

Description

Technical Field

[0001] The present invention relates to a valve operating apparatus for an internal combustion engine.

Background Art

[0002] A conventional valve operating apparatus for an internal combustion engine is disclosed in, for example, Patent Document 1. The aforementioned conventional valve operating apparatus includes a lost motion mechanism that urges a rocker arm in one direction. More specifically, a cylinder head in which the aforementioned valve operating apparatus is mounted includes a boss portion that is formed by casting around a spark plug insertion cylinder (spark plug tube). The aforementioned lost motion mechanism is supported by the boss portion. The applicants are aware of the following documents, which includes the above described document, as documents related to the present invention.

Citation List

Patent Documents

[0003]

Patent Document 1: Japanese Laid-open Patent Application Publication No. 2000-240418

Patent Document 2: Japanese Laid-open Patent Application Publication No. 2007-327378

Patent Document 3: Japanese Laid-open Patent Application Publication No. Hei 6-280522

Summary of Invention

Technical Problem

[0004] When forming a boss portion (support portion) for supporting urging means such as a lost motion mechanism by casting on a top face of a cylinder head as in the above described conventional technique, the necessity arises to guide molten metal that has dropped downward one time in an upward direction again. Consequently, when the fluidity of the molten metal is taken into consideration, the boss portion is a shape that has poor manufacturability and a large amount of excess thickness. As a result, the mass of the internal combustion engine increases, and that increase is a factor that causes the fuel consumption performance of the vehicle to deteriorate.

[0005] The present invention has been conceived to solve the above described problem, and an object of the present invention is to provide a valve operating appa-

ratus for an internal combustion engine that, with respect to a configuration including urging means that urges a transfer member that transfers an acting force of a cam to a valve, can facilitate manufacture of a support portion of the urging means and suppress an increase in the mass of the internal combustion engine.

Solution to Problem

[0006] A first aspect of the present invention is a valve operating apparatus for an internal combustion engine, comprising:

a transfer member that is interposed between a cam and a valve, and transfers an acting force of the cam to the valve;
urging means that urges the transfer member in one direction; and
a holding member that holds the urging means, wherein the urging means is attached to a spark plug tube through the holding member.

[0007] A second aspect of the present invention is the valve operating apparatus for an internal combustion engine according to the first aspect of the present invention, wherein the transfer member includes a first rocker arm that rocks in synchrony with rotation of the cam, and wherein the urging means is means that urges the first rocker arm towards the cam.

[0008] A third aspect of the present invention is the valve operating apparatus for an internal combustion engine according to the second aspect of the present invention, wherein the holding member is attached to the spark plug tube in a condition in which the holding member is rotatable in a circumferential direction of the spark plug tube, wherein the valve operating apparatus for an internal combustion engine further comprising:

an engagement groove that is formed in one of the urging means and the first rocker arm at a contact portion between the urging means and the first rocker arm; and

a projecting portion that is formed in the other of the urging means and the first rocker arm at the contact portion and that engages with the engagement groove.

[0009] A fourth aspect of the present invention is the valve operating apparatus for an internal combustion engine according to the second or third aspect of the present invention, wherein the transfer member further includes a second rocker arm that is capable of pushing and moving the valve, wherein the valve operating apparatus for an internal combustion engine further comprises a switching mech-

anism capable of switching between a connected state in which the first rocker arm and the second rocker arm are in connection and a non-connected state in which the connection is released, and

wherein the urging means is a lost motion mechanism that urges the first rocker arm so as to maintain a state in which the first rocker arm contacts the cam.

[0010] A fifth aspect of the present invention is the valve operating apparatus for an internal combustion engine according to the first or second aspect of the present invention,

wherein the urging means is a lash adjuster that has a function of expanding and contracting so as to make a tappet clearance zero and that is disposed so as to support a fulcrum of the transfer member.

[0011] A sixth aspect of the present invention is the valve operating apparatus for an internal combustion engine according to any one of the first to fifth aspects of the present invention,

wherein the holding member includes a holding portion that covers a trunk portion of the urging means from outside, and an attachment portion that is attached to the spark plug tube.

[0012] A seventh aspect of the present invention is the valve operating apparatus for an internal combustion engine according to the sixth aspect of the present invention,

wherein a cross-sectional shape of the holding portion is an enlarged shape of a cross-sectional shape of the urging means.

[0013] An eighth aspect of the present invention is the valve operating apparatus for an internal combustion engine according to any one of the first to seventh aspects of the present invention,

wherein an end portion on an opposite side to an end portion that contacts the transfer member in the urging means is received and stopped by a base member to which the spark plug tube is fixed.

Advantageous Effects of Invention

[0014] According to the first aspect of the present invention, the necessity to form a support portion of the urging means by casting on a top face of a base member such as a cylinder head on which the valve operating apparatus is mounted is eliminated. As a result, a boss portion (support portion) that includes excess thickness is not required, and hence manufacture of the aforementioned support portion can be facilitated and the mass of the internal combustion engine can be reduced. It is thereby possible to prevent a deterioration in the fuel consumption performance of a vehicle that is caused by an increase in the mass thereof.

[0015] According to the second aspect of the present invention, in the case of a configuration that has the transfer member including the first rocker arm that rocks in synchrony with the cam, and that is equipped with the urging means that urges the first rocker arm toward the

cam, manufacture of a support portion of the urging means can be facilitated and the mass of the internal combustion engine can be reduced.

[0016] According to the third aspect of the present invention, it is possible to accurately perform positioning of the urging means with respect to the first rocker arm without leading to an increase in the number of components.

[0017] According to the fourth aspect of the present invention, in the case of the valve operating apparatus in which the urging means is configured as the lost motion mechanism that urges the first rocker arm toward the cam, manufacture of a support portion of the lost motion mechanism can be facilitated and the mass of the internal combustion engine can be reduced.

[0018] According to the fifth aspect of the present invention, in the case of the valve operating apparatus in which the urging means is configured as the lash adjuster that supports a fulcrum of the transfer member, manufacture of a support portion of the lash adjuster can be facilitated and the mass of the internal combustion engine can be reduced.

[0019] According to the sixth aspect of the present invention, in the case of a configuration equipped with the holding member including the aforementioned holding portion and the aforementioned attachment portion, manufacture of a support portion of the urging means can be facilitated and the mass of the internal combustion engine can be reduced.

[0020] According to the seventh aspect of the present invention, since there is no necessity to provide an unrequired protruding portion in the holding member, the weight of the holding member can be reduced.

[0021] According to the eighth aspect of the present invention, the holding member carries out only a guiding function that guides the urging means, and the base member is responsible for bearing an urging force of the urging means. As a result, a force that acts on the holding member can be decreased, and hence the weight of the holding member can be reduced.

Brief Description of Drawings

[0022]

Figure 1 is a perspective view that illustrates the configuration of a variable valve operating apparatus according to Embodiment 1 of the present invention; Figure 2 shows partial cross-sectional views that illustrate the configuration of the variable valve operating apparatus shown in Figure 1; Figure 3 is a perspective view for describing a characteristic support structure of a lost motion mechanism according to Embodiment 1 of the present invention; Figure 4 is a perspective view that shows the external shape of a holding member 68 shown in Figure 3; Figure 5 shows views for describing a configuration

that the variable valve operating apparatus is provided with for performing positioning between a first rocker arm and the lost motion mechanism; Figure 6 is a view for describing an effect produced by the support structure of the lost motion mechanism according to Embodiment 1 of the present invention; Figure 7 is a cross-sectional view that shows a cross-section of the lost motion mechanism and the first rocker arm taken at the axis line position of the lost motion mechanism as seen from the advancing direction of an engagement groove; Figure 8 is a view that schematically shows the configuration of a valve operating apparatus according to Embodiment 2 of the present invention; and Figure 9 is a view that schematically shows the configuration of another valve operating apparatus that is applicable to the present invention.

Description of Embodiments

Embodiment 1

[Basic configuration of valve operating apparatus of Embodiment 1]

[0023] A valve operating apparatus for an internal combustion engine according to Embodiment 1 of the present invention is configured as a variable valve operating apparatus that is capable of switching an operating state of a valve between a valve operating state and a closed-valve stopped state.

[0024] Figure 1 is a perspective view that illustrates the configuration of a variable valve operating apparatus 10 according to Embodiment 1 of the present invention. Figure 2 shows partial cross-sectional views that illustrate the configuration of the variable valve operating apparatus 10 shown in Figure 1. More specifically, Figure 1 illustrates the configuration of the variable valve operating apparatus 10 with respect to a certain cylinder of the internal combustion engine. Figure 2(A) is a partial cross-sectional view that shows a cross-section of one part (rocker arms 18 and 20, and a rocker shaft 22) of the variable valve operating apparatus 10 along a plane including the axis line of the rocker shaft 22 and the axis line of switching pins 36, 38, and 44. It is assumed that the respective cylinders of the internal combustion engine are equipped with two intake valves and two exhaust valves. Further, it is assumed that the configuration shown in Figure 1 and Figure 2 functions as an apparatus that drives two intake valves or two exhaust valves that are arranged in the respective cylinders.

[0025] The variable valve operating apparatus 10 of the present embodiment includes a camshaft 12. The camshaft 12 is connected by a timing chain or a timing belt to a crankshaft that is not illustrated in the drawings, and is configured so as to rotate at half the speed of the crankshaft. One main cam 14 and one auxiliary cam 16

are formed per cylinder on the camshaft 12.

[0026] Each main cam 14 includes an arcuate base circle portion 14a that is coaxial with the camshaft 12, and a nose portion 14b that is formed such that a part of the base circle is expands outwards in the radial direction. Further, in the present embodiment, each auxiliary cam 16 is constructed as a cam that has only a base circle portion (a zero-lift cam). Each cylinder of the internal combustion engine is provided with one first rocker arm 18 and one second rocker arm 20 that are adjacent to each other. The rocker arms 18 and 20 of each cylinder are rotatably (rockably) supported by one rocker shaft 22.

[0027] As shown in Figure 1, the rocker arms 18 and 20 are interposed between the cams 14 and 16 and valves 26 as transfer members that transfer an acting force of the main cam 14 to the valves 26. A cam roller 28 is rotatably attached to the first rocker arm 18 at a position at which the cam roller 28 can contact the main cam 14. The first rocker arm 18 is urged by means of a lost motion mechanism 60, described later, so that the cam roller 28 is always in contact with the main cam 14. In this connection, the configuration relating to the lost motion mechanism 60 is a characterizing portion of the present embodiment, and hence it is described in detail later referring to Figure 3 to Figure 7. The first rocker arm 18 configured as described above rocks in a manner that takes the rocker shaft 22 as a fulcrum through cooperation between the acting force of the main cam 14 and an urging force of the aforementioned lost motion mechanism 60.

[0028] As shown in Figure 1 and Figure 2, the second rocker arm 20 for driving two of the valves 26 is configured in an integrated manner so as to surround the first rocker arm 18 from both sides. In addition, a pad 20a is provided on the second rocker arm 20 at a position that can contact the auxiliary cam 16 within the base circle section of the main cam 14. Further, each valve 26 is urged in the closing direction by a valve spring 30.

(Configuration of switching mechanism)

[0029] The variable valve operating apparatus 10 is equipped with a switching mechanism 32 for switching between a connected state in which the first rocker arm 18 and the second rocker arm 20 are connected together (see Figure 2(A)) and a non-connected state in which the connection between the first rocker arm 18 and the second rocker arm 20 is released (see Figure 2(B)). Due to the provision of this switching mechanism 32, the variable valve operating apparatus 10 can switch between a state in which the acting force of the main cam 14 is transferred through the first rocker arm 18 to the second rocker arm 20 (the aforementioned connected state) and a state in which the acting force of the main cam 14 is not transferred to the second rocker arm 20 (the aforementioned non-connected state), and can thereby switch the valve opening characteristics of the valve 26 between a valve operating state and a closed-valve stopped state.

[0030] As shown in Figure 2, a first pin hole 34a that is concentric with the cam roller 28 is formed inside a bush 34 that functions as a spindle of the cam roller 28, and two second pin holes 20bL and 20bR are formed at positions corresponding to the first pin hole 34a inside the second rocker arm 20. A cylindrical first switching pin 36 is movably inserted into the first pin hole 34a. A cylindrical second switching pin 38 that contacts against the first switching pin 36 is movably inserted into the second pin hole 20bL (on the left side in Figure 1). In the second pin hole 20bL in which the second switching pin 38 has been inserted, an end portion on an opposite side to the first rocker arm 18 is blocked by a cap 40. Further, a return spring 42 that urges the second switching pin 38 in the direction of the first rocker arm 18 is disposed inside the second pin hole 20bL. In addition, a cylindrical third switching pin 44 that contacts against the first switching pin 36 is movably inserted into the other second pin hole 20bR (on the right side in Figure 1).

[0031] The switching mechanism 32 has a pin driving mechanism for driving the switching pin 36 and the like while resisting the urging force of the return spring 42. More specifically, a link arm 46 having an arm portion 46a that contacts against the third switching pin 44 is disposed at a side of the second rocker arm 20. The link arm 46 is rotatably supported by the rocker shaft 22. Further, as shown in Figure 2, the rocker shaft 22 is formed in a hollow shape. A link shaft 50 is inserted inside the rocker shaft 22. The link shaft 50 is provided to enable the link arm 46 and a link arm (not shown in the drawings) disposed in another cylinder that is not illustrated in the drawings to be displaced in conjunction with each other in the axial direction of the rocker shaft 22.

[0032] As shown in Figure 1 and Figure 2, at a distal end of the arm portion 46a of the link arm 46, a projecting portion 46b is provided at a position at which the projecting portion 46b can project toward the circumferential surface of the camshaft 12. In addition, on the camshaft 12, at a location facing the projecting portion 46b, a guide rail 54 is provided that is formed as a helical groove that extends in the circumferential direction. Further, the switching mechanism 32 includes an electromagnetic solenoid 56 as an actuator that generates a driving force for causing the projecting portion 46b to engage with (be inserted into) the guide rail 54. The electromagnetic solenoid 56 is configured to be duty controlled based on commands from an ECU (Electronic Control Unit) 58 for controlling the operating state of the internal combustion engine.

[0033] The variable valve operating apparatus 10 of the present embodiment is configured so that, as shown in Figure 2(A), in a state in which passage of a current to the electromagnetic solenoid 56 is turned off, the projecting portion 46b of the link arm 46 separates from the guide rail 54 and, further, the link arm 46 receives the urging force of the return spring 42 and is positioned at a displacement end Pmax1. In this state, the first rocker arm 18 and the second rocker arm 20 are in a state in

which they are connected through the switching pins 36 and 38. As a result, the state is a valve operating state in which the acting force of the main cam 14 is transferred to both of the valves 26 through the second rocker arm 20 from the first rocker arm 18.

[0034] Furthermore, the variable valve operating apparatus 10 of the present embodiment is configured so that, as shown in Figure 2(B), when a current is passed to the electromagnetic solenoid 56, the projecting portion 46b engages with the guide rail 54 as a result of rotation of the link arm 46 that is pushed by the drive shaft 56a, and as a result the link arm 46 is displaced toward a displacement end Pmax2. Further, the variable valve operating apparatus 10 is configured so that, during a period in which passage of a current to the electromagnetic solenoid 56 is continuing, in a state in which the projecting portion 46b is separated from the camshaft 12 and in which the urging force of the return spring 42 is being received and borne by the engagement between the link arm 46 and the drive shaft 56a of the electromagnetic solenoid, the link arm 46 is retained in position. In this state that is shown in Figure 2 (B), the first rocker arm 18 and the second rocker arm 20 are not connected to each other. As a result, irrespective of rotation of the main cam 14, since the second rocker arm 20 enters a stationary state, the operating state of the valve 26 is the closed-valve stopped state.

[0035] As described in the foregoing, according to the variable valve operating apparatus 10 of the present embodiment, by switching between states in which passage of a current to the electromagnetic solenoid 56 is turned on and off, the operating state of the valves 26 can be switched between a valve operating state and a closed-valve stopped state by utilizing the switching pin 36 and the like. In this connection, the configuration of the pin driving mechanism is not limited to the above described configuration, and for example, the pin driving mechanism may be a mechanism in which the switching pin 36 and the like are driven utilizing an electric motor or hydraulic pressure.

[Characteristic configuration of Embodiment 1]

[0036] Figure 3 is a perspective view for describing a characteristic support structure of the lost motion mechanism 60 according to Embodiment 1 of the present invention. More specifically, Figure 3 is a partial cross-sectional view that shows a cross-section of each constituent element mounted on a cylinder head 62 taken at a center position of the lost motion mechanism 60.

[0037] As shown in Figure 3, a spark plug tube 66 for guiding attachment and detachment of a spark plug 64 is press-fitted into a center part of the cylinder head 62 that functions as a base member on which the variable valve operating apparatus 10 is mounted. An attachment portion 68a of a holding member 68 that holds the lost motion mechanism 60 is attached to the spark plug tube 66.

[0038] Figure 4 is a perspective view that shows the external shape of the holding member 68 shown in Figure 3.

As shown in Figure 3 and Figure 4, in addition to the aforementioned attachment portion 68a, the holding member 68 includes a holding portion 68b that holds the lost motion mechanism 60, and a connecting portion 68c that connects the attachment portion 68a and the holding portion 68b. More specifically, the lost motion mechanism 60 of the present embodiment is attached to the spark plug tube 66 through the holding member 68.

[0039] As shown in Figure 4, the spark plug tube 66 is formed in a cylindrical shape. The attachment portion 68a into which the spark plug tube 66 is fitted is also formed in a cylindrical shape in which both ends are open. The attachment portion 68a is supported by the spark plug tube 66 in a condition in which the holding member 68 is rotatable in the circumferential direction of the spark plug tube 66.

[0040] As shown in Figure 3, the lost motion mechanism 60 includes a lost motion spring 70, and a lifter 72 that is interposed between the lost motion spring 70 and the first rocker arm 18. The holding portion 68b of the holding member 68 has a cylindrical form in which both ends are open. The lost motion spring 70 and the lifter 72 are accommodated inside the holding portion 68b.

[0041] The lifter 72 is formed in a cylindrical shape in which one end is open and the other end is closed. The lost motion spring 70 is accommodated inside the lifter 72. More specifically, one end of the lost motion spring 70 contacts a top portion 72a of the lifter 72 that is closed, and the other end thereof contacts the cylinder head 62. That is, the lost motion spring 70 is configured so as to urge the first rocker arm 18 toward the main cam 14 through the top portion 72a of the lifter 72 while utilizing the cylinder head 62 as a bearing surface that receives the spring load.

[0042] In other words, the holding portion 68b is formed so as to cover the lateral face of the lifter 72 that is a trunk portion of the lost motion mechanism 60 and a lateral face of the lost motion spring 70 from outside. Further, a cross-sectional shape (annular circular shape) of the holding portion 68b that is taken in a direction perpendicular to the axis line of the lost motion mechanism 60 is an enlarged shape of the cross-sectional shape (circular shape) of the lifter 72.

[0043] Figure 5 shows views for describing a configuration that the variable valve operating apparatus 10 is provided with for performing positioning between the first rocker arm 18 and the lost motion mechanism 60. More specifically, Figure 5(A) is a view that shows the first rocker arm 18 as seen from the direction of a region that the lost motion mechanism 60 contacts, and Figure 5(B) is a view that shows the lifter 72 as seen from the top portion 72a side.

[0044] As shown in Figure 5(B), an engagement groove 72b is formed in the (outer surface of the) top portion 72a of the lifter 72 that contacts with the first rocker

arm 18. More specifically, the engagement groove 72b is formed so as to transverse the outer surface of the top portion 72a while the center in the width direction of the groove passes through the axis line of the lifter 72.

[0045] Further, as shown in Figure 5(A), a protrusion-shaped pad 18a that engages with the engagement groove 72b is formed at an area facing the top portion 72a on the first rocker arm 18. More specifically, the pad 18a is formed so as to extend along the direction of movement of the first rocker arm 18 when viewing the first rocker arm 18 from the lifter 72.

[0046] Figure 6 is a view for describing an effect produced by the support structure of the lost motion mechanism 60 according to Embodiment 1 of the present invention.

As described above, the lost motion mechanism 60 of the present embodiment is attached to the spark plug tube 66 through the holding member 68. Therefore, it is not necessary to form a support portion of the lost motion mechanism 60 by casting on the top face of the cylinder head 62. As a result, as shown in Figure 6, a boss portion that includes excess thickness is not required, and thus manufacture of the aforementioned support portion can be facilitated and the mass of the internal combustion engine can be reduced. It is thus possible to prevent a deterioration in the fuel consumption performance of the vehicle that is attributable to an increase in the mass of the internal combustion engine. Further, since processing with respect to a large component such as the cylinder head 62 can be reduced, the processing costs can be decreased.

[0047] Further, in the above described variable valve operating apparatus 10, the first rocker arm 18 is disposed at a position that is surrounded by the second rocker arm 20 that pushes and moves the two valves 26. In other words, in each cylinder, the first rocker arm 18 is disposed so as to be sandwiched between two of the valves 26. Further, the spark plug tube 66 is disposed in the center of each cylinder. In addition, although not shown in the drawings in this case, in general, the two valves 26 are disposed at positions that are equidistant from the center of the respective cylinders in which the spark plug tube 66 is arranged and that are symmetrical positions in the longitudinal direction of the cylinder head 62 when taking the center of each cylinder as a reference. Accordingly, the first rocker arm 18 and the spark plug tube 66 are disposed adjacent to each other as shown in Figure 3. In the present embodiment, the lost motion mechanism 60 is attached through the holding member 68 to the spark plug tube 66 configured in this manner. Therefore, the connecting portion 68c of the holding member 68 can be shortened. It is thereby possible to favorably ensure the rigidity of the holding member 68 and to also reduce the weight of the holding member 68.

[0048] As described above, one end of the lost motion spring 70 contacts the top portion 72a of the lifter 72 that is closed, and the other end thereof contacts the cylinder head 62. According to this configuration, the holding por-

tion 68b of the holding member 68 carries out only a guiding function that guides expansion and contraction of the lost motion mechanism 60, and the cylinder head 62 as a base member is responsible for bearing the spring load of the lost motion spring 70.

Since it is thereby possible to decrease a force that acts on the holding member 68, the weight of the holding member 68 can be reduced.

[0049] Further, as described above, the cross-sectional shape of the holding portion 68b that is taken in a direction perpendicular to the axis line of the lost motion mechanism 60 is an enlarged shape of the cross-sectional shape of the lifter 72. Since it is thus not necessary to provide an unrequired protruding portion in the holding member 68, the weight of the holding member 68 can be reduced.

[0050] Figure 7 is a cross-sectional view that shows a cross-section of the lost motion mechanism 60 and the first rocker arm 18 taken at the axis line position of the lost motion mechanism 60 as seen from the advancing direction of the engagement groove 72b.

As described above, the attachment portion 68a of the holding member 68 is supported by the spark plug tube 66 in a state in which the holding member 68 is rotatable in the circumferential direction of the spark plug tube 66. As shown in Figure 7, positioning of the lifter 72 with respect to the first rocker arm 18 is performed by engagement between the engagement groove 72b formed in the lifter 72 and the pad 18a formed on the first rocker arm 18.

[0051] If a configuration is employed in which, unlike the above described configuration, the rotational position of an attachment portion with respect to a spark plug tube is fixed in a case where the lost motion mechanism 60 is held by means of the holding member 68 that is separate from the cylinder head 62, the following issue arises. That is, if a contact point between the first rocker arm and the lost motion mechanism deviates from the center of the lost motion mechanism, a force that pushes the lost motion spring in the radial direction thereof acts on the holding member. Accordingly, it is important that positioning of the lost motion mechanism with respect to the first rocker arm is performed accurately. Consequently, when adopting a configuration that fixes the rotational position of the attachment portion with respect to the spark plug tube, the necessity arises to accurately perform assembly with regard to positioning of the lost motion mechanism with respect to the first rocker arm. Therefore, a high degree of processing and assembling accuracy is required with respect to the spark plug tube that is press-fitted into the cylinder head, and the number of working man-hours required for the aforementioned process increases.

[0052] In contrast, according to the configuration of the present embodiment, by causing the engagement groove 72b formed in the lifter 72 and the pad 18a formed in the first rocker arm 18 to engage while configuring the attachment portion 68a of the holding member 68 so as to be rotatable with respect to the spark plug tube 66, it

is possible to accurately perform positioning of the lost motion mechanism 60 with respect to the first rocker arm 18 without leading to an increase in the number of components.

[0053] Note that, in the above described Embodiment 1, the main cam 14 corresponds to "cam" according to the above described first aspect of the present invention, the first rocker arm 18 corresponds to "transfer member" according to the first aspect of the present invention, and the lost motion mechanism 60 corresponds to "urging means" according to the first aspect of the present invention.

In addition, the pad 18a formed on the first rocker arm 18 corresponds to "projecting portion" according to the above described third aspect of the present invention. Further, the cylinder head 62 corresponds to "base member" according to the above described eighth aspect of the present invention.

[0054] Embodiment 2

Next, Embodiment 2 of the present invention is described referring to Figure 8.

Figure 8 is a view that schematically shows the configuration of a valve operating apparatus 80 according to Embodiment 2 of the present invention. Note that, in Figure 8, elements that are the same as constituent elements shown in the above described Figure 1 are denoted by the same reference symbols, and a description of those elements is omitted or simplified hereunder.

[0055] The valve operating apparatus 80 shown in Figure 8 is provided with a rocker arm 84 as a transfer member that is interposed between a cam 82 and the valve 26. More specifically, an end portion of the valve 26 contacts against one end of the rocker arm 84, and a cam roller 86 is arranged at a center part of the rocker arm 84. The other end of the rocker arm 84 is supported by a lash adjuster 88. According to this configuration, the rocker arm 84 can pivot in a manner that takes the end portion (the aforementioned other end) supported by the lash adjuster 88 as a fulcrum. The lash adjuster 88 has a function of expanding and contracting to make the tappet clearance zero.

[0056] As shown in Figure 8, in the present embodiment also, the spark plug tube 66 is press-fitted into the cylinder head 62. The lash adjuster 88 is attached to the spark plug tube 66 through a holding member 90. The holding member 90 includes an attachment portion 90a that is attached to the spark plug tube 66, a holding portion 90b that holds the lash adjuster 88, and a connecting portion 90c that connects the attachment portion 90a and the holding portion 90b.

[0057] One end of the lash adjuster 88 contacts the aforementioned other end of the rocker arm 84 as described above. The other end of the lash adjuster 88 contacts the cylinder head 62. More specifically, the lash adjuster 88 is configured so that the rocker arm 84 can be urged towards the cam 82 while utilizing the cylinder head 62 as a bearing surface that receives a load that acts on the lash adjuster 88 through the rocker arm 84.

[0058] In other words, in the present embodiment also, the holding portion 90b is formed so as to cover the lateral face of the lash adjuster 88 that is a trunk portion of the lash adjuster 88 from outside. Further, a cross-sectional shape (annular circular shape) of the holding portion 90b that is taken in a direction perpendicular to the axis line of the lash adjuster 88 is an enlarged shape of the cross-sectional shape (circular shape) of the lash adjuster 88.

[0059] In addition, according to the present embodiment, a projecting portion 88a of the lash adjuster 88 that functions as a fulcrum of the rocker arm 84 is configured so as to engage with an engagement groove 84a provided in the aforementioned other end of the rocker arm 84.

[0060] As described above, according to the present embodiment, the lash adjuster 88 that is used as urging means that urges the rocker arm 84 that is a transfer member is attached to the spark plug tube 66 through the holding member 90. Thus, the necessity to form a support portion of the lash adjuster 88 by casting on the top face of the cylinder head 62 is eliminated. As a result, a boss portion that includes excess thickness is not required, and thus manufacture of the aforementioned support portion can be facilitated and the mass of the internal combustion engine can be reduced. It is thereby possible to prevent a deterioration in the fuel consumption performance of the vehicle that is attributable to an increase in the mass of the internal combustion engine. In addition, the same advantageous effects as in the above described Embodiment 1 can also be achieved.

[0061] Note that, in the above described Embodiment 2, the rocker arm 84 corresponds to "transfer member" according to the above described first aspect of the present invention, and the lash adjuster 88 corresponds to "urging means" according to the first aspect of the present invention.

[0062] In the above Embodiment 1, an example was described of a configuration in which the lost motion mechanism 60 that urges the first rocker arm 18 is attached to the spark plug tube 66 through the holding member 68. However, the configuration of a valve operating apparatus for an internal combustion engine to which the present invention can be applied is not limited to the above described configuration. For example, a configuration as shown in Figure 9 that is described below may also be adopted.

[0063] Figure 9 is a view that schematically shows the configuration of another valve operating apparatus that is applicable to the present invention. Note that, in Figure 9, elements that are the same as constituent elements shown in the above described Figure 1 are denoted by the same reference symbols, and a description of those elements is omitted or simplified hereunder.

A variable valve operating apparatus 100 shown in Figure 9 is equipped with a first rocker arm 102 that is the same as the above described first rocker arm 18, as a transfer member that is interposed between the main cam 14 and the valve 26 (not shown in Figure 9). More specifically, one end of the first rocker arm 102 is rotatably supported

by the rocker shaft 22, and a cam roller 104 is arranged at a center part of the first rocker arm 102. A lost motion arm 106 formed in an L-shape is fixed to the other end of the first rocker arm 102.

[0064] The variable valve operating apparatus 100 is also equipped with a lost motion mechanism 108 that urges the first rocker arm 102 toward the main cam 14 through the lost motion arm 106. The lost motion mechanism 108 includes a lost motion spring 110 and a lifter 112 that is interposed between the lost motion spring 110 and the lost motion arm 106.

[0065] In the configuration shown in Figure 9 also, the spark plug tube 66 is press-fitted into the cylinder head 62. The lost motion mechanism 108 is attached to the spark plug tube 66 through a holding member 114. The holding member 114 includes an attachment portion 114a that is attached to the spark plug tube 66, and a holding portion 114b that holds the lost motion mechanism 108. Note that, the holding member 114 shown in Figure 9 is not equipped with a connecting portion, and the holding portion 114b is attached in a perpendicular direction with respect to the attachment portion 114a.

[0066] Further, as shown in Figure 9(B), an engagement groove 112b that engages with a pad 106a provided on the lost motion arm 106 is formed in a top portion 112a of the lifter 112. The same advantageous effects as in the above described Embodiment 1 can also be achieved according to the configuration shown in Figure 9 that is described above.

[0067] Although examples in which the auxiliary cam 16 is configured as a zero-lift cam have been described in the foregoing Embodiments 1 and 2, an auxiliary cam of the present invention is not limited to a zero-lift cam. More specifically, for example, with respect to the configuration of the above described variable valve operating apparatus 10, a configuration may also be adopted in which the auxiliary cam includes a nose portion that is constructed so as to obtain a lift that is less than that of the main cam 14. According to a configuration in which this kind of auxiliary cam is provided, it is possible to switch a lift amount (and/or a working angle) of a valve between two stages by means of the main cam and auxiliary cam.

[0068] Further, in the above described Embodiment 1, the variable valve operating apparatus 10 is described as an example of a valve operating apparatus. However, as described above in Embodiment 2 also, a valve operating apparatus that is an object of the present invention is not limited to a valve operating apparatus configured as a variable valve operating apparatus. More specifically, it is sufficient that the valve operating apparatus is equipped with a holding member that holds urging means that urges a transfer member that is interposed between a cam and a valve.

[0069] Furthermore, in the foregoing Embodiments 1 and 2, the first rocker arm 18 or the like is described as an example of an object that is urged by the lost motion mechanism 60 or the lash adjuster 88 functioning as urg-

ing means. However, a transfer member according to the present invention is not limited to a rocker arm. More specifically, it is sufficient that a transfer member is a member that is interposed between a cam and a valve and transfers an acting force of the cam to the valve.

[0070] Further, in the above Embodiment 1, an example is described in which the engagement groove 72b is formed in the top portion 72a of the lifter 72 of the lost motion mechanism 60, and the pad (projecting portion) 18a that engages with the engagement groove 72b is formed at a region that faces the lifter 72 on the first rocker arm 18. However, the present invention is not limited thereto and, for example, a configuration may be adopted in which a projecting portion such as a pad is formed on the top portion 72a side of the lifter 72 that is the urging means and an engagement groove is formed on first rocker arm 18 side that is the transfer member.

[0071] In addition, the above Embodiment 1 has been described taking the lost motion mechanism 60 that urges the first rocker arm 18 in a pushing direction towards the main cam 14 as an example. However, the configuration of urging means according to the present invention is not limited thereto and, for example, it is sufficient that the urging means is means that generates an urging force in a direction that draws in a transfer member such as the first rocker arm 18.

Description of symbols

[0072]

10, 100	variable valve operating apparatus
12	camshaft
14	main cam
14a	base circle portion
14b	nose portion
16	auxiliary cam
18, 102	first rocker arm
18a	pad
20	second rocker arm
20bL, 20bR	second pin hole
22	rocker shaft
26	valve
28, 86, 104	cam roller
32	switching mechanism

34a	first pin hole
36	first switching pin
38	second switching pin
42	return spring
44	third switching pin
46	link arm
50	link shaft
54	guide rail
56	electromagnetic solenoid
58	ECU (Electronic control Unit)
60, 108	lost motion mechanism
62	cylinder head
64	spark plug
66	spark plug tube
68, 90, 114	holding member
68a, 90a, 114a	attachment portion
68b, 90b, 114b	holding portion
68c, 90c	connecting portion
70, 110	lost motion spring
72, 112	lifter
72b, 84a, 112b	engagement groove
80	valve operating apparatus
82	cam
84	rocker arm
88	lash adjuster
88a	projecting portion
106	lost motion arm
106a	pad
Pmax 1	displacement end

P_{max} 2 displacement end

Claims

1. A valve operating apparatus for an internal combustion engine, comprising:
 - a transfer member that is interposed between a cam and a valve, and transfers an acting force of the cam to the valve;
 - urging means that urges the transfer member in one direction; and
 - a holding member that holds the urging means, wherein the urging means is attached to a spark plug tube through the holding member.
2. The valve operating apparatus for an internal combustion engine according to claim 1, wherein the transfer member includes a first rocker arm that rocks in synchrony with rotation of the cam, and wherein the urging means is means that urges the first rocker arm towards the cam.
3. The valve operating apparatus for an internal combustion engine according to claim 2, wherein the holding member is attached to the spark plug tube in a condition in which the holding member is rotatable in a circumferential direction of the spark plug tube, wherein the valve operating apparatus for an internal combustion engine further comprising:
 - an engagement groove that is formed in one of the urging means and the first rocker arm at a contact portion between the urging means and the first rocker arm; and
 - a projecting portion that is formed in the other of the urging means and the first rocker arm at the contact portion and that engages with the engagement groove.
4. The valve operating apparatus for an internal combustion engine according to claim 2 or 3, wherein the transfer member further includes a second rocker arm that is capable of pushing and moving the valve, wherein the valve operating apparatus for an internal combustion engine further comprises a switching mechanism capable of switching between a connected state in which the first rocker arm and the second rocker arm are in connection and a non-connected state in which the connection is released, and wherein the urging means is a lost motion mechanism that urges the first rocker arm so as to maintain a state in which the first rocker arm contacts the cam.
5. The valve operating apparatus for an internal combustion engine according to claim 1 or 2, wherein the urging means is a lash adjuster that has a function of expanding and contracting so as to make a tappet clearance zero and that is disposed so as to support a fulcrum of the transfer member.
6. The valve operating apparatus for an internal combustion engine according to any one of claims 1 to 5, wherein the holding member includes a holding portion that covers a trunk portion of the urging means from outside, and an attachment portion that is attached to the spark plug tube.
7. The valve operating apparatus for an internal combustion engine according to claim 6, wherein a cross-sectional shape of the holding portion is an enlarged shape of a cross-sectional shape of the urging means.
8. The valve operating apparatus for an internal combustion engine according to any one of claims 1 to 7, wherein an end portion on an opposite side to an end portion that contacts the transfer member in the urging means is received and stopped by a base member to which the spark plug tube is fixed.

Fig. 1

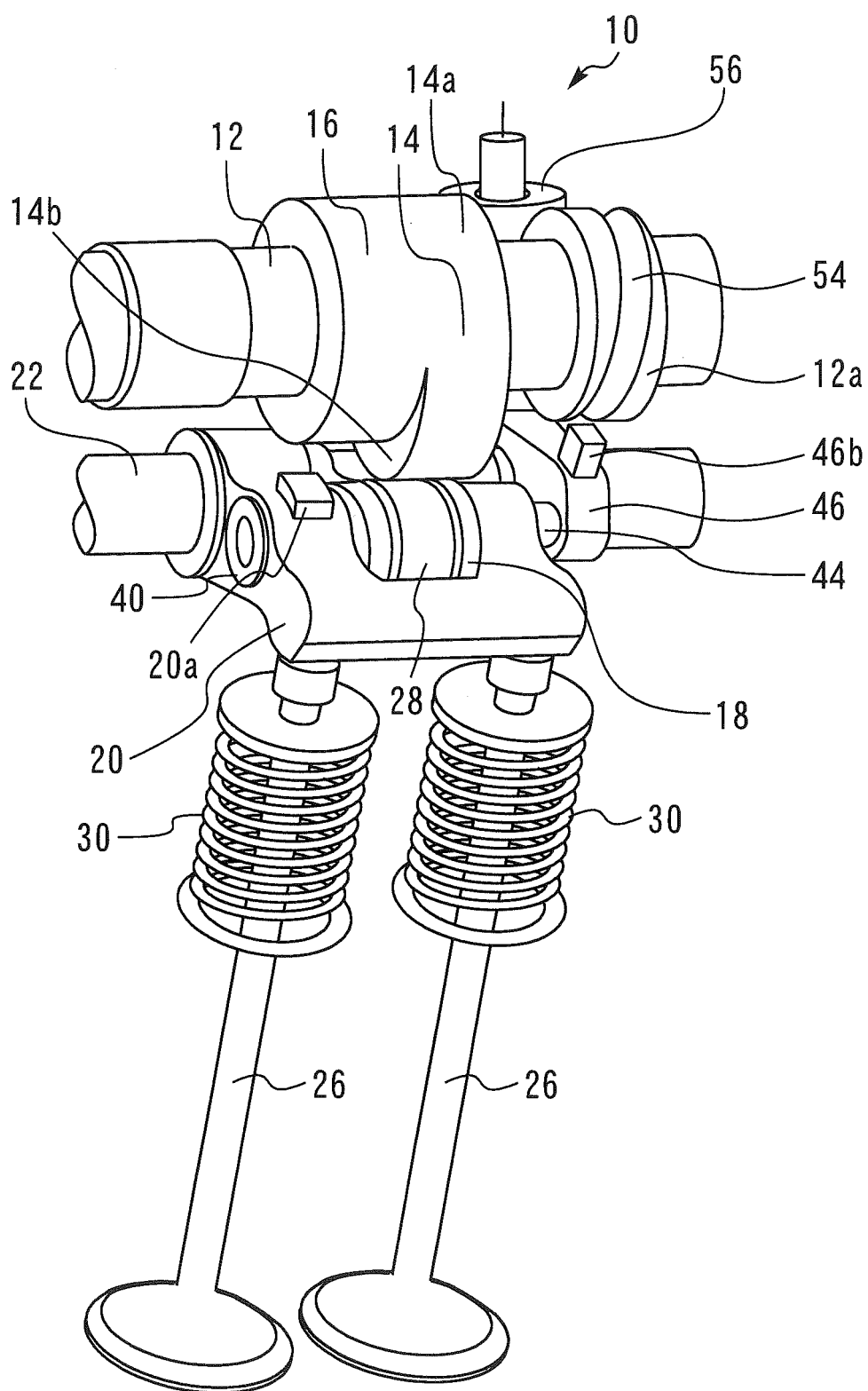


Fig. 2

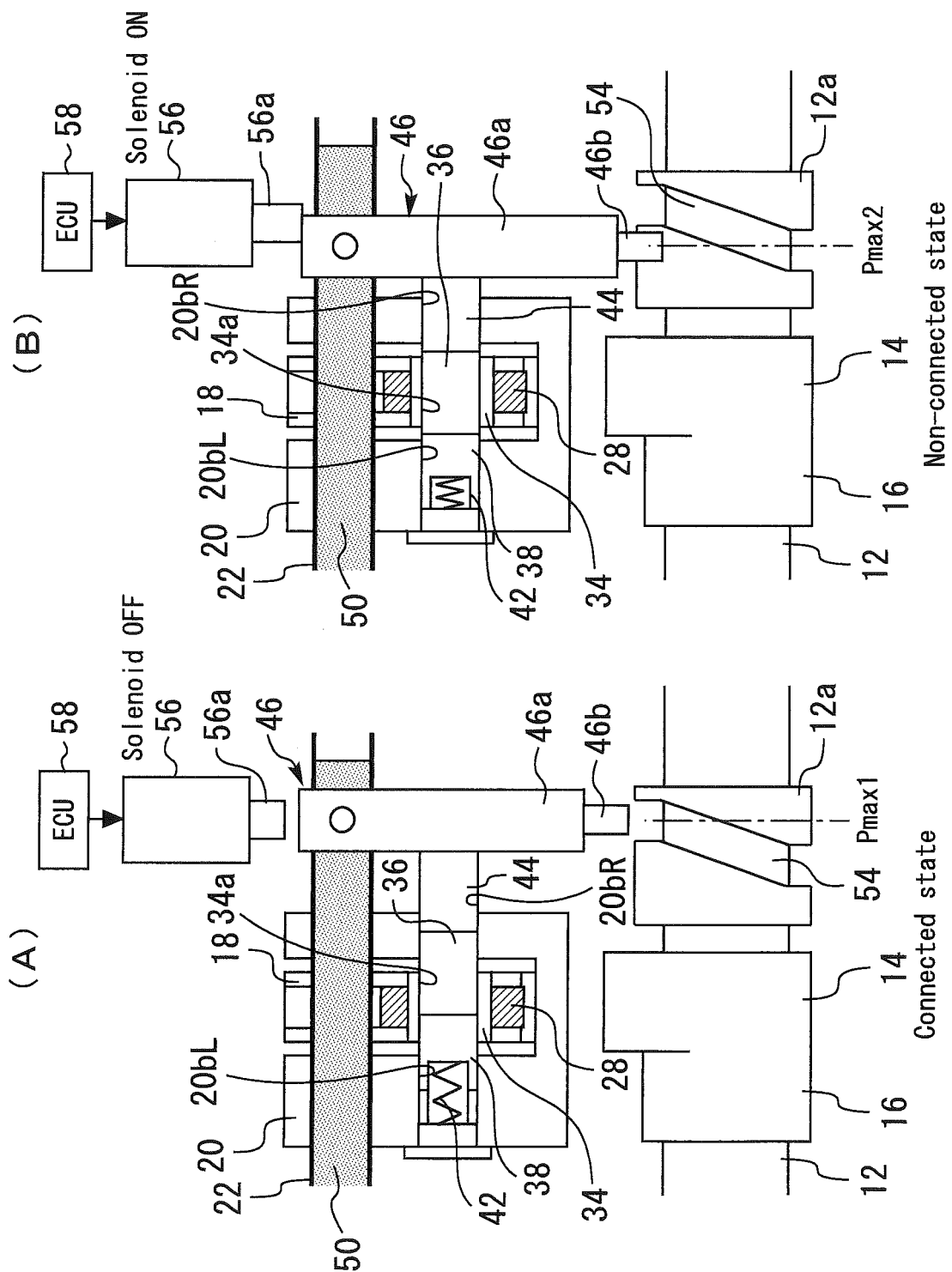


Fig. 3

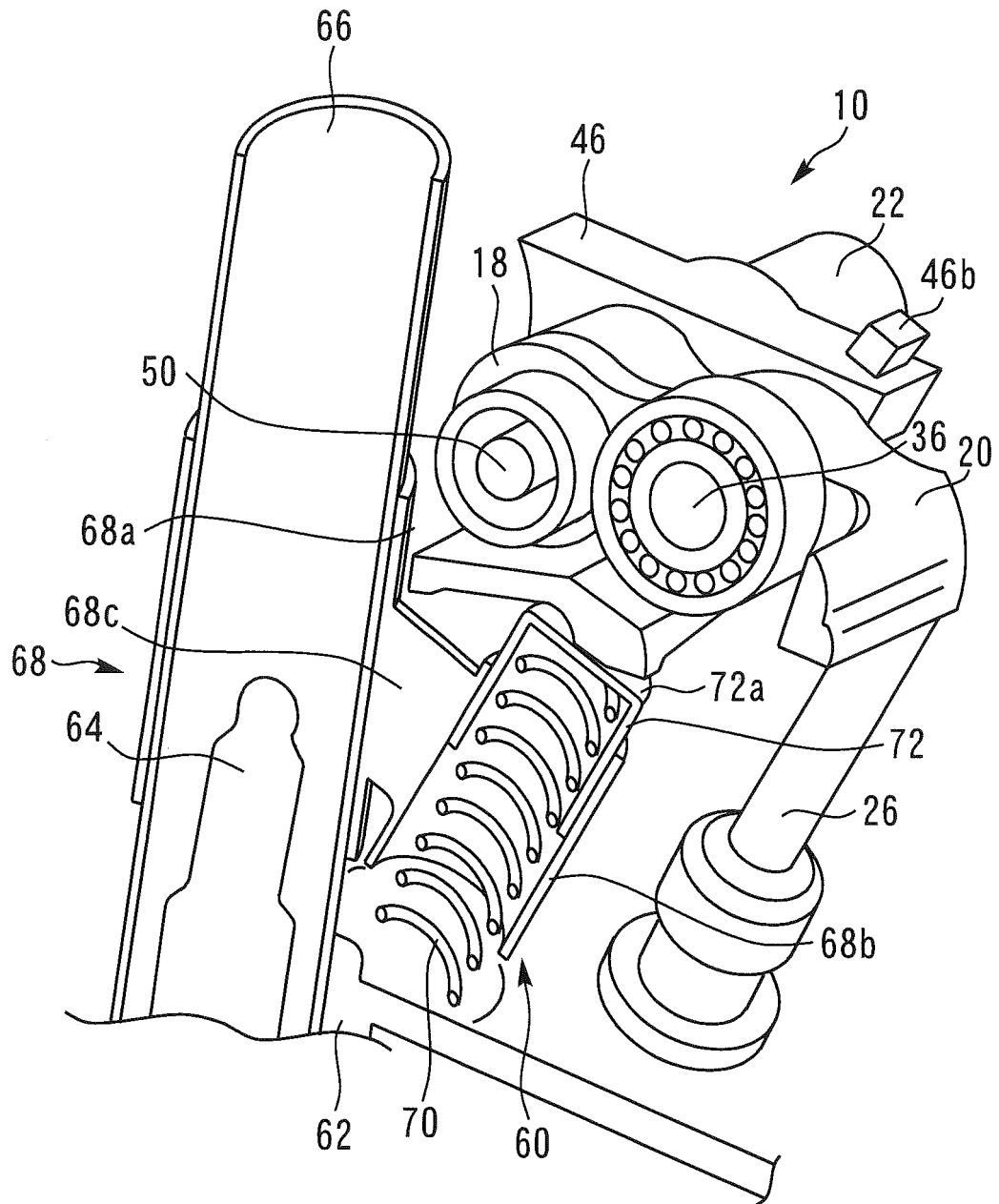


Fig. 4

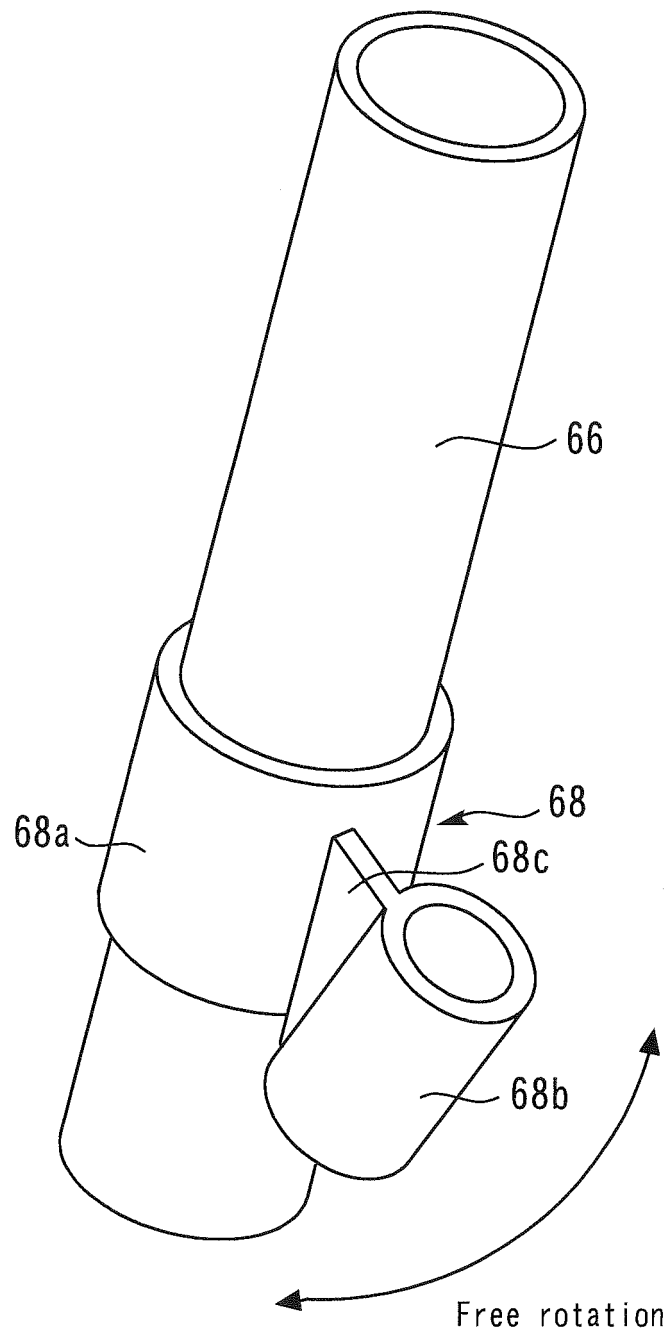


Fig. 5

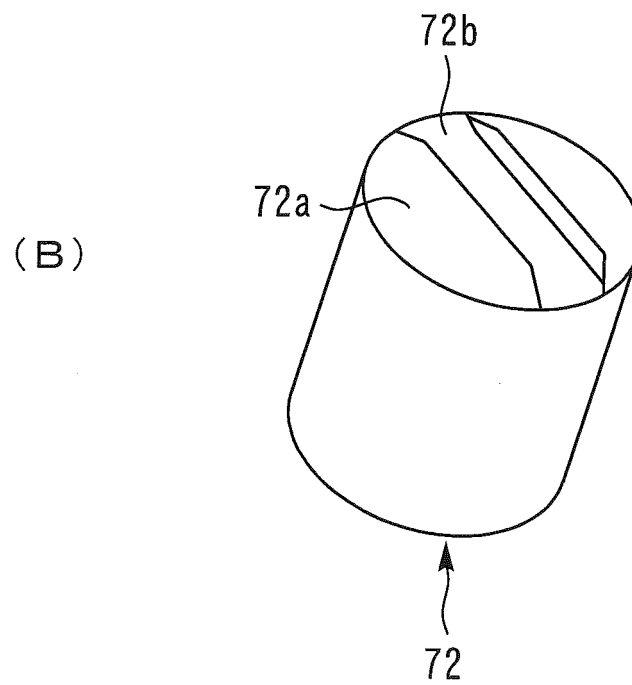
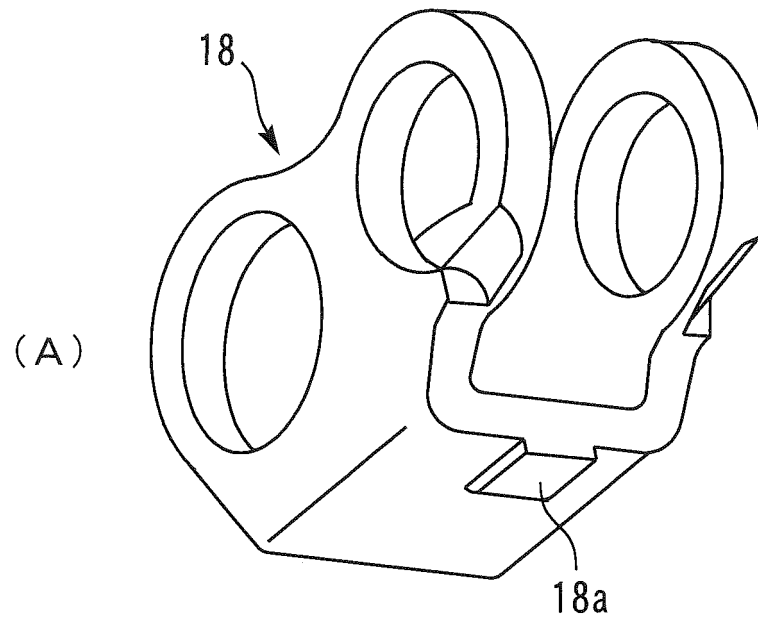


Fig. 6

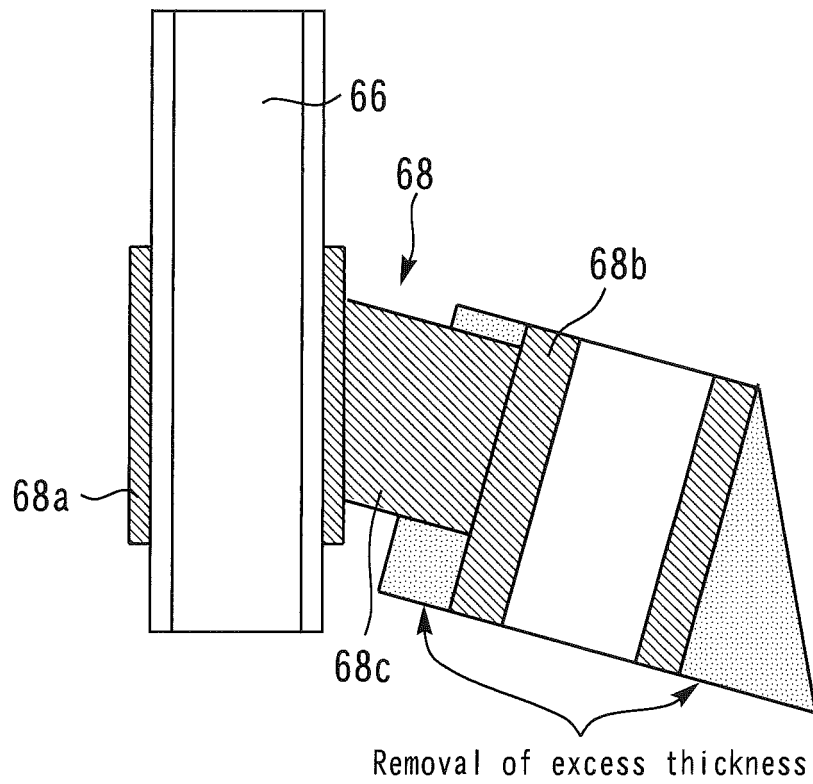


Fig. 7

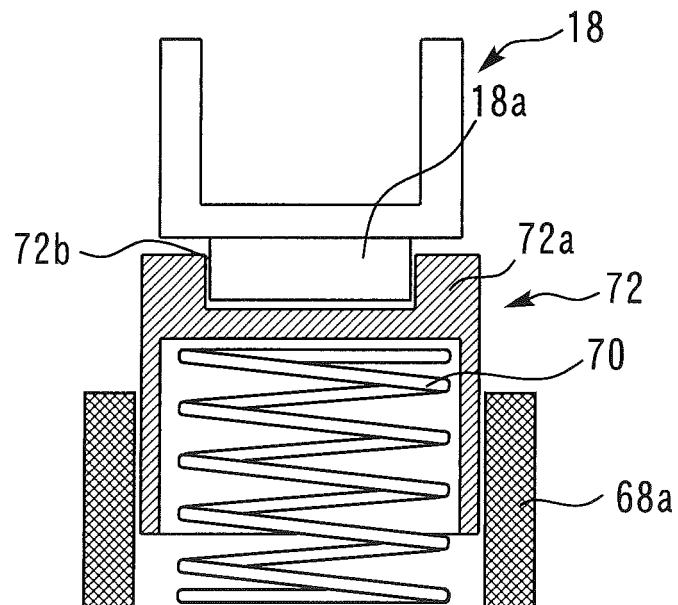


Fig. 8

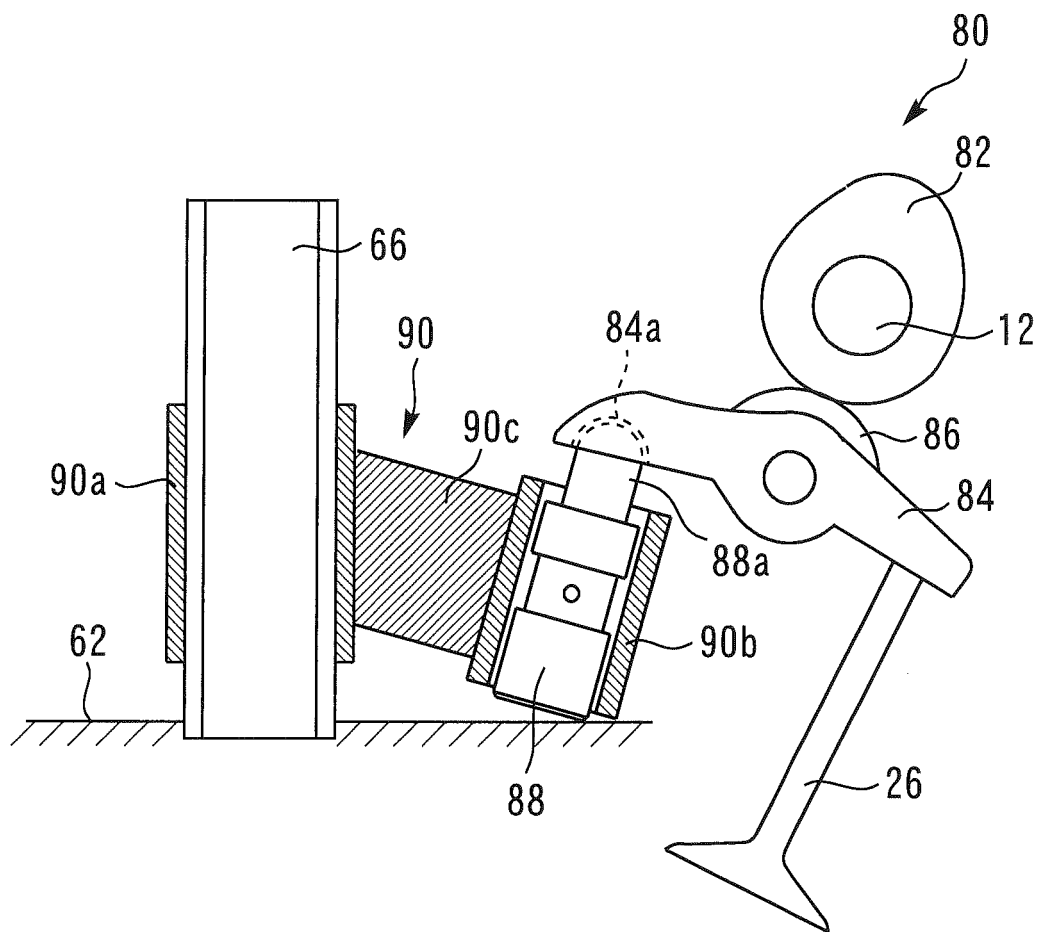
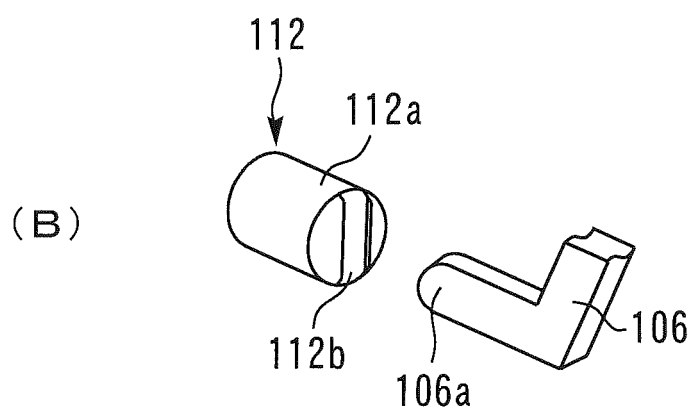
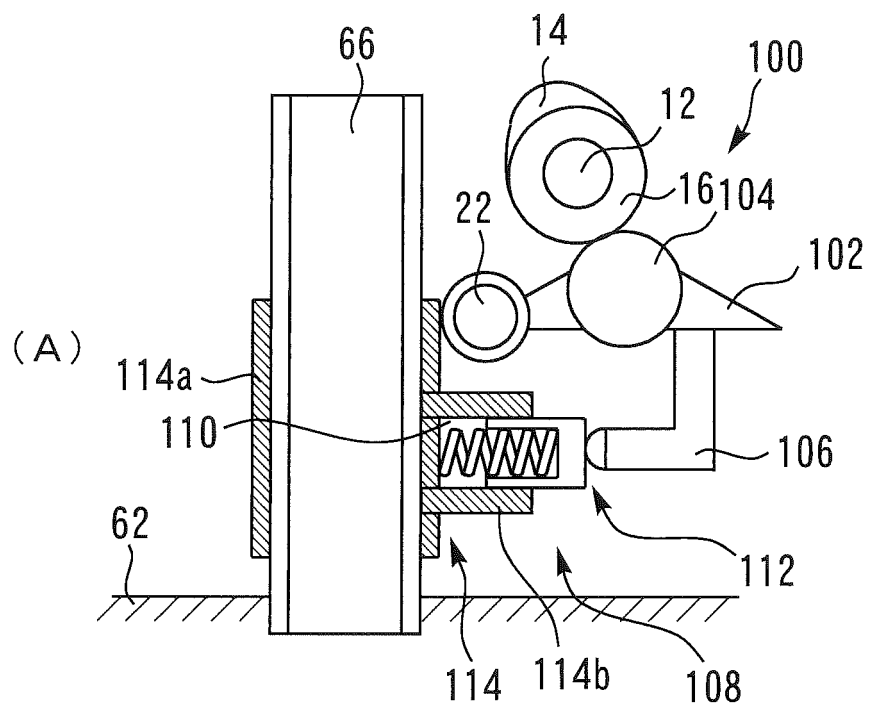


Fig. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/056332

A. CLASSIFICATION OF SUBJECT MATTER

F01L13/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F01L13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010

Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 124876/1988 (Laid-open No. 46006/1990) (Mitsubishi Motors Corp.), 29 March 1990 (29.03.1990), entire text; fig. 1 to 2 (Family: none)	1-8
Y	JP 2000-87719 A (Honda Motor Co., Ltd.), 28 March 2000 (28.03.2000), paragraphs [0011] to [0012], [0019]; fig. 1 to 7 (Family: none)	1-8

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
04 June, 2010 (04.06.10)Date of mailing of the international search report
22 June, 2010 (22.06.10)Name and mailing address of the ISA/
Japanese Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/056332

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2002-242629 A (Yamaha Motor Co., Ltd.), 28 August 2002 (28.08.2002), paragraphs [0016] to [0017]; fig. 1 to 2 (Family: none)	4, 6-8 1-3, 5

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2000240418 A [0003]
- JP 2007327378 A [0003]
- JP HEI6280522 B [0003]