



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.07.2010 Bulletin 2010/30

(51) Int Cl.:
F01L 1/46 (2006.01) **F01L 13/00** (2006.01)

(21) Application number: **09177705.2**

(22) Date of filing: **02.12.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(72) Inventor: **Yamaguchi, Koki**
Nishio-shi Aichi 444-0392 (JP)

(30) Priority: **23.01.2009 JP 2009012896**

(74) Representative: **TBK-Patent**
Bavariaring 4-6
80336 München (DE)

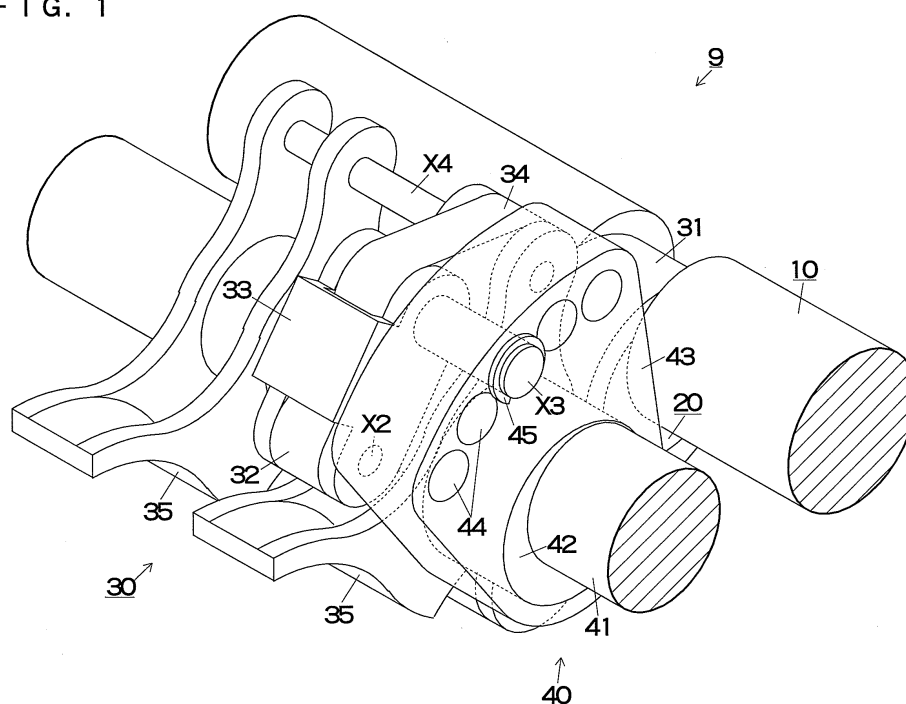
(71) Applicant: **Otics Corporation**
444-0392 Aichi Nishio-shi (JP)

(54) **Variable Valve Mechanism**

(57) The present invention provides a variable valve mechanism includes a drive shaft, a drive cam, a power transmission mechanism that transmits power from the drive cam to a valve, and an opening and closing amount variable mechanism that displaces an intermediate portion of the power transmission mechanism to change an opening and closing amount of the valve. The opening and closing amount variable mechanism includes a control shaft, a control cam, and a control arm that has a rear end portion rotatably externally attached to the control

cam and a distal end portion provided with a plurality of pin holes to which the distance from the center of the control cam varies from each other, and swingably supports the intermediate portion of the power transmission mechanism in a circumferential direction of the control cam by selectively inserting one connecting pin provided to the intermediate portion of the power transmission mechanism into one of the plurality of pin holes. The opening and closing amount of the valve is adjusted by changing a pin hole into which the connecting pin is inserted.

FIG. 1



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] Variable valve mechanisms, such as a variable valve mechanism 90 as shown in FIG. 8, include a drive shaft 91 provided rotatably, a drive cam 92 provided on the drive shaft 91, a power transmission mechanism 93 that transmits the power of the drive cam 92 to a valve 8 so as to open and close the valve 8; and an opening and closing amount variable mechanism 94 that displaces an intermediate portion of the power transmission mechanism 93 to change the opening and closing amount of the valve 8.

CITATION LIST

[0003] Patent Literature Japanese Patent Application Publication No. H11-324625

SUMMARY OF INVENTION

Technical Problem

[0004] However, in the above variable valve mechanism 90, the overall opening and closing amount of the valve 8 may be deviated from a desired opening and closing amount due to the deviation in dimensions of components and the like. Therefore, the engine performance may deteriorate.

[0005] It is therefore an object of the present invention to provide a variable valve mechanism that can adjust an opening and closing amount of a valve even when the overall opening and closing amount of the valve is deviated from a desired amount due to the deviation in dimensions of components and the like.

Solution to Problem

[0006] In order to achieve the above object, a variable valve mechanism of the present invention includes a drive shaft provided rotatably, a drive cam provided on the drive shaft, a power transmission mechanism that transmits power from the drive cam to a valve to open and close the valve, and an opening and closing amount variable mechanism that displaces an intermediate portion of the power transmission mechanism to change an opening and closing amount of the valve. The opening and closing amount variable mechanism includes a control shaft provided rotatably, a control cam provided on the control shaft and having a circular sectional shape

whose center is eccentric with respect to an axial center of the control shaft, and a control arm that extends in a radial direction of the control cam, has a rear end portion rotatably externally attached to the control cam and a distal end portion provided with a plurality of pin holes to which the distance from the center of the control cam varies from each other, and swingably supports the intermediate portion of the power transmission mechanism in a circumferential direction of the control cam by selectively inserting one connecting pin provided to protrude or attached in the intermediate portion of the power transmission mechanism into one of the plurality of pin holes. The variable valve mechanism is configured to adjust the opening and closing amount of the valve by changing a pin hole into which the connecting pin is inserted.

[0007] Here, in order to adjust the opening and closing amount of the valves easily, it is preferred that the connecting pin is detachably attached to a specific attachment position of the intermediate portion of the power transmission mechanism, and that the variable valve mechanism is configured to adjust the opening and closing amount of the valve by detaching the connecting pin from the attachment position, removing the connecting pin from the one of the plurality of pin holes, and inserting the connecting pin into another pin hole of the plurality of pin holes and reattaching the connecting pin to the attachment position without reassembling both the power transmission mechanism and the opening and closing amount variable mechanism.

Advantageous Effects of Invention

[0008] According to the present invention, as described above, the opening and closing amount of the valve can be adjusted by changing the pin hole into which the connecting pin is inserted.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

FIG. 1 is a perspective view that shows a variable valve mechanism according to an embodiment of the present invention;

FIG. 2 is an exploded perspective view that shows the variable valve mechanism according to the embodiment;

FIG. 3A is a side sectional view of the variable valve mechanism according to the embodiment; and FIG. 3B is a side sectional view that shows an operating condition of the variable valve mechanism according to the embodiment;

FIG. 4A and 4B are side sectional views that show conditions of the variable valve mechanism according to the embodiment when an opening and closing amount decreases and increases, respectively;

FIG. 5 is an enlarged partial side sectional view that shows the variable valve mechanism according to

the embodiment;

FIG. 6A and 6B are enlarged partial side sectional views that show conditions of the variable valve mechanism according to the embodiment when the overall opening and closing amount is adjusted to decrease and increase, respectively;

FIG. 7 is a perspective view that shows another variable mechanism that is provided for one cylinder in a parallel multi-cylinder internal combustion engine having two or more cylinders where the variable valve mechanisms according to the present embodiment are provided for the other cylinders except the one cylinder; and

FIG. 8 is a side sectional view that shows a variable valve mechanism according to a related art.

DESCRIPTION OF EMBODIMENTS

[0010] A variable valve mechanism 9 according to the present embodiment as shown FIGS. 1 to 6B is provided for two intake valves or exhaust valves 8, 8 that are provided for a cylinder, and continuously changes an opening and closing amount L of the two valves 8, 8. The variable mechanism 9 includes a drive shaft 10, a drive cam 20, a power transmission mechanism 30, an opening and closing amount variable mechanism 40, and rocker arms 50, 50 that will be described below.

[Drive shaft 10]

[0011] The drive shaft 10 is a common shaft to a plurality of variable valve mechanisms 9 and rotates in accordance with the rotation of an internal combustion engine.

[Drive cam 20]

[0012] The drive cam 20 is provided on the drive shaft 10 and rotates together with the rotation of the drive shaft 10. A sectional shape of the drive cam 20 is circular and the center A of the circular cross-section is eccentric with respect to an axial center Ao of the drive shaft 10.

[Power transmission mechanism 30]

[0013] The power transmission mechanism 30 changes a rotary motion of the drive cam 20 to a reciprocating motion and transmits the motion to the rocker arms 50, 50 to open and close the valves 8, 8 via the rocker arms 50, 50. The power transmission mechanism 30 includes a drive arm 31, an input swing arm 32, a first lever 33, a second lever 34, and a pair of output swing arms 35, 35 that will be described below. The drive arm 31 extends in a radial direction of the drive cam 20 and has a ring-shaped rear end portion that is rotatably externally attached to the drive cam 20 and a distal end portion that is rotatably attached to a rear end portion of the input swing arm 32 via a first connecting pin X1. The input

swing arm 32 has an intermediate portion in a longitudinal direction that is rotatably externally attached to a control shaft 41 (to be described later), and a distal end portion that is rotatably attached to a rear end portion of the first lever 33 via a second connecting pin X2. The first lever 33 has a distal end portion that is rotatably attached to a rear end portion of the second lever 34 via a third connecting pin X3. The second lever 34 has a distal end portion that is rotatably attached to rear end portions of the pair of output swing arms 35, 35 via a fourth connecting pin X4. The pair of output swing arms 35, 35 have intermediate portions in a longitudinal direction that are rotatably externally attached to the control shaft 41, and distal end portions that are in contact with the rocker arms 50, 50. The third connecting pin X3 has a distal end portion that protrudes from the first lever 33 and the second lever 34. The protrusion portion is supported by the opening and closing amount variable mechanism 40 so as to be displaceable in a circumferential direction.

[0014] When the drive shaft 10 rotates, as shown in FIG. 3B, the drive cam 20 rotates in accordance with the rotation of the drive shaft 10. The power from the drive cam 20 is transmitted to the drive arm 31, the input swing arm 32, the first lever 33, the second lever 34, the pair of output swing arms 35, 35, the pair of rocker arms 50, 50, and the pair of valves 8, 8 in this order. Accordingly, the pair of valves 8, 8 reciprocate in the opening and closing direction of the valves by the opening and closing amount L.

[Opening and closing amount variable mechanism 40]

[0015] The opening and closing amount variable mechanism 40 displaces the third connecting pin X3 in an intermediate portion of the power transmission mechanism 30 to change the opening and closing amount of the valves 8, 8. The opening and closing amount variable mechanism 40 includes the control shaft 41, a control cam 42, and a control arm 43 that will be described below. The control shaft 41 is provided in parallel to the drive shaft 10 and is rotationally driven by a rotating device (not shown). The control cam 42 is provided on the control shaft 41 and rotates with the rotation of the control shaft 41. A sectional shape of the control cam 42 is circular and the center B of the circular cross-section is eccentric with respect to an axial center Bo of the control shaft 41. The control arm 43 extends in a radial direction of the control cam 42 and has a ring-shaped rear end portion that is rotatably externally attached to the control cam 42. The control arm 43 has a distal end portion that is provided with a plurality of pin holes (e.g. three or more pin holes in the present embodiment) 44, 44. The plurality of pin holes are arranged in a direction slightly displaced from circumferential directions R, R of a circle around the center B of the control cam 42. Therefore, the distance from the plurality of pin holes 44, 44 to the center B of the control cam 42 varies from each other. By selectively inserting the protrusion portion of the third connecting pin

X3 into one of the plurality of pin holes 44, 44, the distal end portion of the control arm 43 is rotatably attached to the attachment portion between the distal end portion of the first lever 33 and the rear end portion of the second lever 34. Accordingly, the attachment portion is supported by the control arm 43 so as to be swingable in a circumferential direction of the control cam 42. A stopper 45 is attached to the third connecting pin X3 to prevent the third connecting pin X3 from displacing in the longitudinal direction of the third connecting pin X3.

[0016] As shown in FIG. 4A, when the control shaft 41 rotates in one circumferential direction thereof, the control cam 42 rotates in accordance with the rotation of the control shaft 41. The power from the control cam 42 is transmitted to the control arm 43, the second lever 34, and the pair of output swing arms 35, 35 in this order. Accordingly, the pair of output swing arms 35, 35 rotates in the one circumferential direction around the axial center Bo of the control shaft 41 while swinging around the axial center Bo, and the opening and closing amount L of the valves 8, 8 decreases. At the same time, the power from the control cam 42 is transmitted to the first lever 33, the input swing arm 32, and the drive arm 31 in this order. Accordingly, the drive arm 31 rotates in the reverse direction from the rotational direction of the drive shaft 10, accelerating the timing to maximally open the valves 8, 8.

[0017] As shown in FIG. 4B, when the control shaft 41 rotates in another circumferential direction thereof, the control cam 42 rotates in accordance with the rotation of the control shaft 41. The power from the control cam 42 is transmitted to the control arm 43, the second lever 34, and the pair of output swing arms 35, 35 in this order. Accordingly, the pair of output swing arms 35, 35 rotates in the another circumferential direction around the axial center Bo of the control shaft 41 while swinging around the axial center Bo, and the opening and closing amount L of the valves 8, 8 increases. At the same time, the power from the control cam 42 is transmitted to the first lever 33, the input swing arm 32, and the drive arm 31 in this order. Accordingly, the drive arm 31 rotates in the rotational direction of the drive shaft 10, decelerating the timing to maximally open the valves 8, 8.

[Rocker arm 50, 50]

[0018] Each of the rocker arms 50, 50 is provided for each of the valves 8, 8. Each rocker arm 50 has a rear end portion that is swingably supported by a lash adjuster 59 and a distal end portion that presses a stem end of the valve 8. The rocker arm 50 is provided with a roller 51 at an intermediate portion in the longitudinal direction of the rocker arm. The roller 51 contacts with an edge portion of the output swing arm 35. Each valve 8 is provided with a valve spring (not shown) that closes the valve 8 following the displacement of the distal end portion of the rocker arm 50 in a direction away from the stem end of the valve 8.

[0019] Next, with respect to adjustment of the opening and closing amount L of the valves 8, 8 using the variable valve mechanism 9, (1) decreasing adjustment where the opening and closing amount is adjusted to decrease and (2) increasing adjustment where the amount is adjusted to increase will be separately described below.

[Decreasing adjustment]

[0020] First, the stopper 45 is detached from the third connecting pin X3, the third connecting pin X3 is detached from a specific attachment position in the attachment portion between the distal end portion of the first lever 33 and the rear end portion of the second lever 34 (shifted within a range in which the attachment is not detached), and is removed from the pin hole 44 into which the third connecting pin X3 was inserted. Next, the third connecting pin X3 is inserted into another pin hole 44 to which the distance from the center B of the control cam 42 is shorter than the distance from the center B to the pin hole 44 into which the third connecting pin X3 was inserted. In addition, the third connecting pin X3 is returned to the specific attachment position, and the stopper 45 is reattached to the third connecting pin X3 so as to reattach the third connecting pin X3 to the specific position. Thus, as shown in FIG. 6A, the attachment portion between the distal end portion of the first lever 33 and the rear portion of the second lever 34 is slightly shifted toward the center B of the control cam 42. Accordingly, the output swing arm 35 is slightly shifted in one rotational direction around the axial center Bo of the control shaft 41, slightly decreasing the opening and closing amount of the valve 8.

[Increasing adjustment]

[0021] First, the stopper 45 is detached from the third connecting pin X3, the third connecting pin X3 is detached from a specific attachment position in the attachment portion between the distal end portion of the first lever 33 and the rear end portion of the second lever 34 (shifted within a range in which the attachment is not detached), and is removed from the pin hole 44 into which the third connecting pin X3 was inserted. Next, the third connecting pin X3 is inserted into another pin hole 44 to which the distance from the center B of the control cam 42 is longer than the distance from the center B to the pin hole 44 into which the third connecting pin X3 was inserted. In addition, the third connecting pin X3 is returned to the specific attachment position, and the stopper 45 is reattached to the third connecting pin X3 so as to reattach the third connecting pin X3 to the specific position. Thus, as shown in FIG. 6B, the attachment portion between the distal end portion of the first lever 33 and the rear portion of the second lever 34 is slightly shifted away from the center B of the control cam 42. Accordingly, the output swing arm 35 is slightly shifted in another rotational direction around the axial center Bo

of the control shaft 41, slightly increasing the opening and closing amount of the valve 8.

[0022] According to the present embodiment, the opening and closing amount of the valves 8, 8 can be easily adjusted by changing the pin hole 44 into which the connecting pin X3 is inserted without reassembling the components other than the connecting pin X3 (and the stopper 45). Therefore, the component accuracy can be reduced, improving the manufacturability. In addition, the three or more pin holes 44, 44, enables multiple step adjustment and accurate adjustment.

[0023] The present invention is not limited to the above structure of the embodiment, and may be modified and realized within a range that does not depart from the scope of the invention.

[0024] For example, in a parallel multi-cylinder internal combustion engine having two or more cylinders, for one cylinder, a variable valve mechanism 69 is provided that is substantially the same as the variable valve mechanism 9 according to the present embodiment but is different from the variable valve mechanism 9 in that the control arm 43 has only one pin hole 44 (that is, the variable valve mechanism 69 has no function to adjust the opening and closing amount). For the other cylinders, the variable valve mechanisms 9 according to the present embodiment are provided. In this case, the variable valve mechanisms 9 according to the present embodiment can adjust the opening and closing amount of the valves 8, 8 in accordance with the opening and closing amount of the valves 8, 8 of the variable valve mechanism 69. Therefore, the valve timing among the cylinders can be more accurately synchronized, improving the engine performance. The present invention provides a variable valve mechanism includes a drive shaft, a drive cam, a power transmission mechanism that transmits power from the drive cam to a valve, and an opening and closing amount variable mechanism that displaces an intermediate portion of the power transmission mechanism to change an opening and closing amount of the valve. The opening and closing amount variable mechanism includes a control shaft, a control cam, and a control arm that has a rear end portion rotatably externally attached to the control cam and a distal end portion provided with a plurality of pin holes to which the distance from the center of the control cam varies from each other, and swingably supports the intermediate portion of the power transmission mechanism in a circumferential direction of the control cam by selectively inserting one connecting pin provided to the intermediate portion of the power transmission mechanism into one of the plurality of pin holes. The opening and closing amount of the valve is adjusted by changing a pin hole into which the connecting pin is inserted.

Claims

1. A variable valve mechanism that comprises a drive

shaft (10) provided rotatably, a drive cam (20) provided on the drive shaft (10), a power transmission mechanism (30) that transmits power from the drive cam (20) to a valve (8) to open and close the valve (8), and an opening and closing amount variable mechanism (40) that displaces an intermediate portion of the power transmission mechanism (30) to change an opening and closing amount of the valve (8), **characterized in that,**

the opening and closing amount variable mechanism (40) comprises

a control shaft (41) provided rotatably, a control cam (42) provided on the control shaft (41) and having a circular sectional shape whose center (B) is eccentric with respect to an axial center (Bo) of the control shaft (41), and

a control arm (43) that extends in a radial direction of the control cam (42), has a rear end portion rotatably externally attached to the control cam (42) and a distal end portion provided with a plurality of pin holes (44) to which the distance from the center (B) of the control cam (42) varies from each other, and swingably supports the intermediate portion of the power transmission mechanism (30) in a circumferential direction of the control cam (42) by selectively inserting one connecting pin (X3) provided to protrude or attached in the intermediate portion of the power transmission mechanism (30) into one of the plurality of pin holes (44),

wherein the variable valve mechanism is configured to adjust the opening and closing amount of the valve (8) by changing a pin hole (44) into which the connecting pin (X3) is inserted.

2. The variable valve mechanism according to claim 1, wherein the connecting pin (X3) is detachably attached to a specific attachment position of the intermediate portion of the power transmission mechanism (30), and

wherein the variable valve mechanism is configured to adjust the opening and closing amount of the valve (8) by detaching the connecting pin (X3) from the attachment position, removing the connecting pin (X3) from the one of the plurality of pin holes (44), and inserting the connecting pin (X3) into another pin hole (44) of the plurality of pin holes (44) and reattaching the connecting pin (X3) to the attachment position without reassembling both the power transmission mechanism (30) and the opening and closing amount variable mechanism (40).

3. The variable valve mechanism according to claim 1, wherein the plurality of pin holes (44) are arranged in a direction slightly displaced from circumferential directions (R) of a circle around the center (B) of the control cam (42).

4. The variable valve mechanism according to claim 1,

wherein a stopper (45) is attached to the connecting pin (X3) to prevent the connecting pin (X3) from displacing in the longitudinal direction of the connecting pin (X3).

5

10

15

20

25

30

35

40

45

50

55

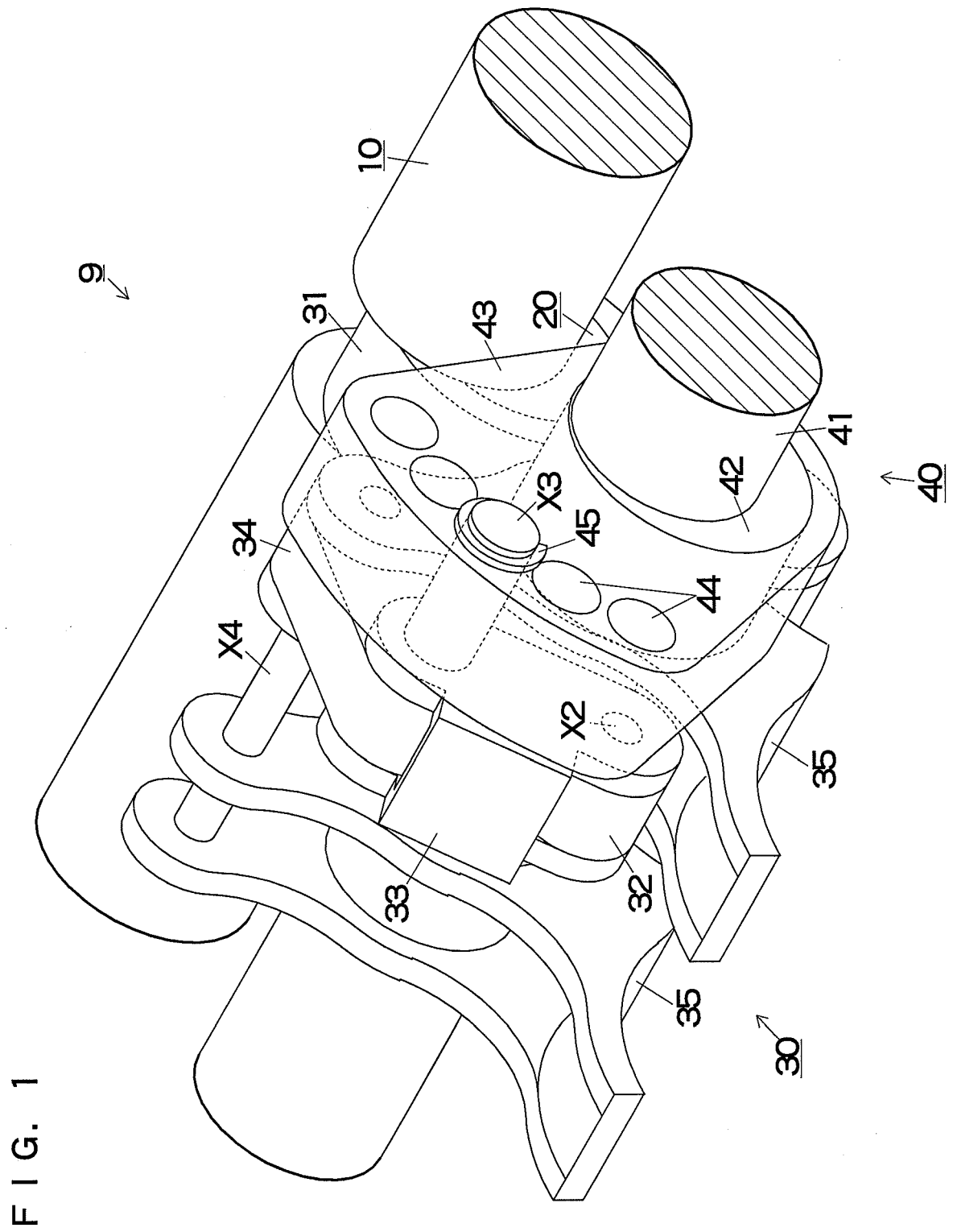


FIG. 2

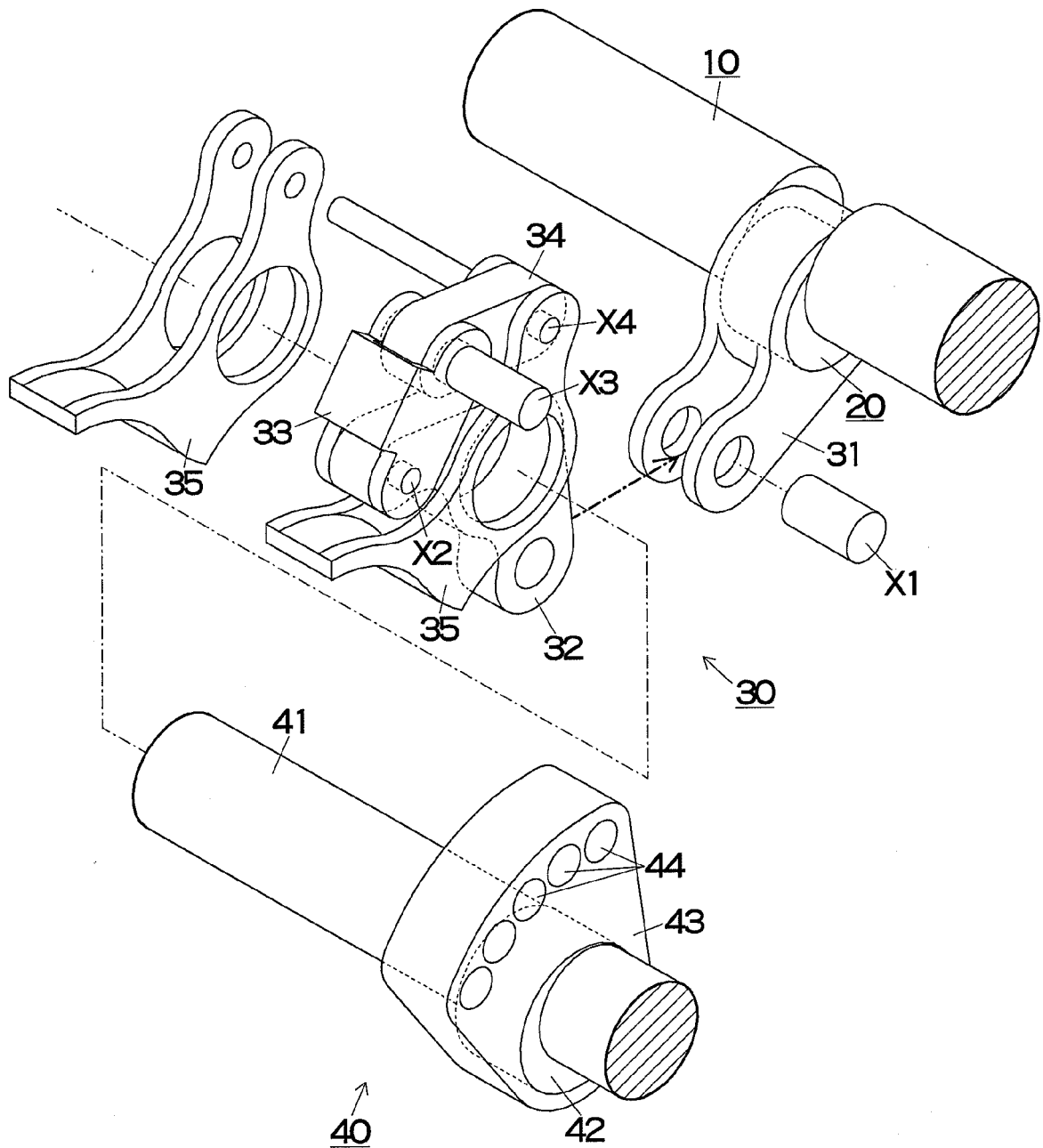


FIG. 3B

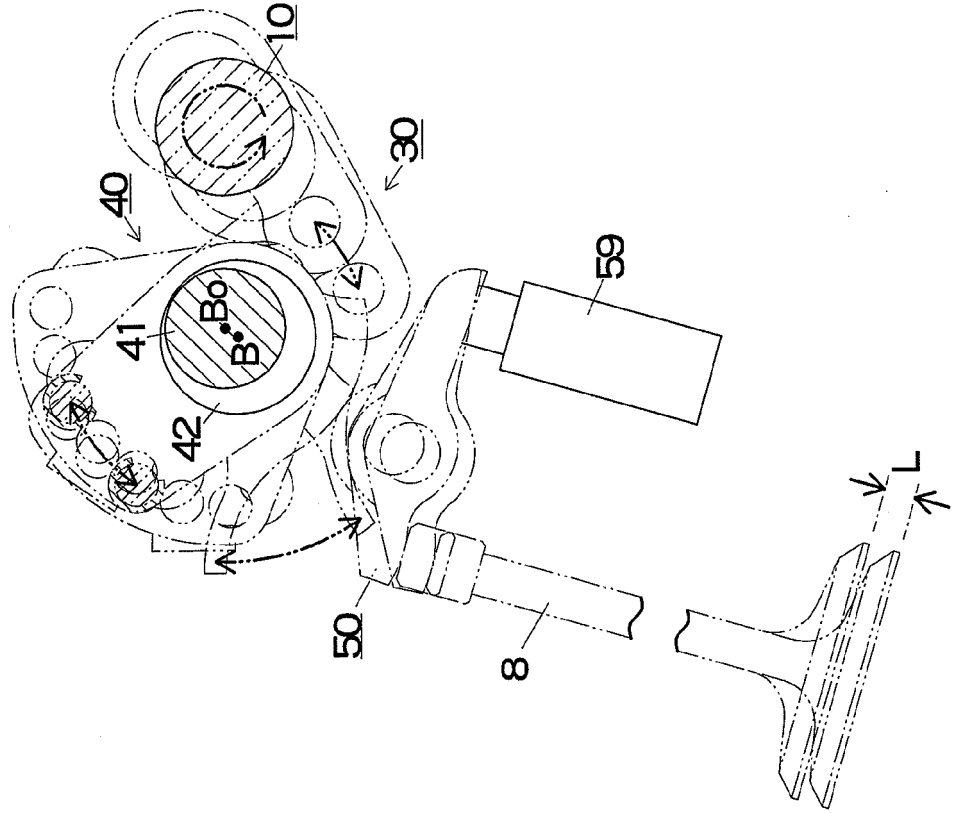


FIG. 3A

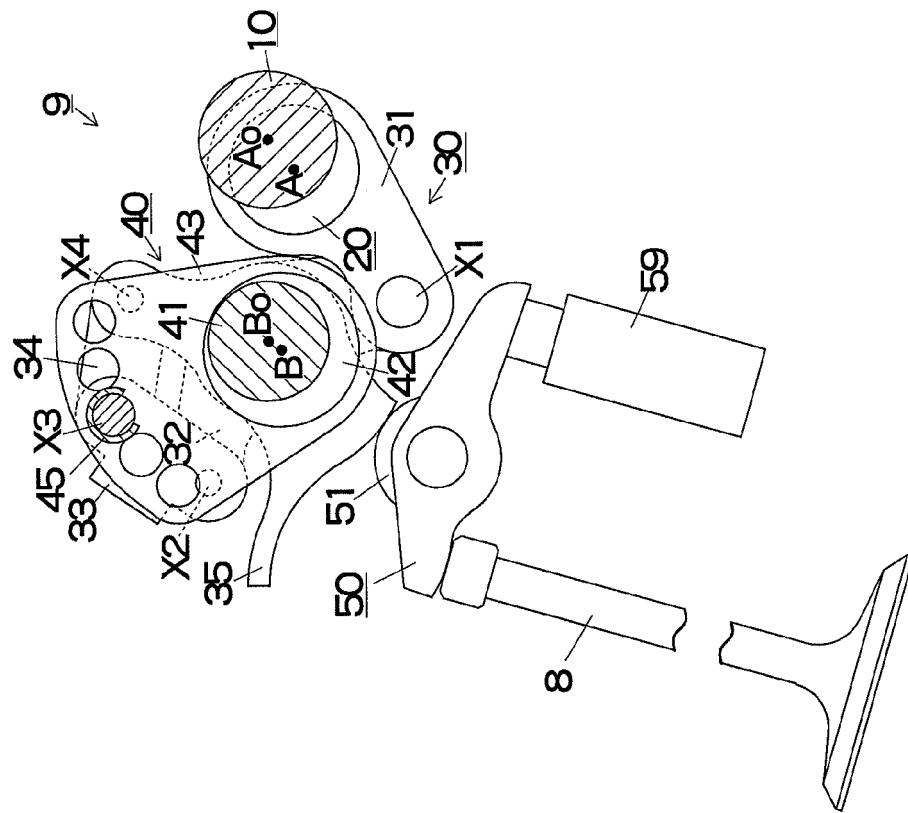


FIG. 4B

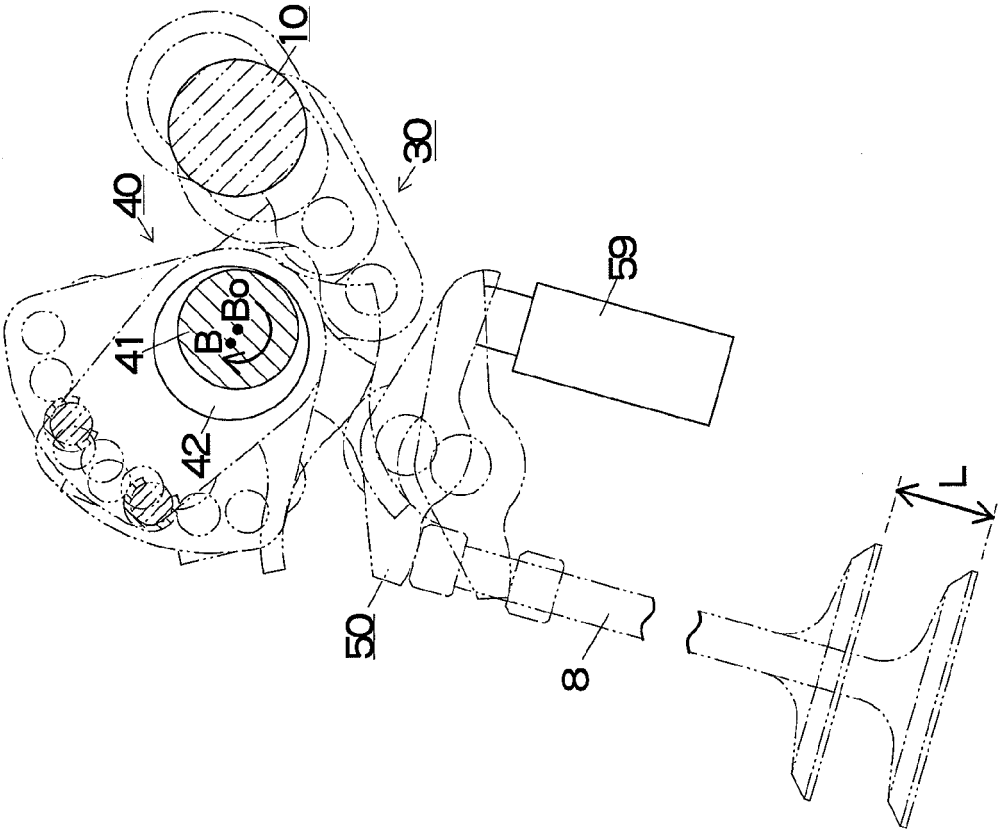


FIG. 4A

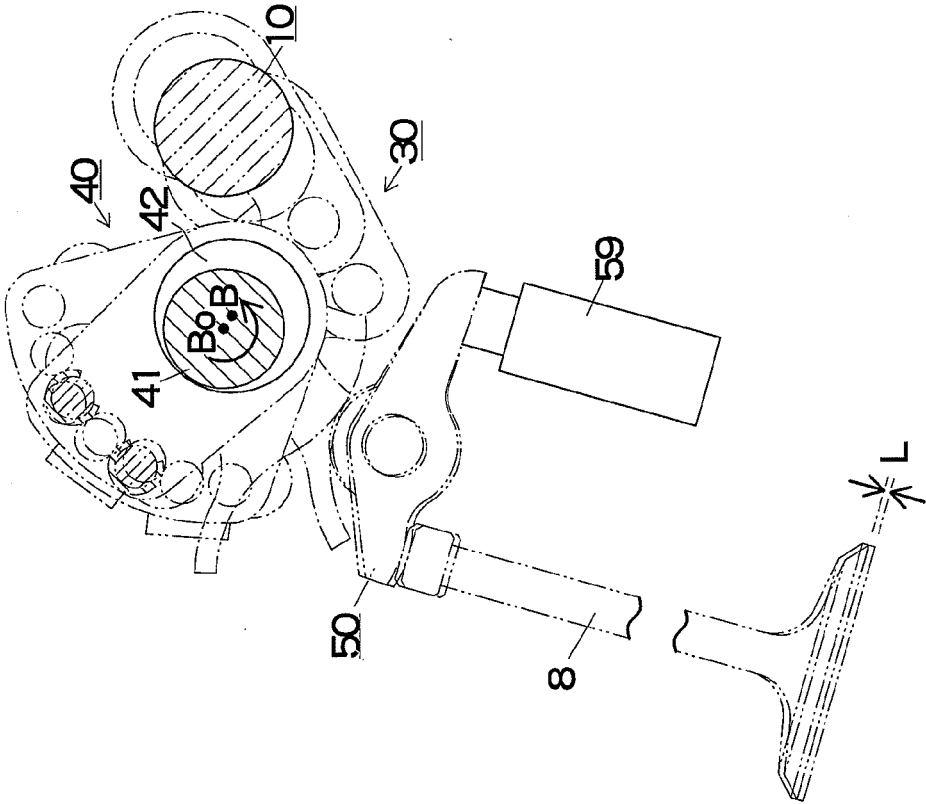


FIG. 5

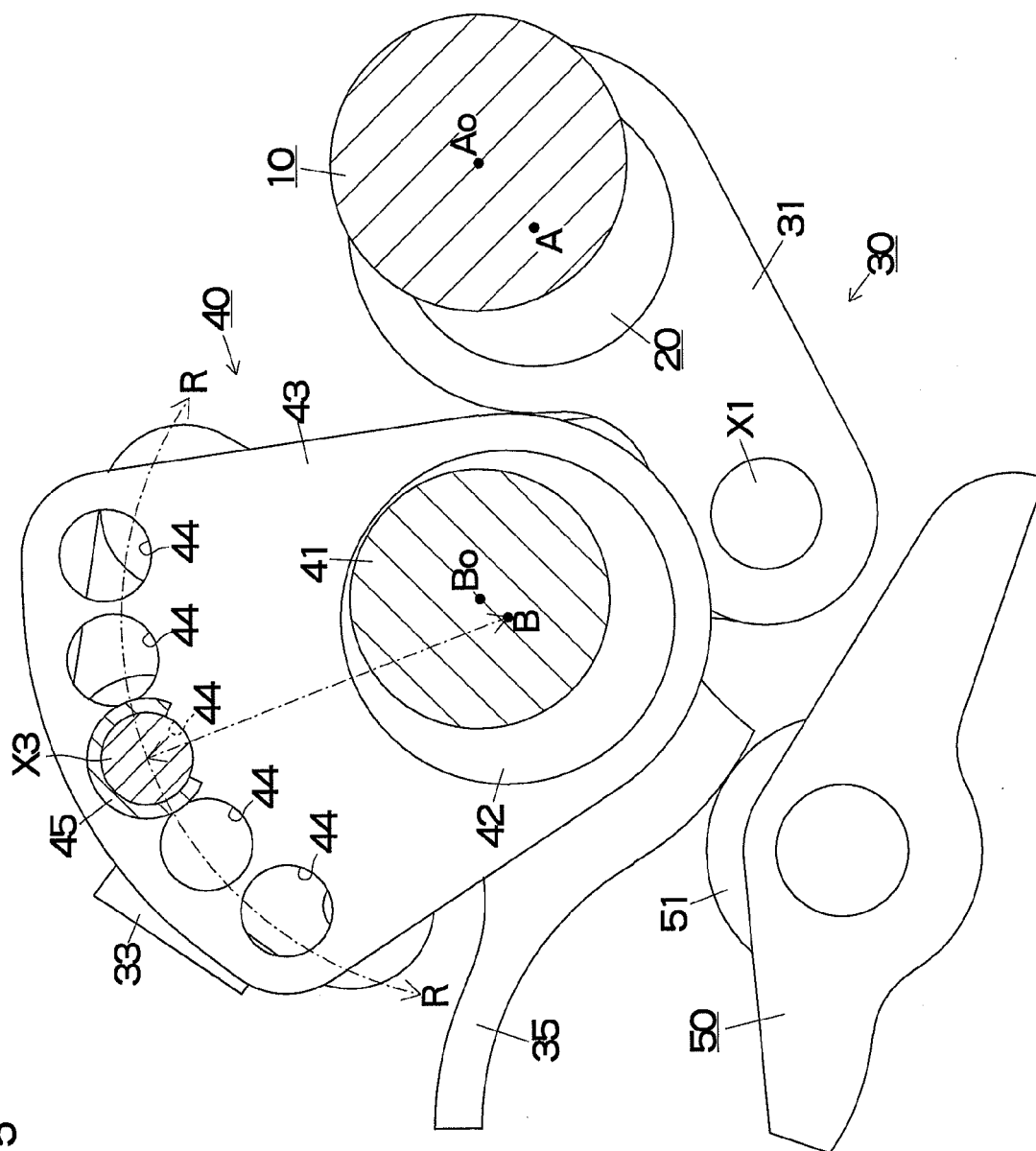


FIG. 6A

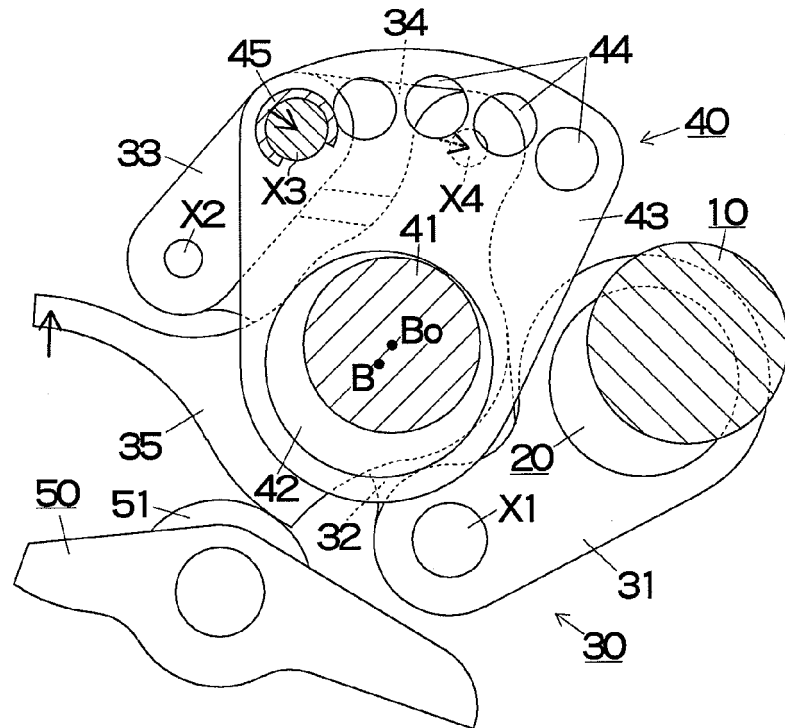
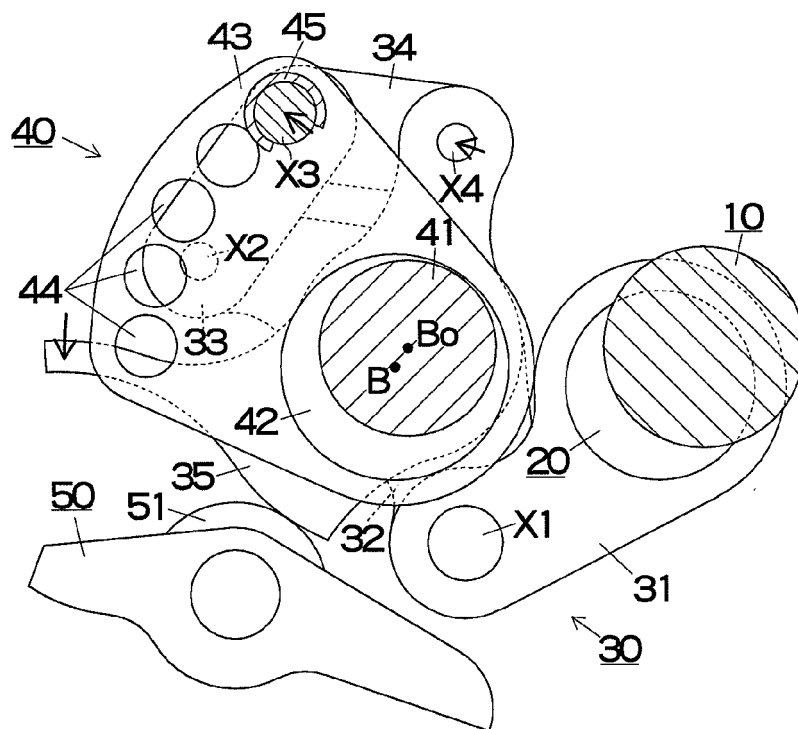


FIG. 6B



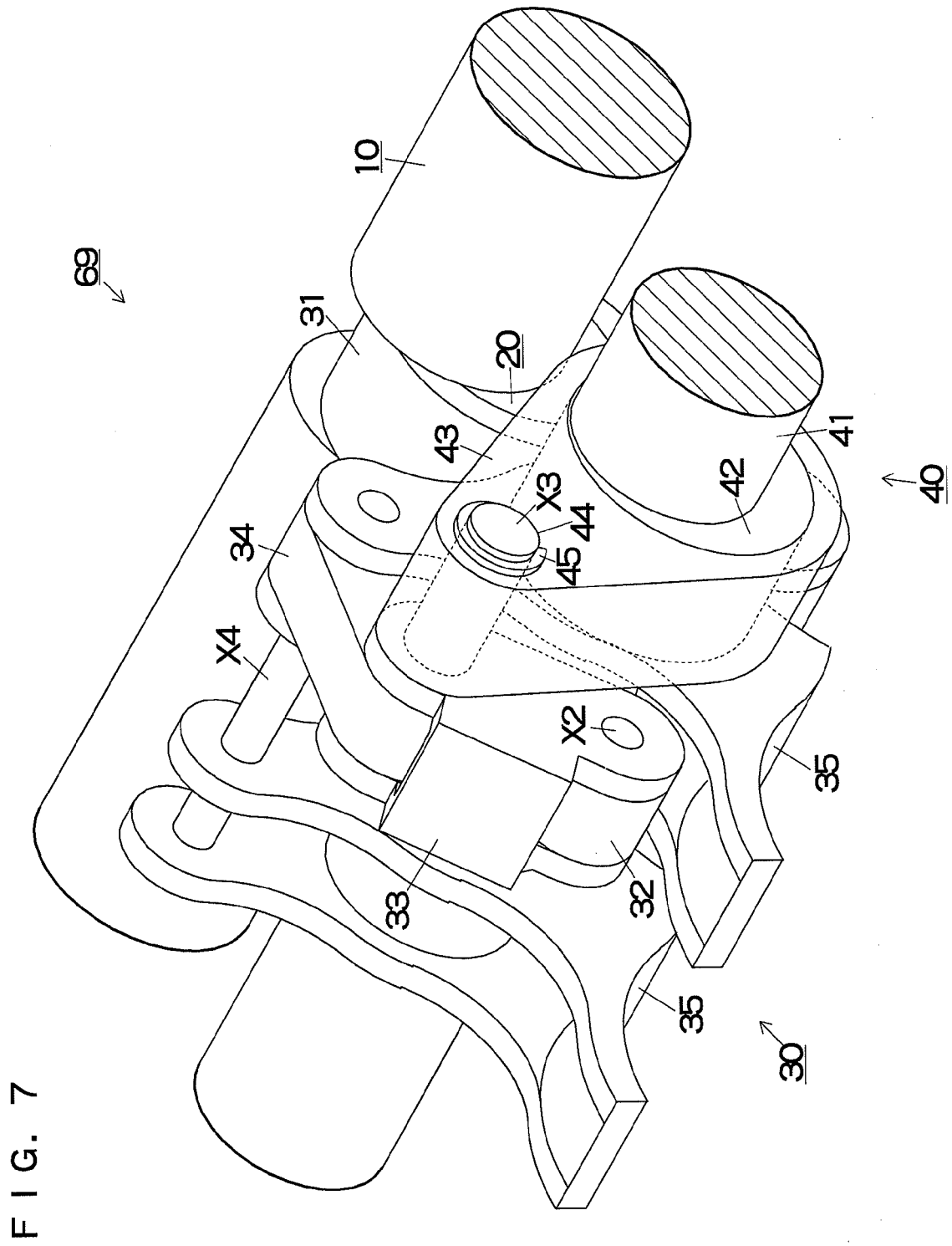
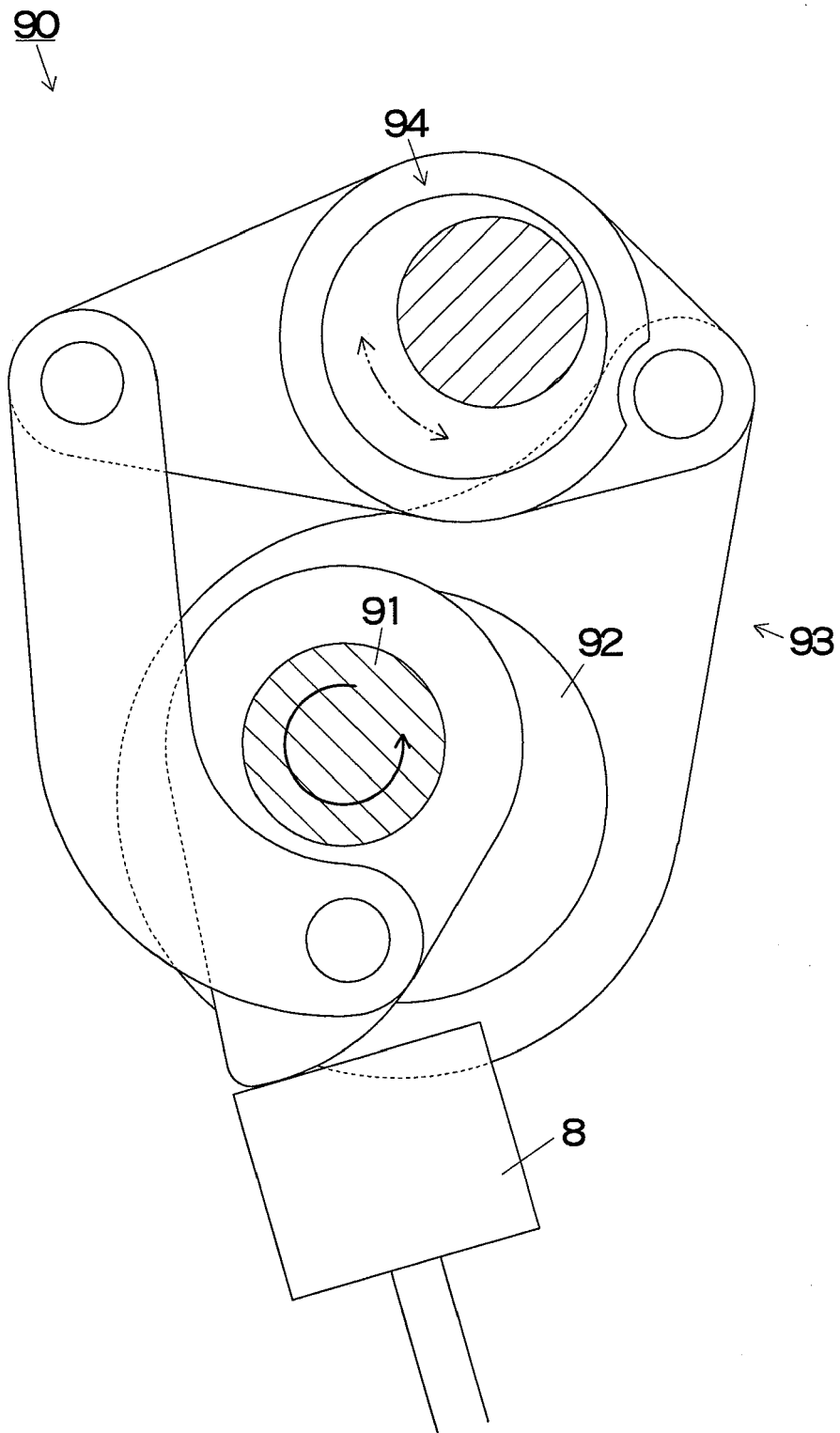


FIG. 8





EUROPEAN SEARCH REPORT

Application Number
EP 09 17 7705

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 7 311 073 B1 (KIM DAE SUNG [KR] ET AL) 25 December 2007 (2007-12-25) * the whole document *	1	INV. F01L1/46 F01L13/00
A	WO 2006/054147 A1 (NISSAN MOTOR [JP]; AKASAKA YUUZOU [JP]) 26 May 2006 (2006-05-26) * the whole document *	1	
A	US 2005/241598 A1 (EZAKI SHUICHI [JP]) 3 November 2005 (2005-11-03) * the whole document *	1	
A	WO 2005/059321 A1 (TOYOTA MOTOR CO LTD [JP]; ASADA TOSHIKI [JP]; EZAKI SHUICHI [JP]; TAT) 30 June 2005 (2005-06-30) * the whole document *	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F01L
Place of search		Date of completion of the search	Examiner
The Hague		9 April 2010	Klinger, Thierry
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 1
EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 17 7705

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-04-2010

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 7311073	B1	25-12-2007	CN 101182807 A	21-05-2008
			DE 102006062080 A1	21-05-2008
			KR 20080044529 A	21-05-2008

WO 2006054147	A1	26-05-2006	CN 1842639 A	04-10-2006
			EP 1689981 A2	16-08-2006
			JP 4096938 B2	04-06-2008
			JP 2006144581 A	08-06-2006
			KR 20060086935 A	01-08-2006
			US 2008053387 A1	06-03-2008

US 2005241598	A1	03-11-2005	DE 102005019583 A1	01-12-2005
			JP 4412190 B2	10-02-2010
			JP 2005337233 A	08-12-2005

WO 2005059321	A1	30-06-2005	DE 602004006649 T2	31-01-2008
			EP 1700014 A1	13-09-2006
			KR 20060018889 A	02-03-2006
			US 2006219196 A1	05-10-2006

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H11324625 B [0003]