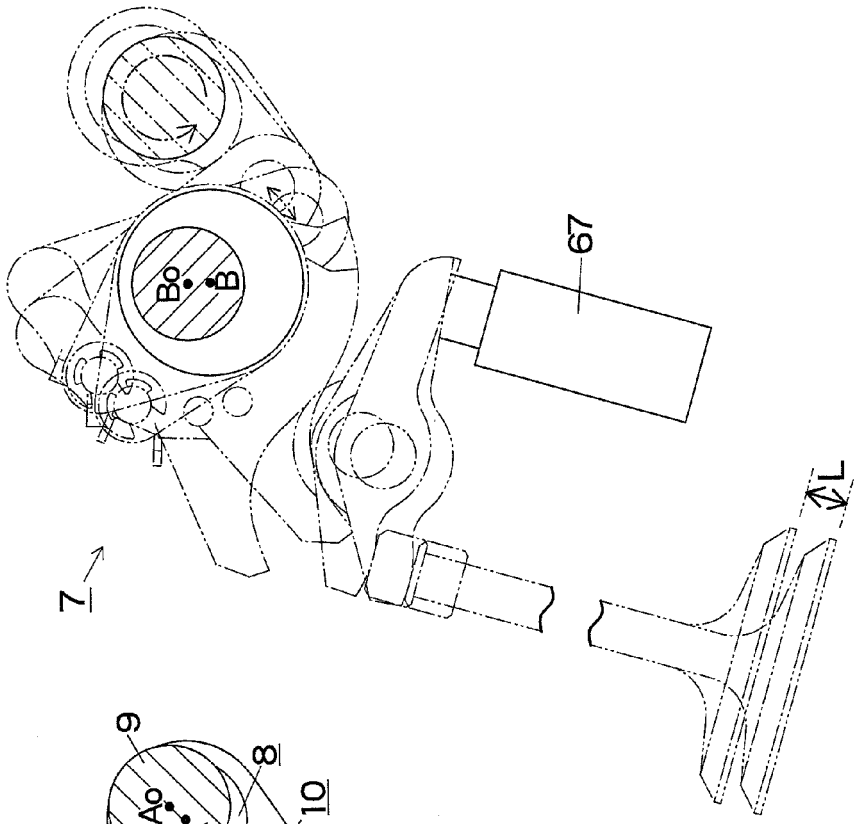
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FIG. 3A

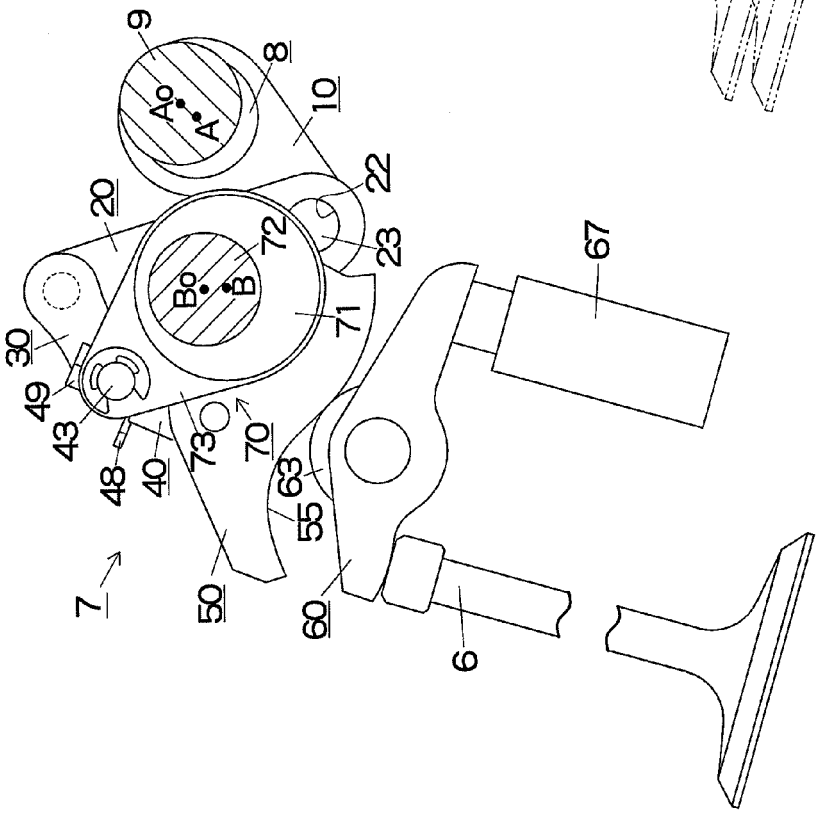
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FIG. 4B

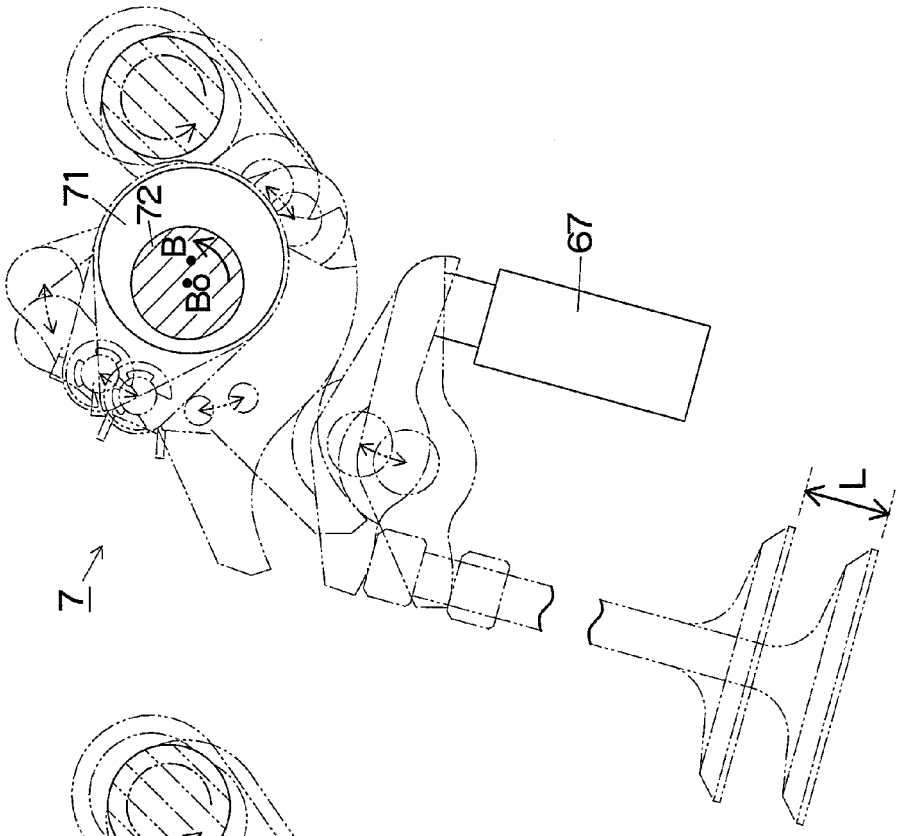

FIG. 4A

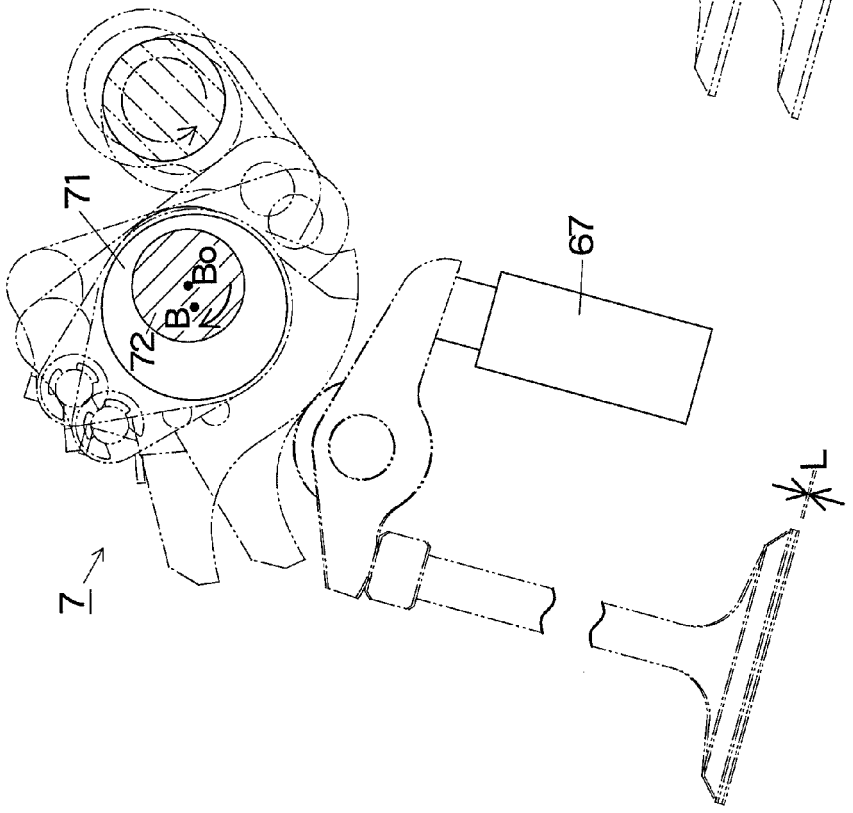

FIG. 5B

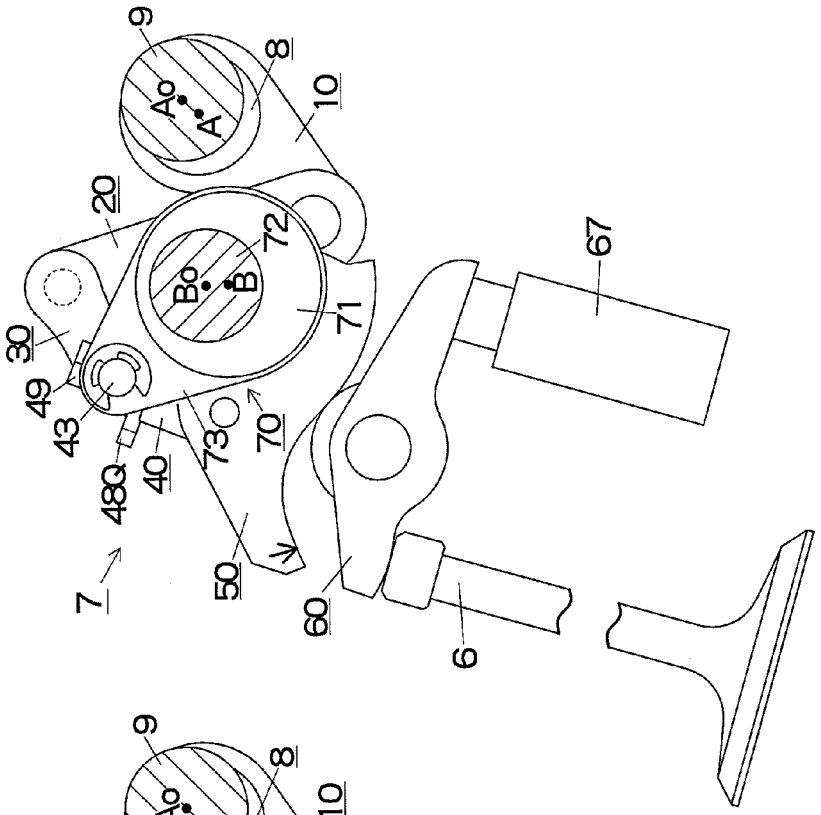
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FIG. 5A

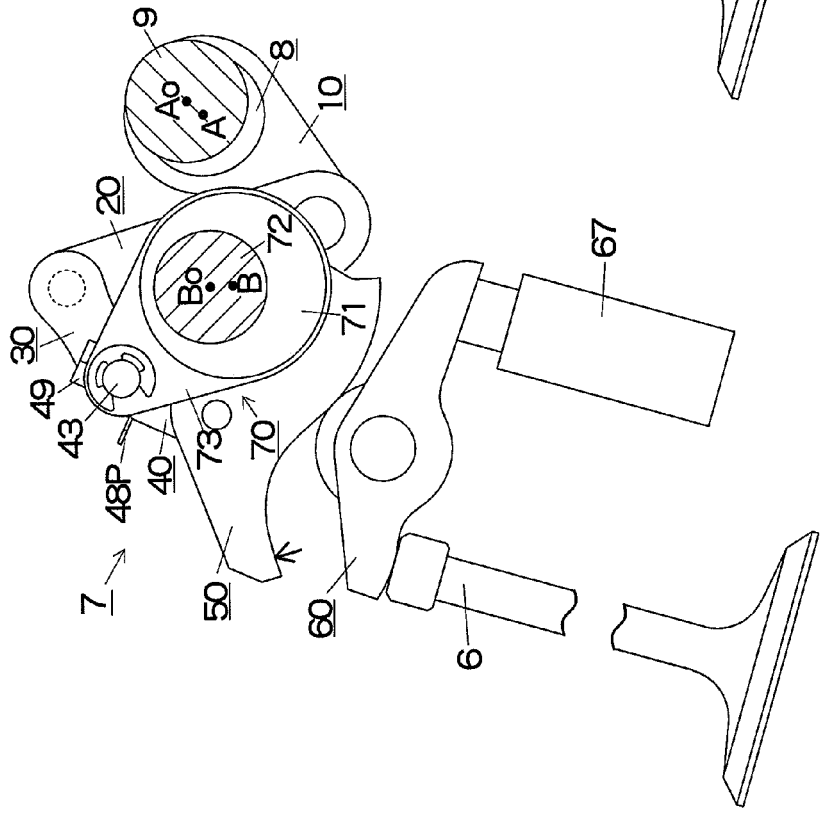
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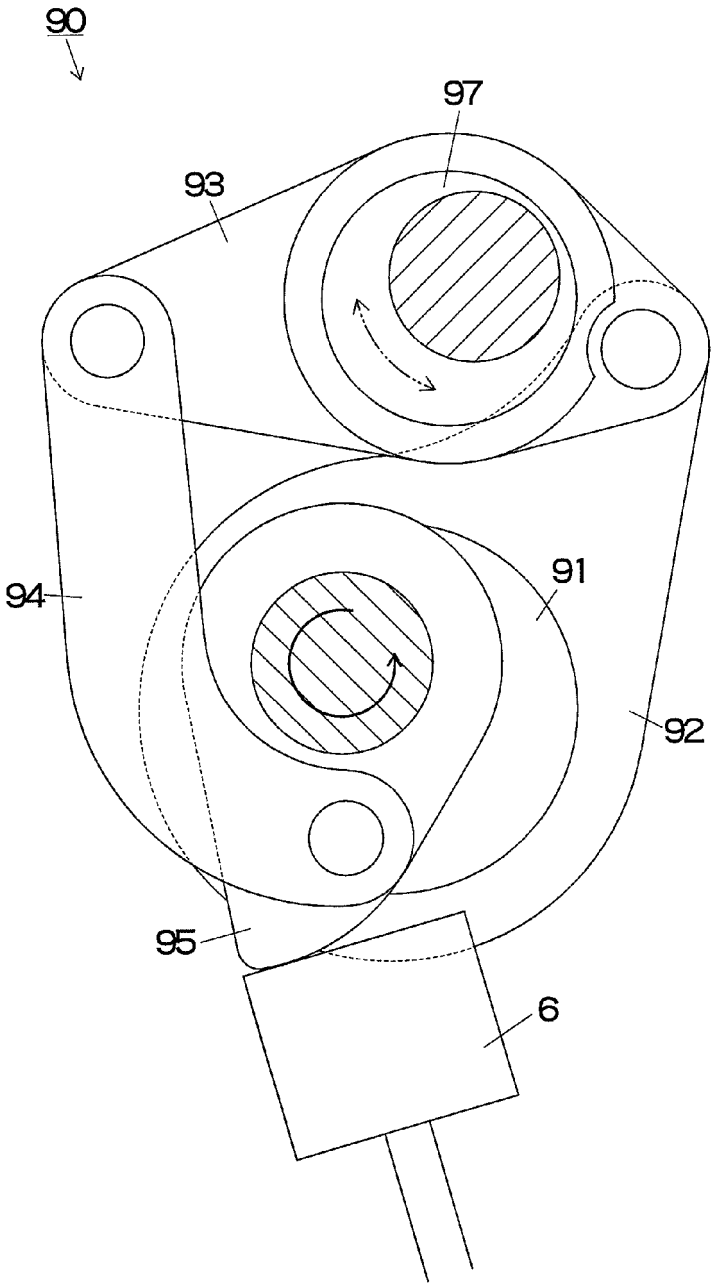
FIG. 6



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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 0089

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	JP 2006 029246 A (HITACHI LTD) 2 February 2006 (2006-02-02) * figure 5 * -----	1-4	INV. F01L13/00 F01L1/20
X	EP 1 873 362 A1 (OTICS CORP [JP]) 2 January 2008 (2008-01-02) * paragraphs [0054] - [0058]; figures 24A,24B * -----	1,2	
X	EP 1 801 368 A1 (OTICS CORP [JP]) 27 June 2007 (2007-06-27) * paragraph [0037]; figures 1,2,8 * -----	1	
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