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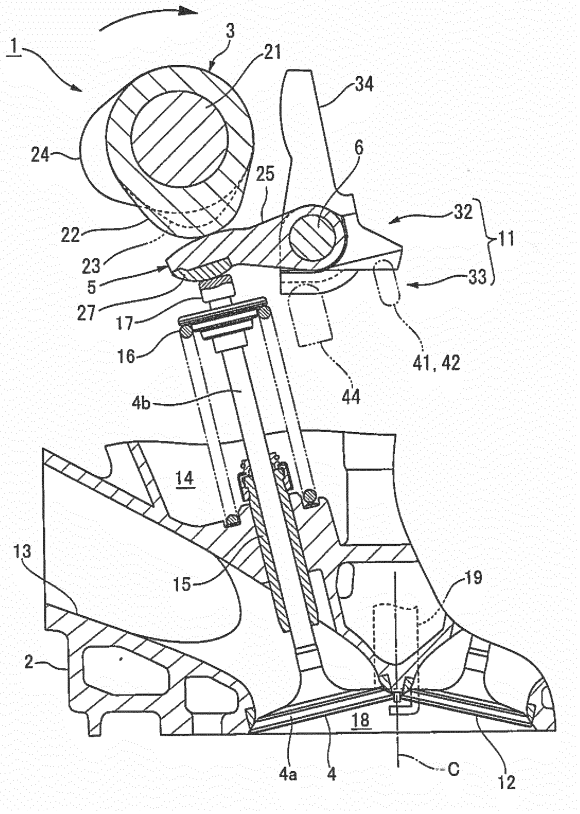
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(54) VALVE OPERATING DEVICE FOR ENGINE

(57) A valve gear includes a camshaft (3), a first cam (22) and a second cam (23) configured to drive an intake valve (4) or an exhaust valve (12), and a synchronous cam (24) configured to rotate in synchronism with the first and second cams. The valve gear includes a rocker shaft (6), a rocker arm (5), and a cam follower (34) swingably supported by the rocker shaft (6) and configured to come into contact with the synchronous cam (24). The valve gear includes a thrust generation mechanism (11) configured to convert the swing motion of the cam follower (34) into a thrust and move the rocker arm (5) to one side or the other side in the axial direction. It is possible to provide a valve gear for an engine, which can make the camshaft compact, and also increases the reliability of an operation in high rotation and reduces an operation sound in low rotation.

FIG.1



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Description

Technical Field

[0001] The present invention relates to a valve gear for an engine, which has a function of switching a plurality of cams of different cam profiles.

Background Art

[0002] Some of recent engines mounted in vehicles can switch operation modes during an operation. The operation modes to be switched are two operation modes of different fuel consumptions or output characteristics. Switching of the operation mode is often done using a valve gear that drives an intake valve and an exhaust valve.

[0003] A conventional valve gear capable of switching the operation mode is described in, for example, patent literature 1. The valve gear disclosed in patent literature 1 includes a camshaft, a rocker arm that transmits a driving force between the camshaft and an intake valve or an exhaust valve, and a driving device configured to switch the operation mode. The camshaft is provided with first and second cams configured to drive the intake valve or the exhaust valve, and an advancing and retreating cams configured to switch the operation mode.

[0004] The first cam and the second cam are formed into shapes of different cam profiles. For example, the first cam is formed into a shape with a cam nose projecting from a base circle, and the second cam is formed into a perfect circle (for cylinder deactivation). The first and second cams or the rocker arm is configured to be movable in the axial direction of the camshaft. The first and second cams movable in the axial direction rotate integrally with the camshaft.

[0005] The valve gear described in patent literature 1 presses the first and second cams or the rocker arm in the axial direction of the camshaft using the above-described advancing and retreating cams. That is, switching is done between a first operation mode in which the rocker arm is pressed by the first cam and a second operation mode in which the rocker arm is pressed by the second cam.

[0006] The advancing cam and the retreating cam are constituted by spirally formed cam grooves and disposed side by side in the axial direction of the camshaft. The spiral of the advancing cam extends along the outer surface of the camshaft in one axial direction and the rotation direction. The spiral of the retreating cam extends along the outer surface of the camshaft in the other axial direction and the rotation direction. That is, the advancing cam and the retreating cam are formed into shapes with spirals extending in opposite directions. This valve gear includes an advancing cam follower that selectively comes into contact with the advancing cam, and a retreating cam follower that selectively comes into contact with the retreating cam.

[0007] If the first and second cams can move in the axial direction, an arrangement for moving the advancing cam and the retreating cam in the axial direction integrally with the first and second cams is employed. In this case, the advancing cam follower, the retreating cam follower, and the rocker arm are supported by a cylinder head in a state in which they cannot move in the axial direction of the camshaft.

[0008] On the other hand, if the rocker arm can move in the axial direction, the advancing cam follower and the retreating cam follower are supported by a slide member that moves in the axial direction integrally with the rocker arm.

[0009] Another conventional valve gear of this type moves the rocker arm by the spring force of a helical compression spring without using the above-described advancing and retreating cams. In this valve gear, a timing of switching between the first operation mode and the second operation mode is defined by a switching timing control cam that rotates integrally with the first and second cams.

Related Art Literature

Patent Literature

[0010] Patent Literature 1: Japanese Patent Laid-Open No. 2010-249123

Disclosure of Invention

Problem to be Solved by the Invention

[0011] In the valve gear for an engine described in patent literature 1, since the advancing cam and the retreating cam are needed on the camshaft, the total length of the camshaft increases. A recent camshaft has many functions to implement a 4-valve engine or expand capabilities. For example, the camshaft is provided with members such as gears and cams used to drive auxiliary machinery such as a high pressure fuel pump and a vacuum pump, and a rotation angle detection rotor. For this reason, to provide the advancing cam and the retreating cam on such a camshaft, the total length of the camshaft needs to be increased.

[0012] In the valve gear configured to move the rocker arm in the axial direction by the spring force of a helical compression spring, a problem arises because the switching speed depends on only the spring load of the helical compression spring. In this valve gear, to correctly perform switching in a state in which the operation range of the engine is the high rotation range, a high spring load is necessary to increase the switching speed. However, if the spring load is high, a high impact load is applied to the switching portion at the time of switching, resulting in abnormal noise. The abnormal noise is not problematic at all in a high rotation mode with a loud engine sound. In a low rotation mode with a small engine sound, how-

ever, the abnormal noise may grate on the ear.

[0013] The present invention has been made to solve the above-described problems, and has as its object to provide a valve gear for an engine, which can make a camshaft compact and also increases the reliability of a switching operation and reduces a switching operation sound.

Means of Solution to the Problem

[0014] In order to achieve the above object, according to the present invention, there is provided a valve gear for an engine, comprising a camshaft rotatably supported by a cylinder head, a first cam provided on the camshaft and configured to drive one of an intake valve and an exhaust valve, a second cam provided on the camshaft to be arranged with the first cam in an axial direction, and configured to drive one of the intake valve and the exhaust valve, the second cam formed into a shape with a cam profile different from the first cam, a synchronous cam provided on the camshaft and configured to rotate in synchronism with the first cam and the second cam, a rocker shaft parallel to the camshaft, a rocker arm supported by the rocker shaft to be swingable and movable in the axial direction and configured to convert a rotation of one of the first cam and the second cam into a reciprocal motion and transmit the reciprocal motion to one of the intake valve and the exhaust valve, a cam follower swingably supported by the rocker shaft and configured to come into contact with the synchronous cam, and a thrust generation mechanism configured to convert the swing motion of the cam follower into a thrust in the axial direction and move the rocker arm to one of one side and the other side in the axial direction.

[0015] According to the present invention, in the valve gear for the engine, the thrust generation mechanism may comprise a slide portion configured to swing integrally with the cam follower and move in the axial direction integrally with the rocker arm, and a switching portion supported by the cylinder head and including a first switching member and a second switching member, wherein the first switching member and the second switching member are configured to selectively come into contact with the slide portion, and the slide portion may comprise a first inclined cam face that receives a force in one side thereof in the axial direction, wherein the fore is generated by one switching member of the first switching member and the second switching member is in contact with the first inclined cam face, and a second inclined cam face that receives a force in the other side thereof in the axial direction, wherein the force is generated by the other switching member of the first switching member and the second switching member is in contact with the second inclined cam face.

[0016] According to the present invention, in the valve gear for the engine, a movement of the cam follower in the axial direction may be regulated, and the slide portion may be formed separately from the cam follower and be movable in the axial direction relative to the cam follower.

[0017] According to the present invention, in the valve gear for the engine, each of the first switching member and the second switching member may be formed by a pin configured to move between an advancing position at which one end comes into contact with the slide portion and a retreating position at which the one end separates from the slide portion, the other end of the pin may abut against a pin cam of a moving member configured to move in a direction orthogonal to a direction in which the pin moves, and the pin cam may be formed into a shape with which when the moving member moves to one side, the first switching member moves to the advancing position, and the second switching member moves to the retreating position, and when the moving member moves to the other side, the first switching member moves to the retreating position, and the second switching member moves to the advancing position.

Effect of the Invention

[0018] In the present invention, when the cam follower is pressed by the synchronous cam and swings, the thrust generation mechanism moves the rocker arm to one side or the other side in the axial direction. When the rocker arm moves in the axial direction, switching is done between a first operation mode in which the rocker arm is driven by the first cam and a second operation mode in which the rocker arm is driven by the second cam.

[0019] The synchronous cam can be formed to be short in the axial direction, as compared to conventional advancing and retreating cams formed from helical grooves.

[0020] In the valve gear, the switching speed when switching the operation mode is determined depending on the profile (shape) and the cam rotational speed of the synchronous cam. For this reason, the switching speed changes in proportion to the cam rotational speed. As compared to a case in which the spring load of a spring member is increased when increasing the switching speed, reliability in switching in a high rotation state becomes high, and the operation sound in low rotation becomes small.

[0021] Hence, according to the present invention, it is possible to provide a valve gear for an engine, which can make a camshaft compact and also increases operation reliability and reduces the operation sound.

Brief Description of Drawings

[0022]

Fig. 1 is a sectional view showing the arrangement of a valve gear for an engine according to the first embodiment of the present invention;

Fig. 2 is a front view showing the main part of the valve gear according to the first embodiment in a state in which a cylinder head and part of a thrust

generation mechanism are cut away;
Fig. 3 is a sectional view showing the main part of the valve gear according to the first embodiment taken along a line III - III in Fig. 2;
Fig. 4 is a rear view showing the main part of the valve gear according to the first embodiment in a state in which the cylinder head and part of the thrust generation mechanism are cut away;
Fig. 5A is a plan view of a cam follower of the valve gear according to the first embodiment;
Fig. 5B is a left side view of the cam follower of the valve gear according to the first embodiment;
Fig. 5C is a front view of the cam follower of the valve gear according to the first embodiment;
Fig. 5D is a right side view of the cam follower of the valve gear according to the first embodiment;
Fig. 5E is a rear view of the cam follower of the valve gear according to the first embodiment;
Fig. 5F is a bottom view of the cam follower of the valve gear according to the first embodiment;
Fig. 5G is a perspective view of the cam follower of the valve gear according to the first embodiment viewed obliquely from the lower left side;
Fig. 6A is a sectional view showing the main part viewed from the axial direction of a camshaft so as to explain the operation of the valve gear according to the first embodiment;
Fig. 6B is a front view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 6C is a rear view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 7A is a sectional view showing the main part viewed from the axial direction of the camshaft so as to explain the operation of the valve gear according to the first embodiment;
Fig. 7B is a front view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 7C is a rear view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 8A is a sectional view showing the main part viewed from the axial direction of the camshaft so as to explain the operation of the valve gear according to the first embodiment;
Fig. 8B is a front view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 8C is a rear view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 9A is a sectional view showing the main part viewed from the axial direction of the camshaft so as to explain the operation of the valve gear according to the first embodiment;
Fig. 9B is a front view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 9C is a rear view showing the main part so as to explain the operation of the valve gear according to the first embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 10 is a perspective view of the cam follower and the slide portion of a valve gear according to the second embodiment;
Fig. 11 is a rear view showing the main part of the valve gear according to the second embodiment in a state in which part of a thrust generation mechanism is cut away;
Fig. 12 is a rear view showing the main part of the valve gear according to the second embodiment in a state in which part of the thrust generation mechanism is cut away;
Fig. 13 is an exploded perspective view of the main part of a valve gear according to the third embodiment;
Fig. 14 is a sectional view of the main part of the valve gear according to the third embodiment in an operation pause state;
Fig. 15 is a front view of the valve gear according to the third embodiment in an operation pause state;
Fig. 16 is a rear view of the valve gear according to the third embodiment in an operation pause state in which the cutaway position in Fig. 14 is indicated by a line XIV - XIV;
Fig. 17 is a sectional view of the valve gear according to the third embodiment in a normal operation state;
Fig. 18 is a front view of the valve gear according to the third embodiment in a normal operation state;
Fig. 19 is a rear view of the valve gear according to the third embodiment in a normal operation state;
Fig. 20 is a perspective view of the main part of a valve gear according to the fourth embodiment;
Fig. 21 is a side view of the valve gear according to the fourth embodiment in which the shaft main body of a camshaft is not illustrated;
Fig. 22 is a plan view of the valve gear according to the fourth embodiment in which the shaft main body of the camshaft is not illustrated; and
Fig. 23 is an exploded perspective view of the main part of the valve gear according to the fourth embodiment.

Best Mode for Carrying Out the Invention

(First Embodiment)

[0023] A valve gear for an engine according to an embodiment of the present invention will now be described in detail with reference to Figs. 1 to 9C.

[0024] A valve gear 1 for an engine shown in Fig. 1 includes a camshaft 3 provided in a cylinder head 2, and a rocker arm 5 that intervenes between the camshaft 3 and an intake valve 4. The rocker arm 5 is supported by a rocker shaft 6 to be swingable and movable in the axial direction.

[0025] The rocker shaft 6 is supported by the cylinder head 2 to be parallel to the camshaft 3. The position of the rocker arm 5 in the axial direction is regulated by a thrust generation mechanism 11 to be described later.

[0026] The present invention is applicable to both the valve gear 1 for an intake valve shown in Fig. 1 and a valve gear for an exhaust valve (not shown) configured to drive an exhaust valve 12. Note that the valve gear for an exhaust valve to which the present invention is applied has the same structure as the valve gear 1 for an intake valve. Hence, in this embodiment, an illustration and explanation of the valve gear for an exhaust valve are omitted.

[0027] Two intake valves 4 are provided for each cylinder. Each intake valve 4 is formed from a valve body 4a that opens/closes an intake port 13 in the cylinder head 2, and a valve stem 4b extending from the valve body 4a into a valve gear chamber 14 in the cylinder head 2. The valve stem 4b is movably supported on the cylinder head 2 via a valve stem guide 15. A valve spring 16 that biases the intake valve 4 in a closing direction is provided between the cylinder head 2 and the distal end of the valve stem 4b. A cap-shaped shim 17 is provided at the distal end of the valve stem 4b.

[0028] The intake port 13 is formed into a fork shape branching in the cylinder head 2. The upstream end of the intake port 13 opens to a side of the cylinder head 2, and the downstream end of the intake port 13 opens to a combustion chamber 18. A spark plug 19 is provided at the center of the combustion chamber 18. As shown in Fig. 1, the spark plug 19 is provided at a position different from a cylinder axis C when viewed from the axial direction of the camshaft 3.

[0029] The camshaft 3 rotates when the rotation of a crankshaft (not shown) is transmitted via a transmission mechanism. The camshaft 3 according to this embodiment includes a camshaft main body 21 formed into a rod shape, and a plurality of cams provided on the camshaft main body 21, as shown in Fig. 2. The plurality of cams include a first cam 22 and a second cam 23 which are provided for each intake valve 4, and a synchronous cam 24 located between the two sets of first cams 22 and second cams 23.

[0030] The first cam 22 and the second cam 23 are configured to drive the intake valve 4. The second cam 23 has a cam profile different from that of the first cam 22, and is formed into a shape of a different valve lift amount in this embodiment. In addition, the second cam 23 is provided on the camshaft 3 at a position arranged with the first cam 22 in the axial direction. As shown in Fig. 3, the first cam 22 and the second cam 23 include base circle portions 22a and 23a and nose portions 22b and 23b, respectively. Each of the base circle portions 22a and 23a has a shape as part of a column located on the same axis as the camshaft main body 21, and is formed into a size with which the valve lift amount of the intake valve 4 becomes 0.

[0031] Each of the nose portions 22b and 23b is formed into a shape projecting from a corresponding one of the base circle portions 22a and 23a outward in the radial direction by a predetermined projecting amount so as to have a mountain-shaped section. The projecting amount of the nose portion 22b of the first cam 22 is larger than the projecting amount of the nose portion 23b of the second cam 23.

[0032] The synchronous cam 24 is configured to drive the thrust generation mechanism 11 (to be described later), and is formed from a base circle portion 24a and a nose portion 24b. The synchronous cam 24 rotates in synchronism with valve driving cams including the first cams 22 and the second cams 23. The nose portion 24b of the synchronous cam 24 is formed at a position different from the positions of the nose portions 22b and 23b of the first cam 22 and the second cam 23 in the rotation direction of the camshaft 3.

[0033] The rocker arm 5 is formed into an almost U shape in a plan view including two arm main bodies 25 each configured to convert the rotation of the first cam 22 or the second cam 23 into a reciprocal motion and transmit it to the intake valve 4, and a connecting portion 26 that connects the swing ends of the arm main bodies 25 to each other. The rocker shaft 6 extends through the proximal portions of the two arm main bodies 25.

[0034] A pressing portion 27 configured to press the intake valve 4 is provided at each swing end of the rocker arm 5, as shown in Fig. 2. The pressing portion 27 is formed to be larger than the shim 17 in the axial direction of the rocker shaft 6. For this reason, the pressing portion 27 of the rocker arm 5 never disengages from the shim 17 even if the rocker arm 5 moves in the axial direction of the rocker shaft 6.

[0035] As shown in Fig. 4, the two arm main bodies 25 are spaced apart at a predetermined interval in the axial direction of the rocker shaft 6. A slider 31 that forms part of the thrust generation mechanism 11 is inserted between the two arm main bodies 25.

[0036] As shown in Fig. 3, the thrust generation mechanism 11 includes a slide portion 32 with the above-described slider 31, and a switching portion 33 provided at a position adjacent to the slide portion 32.

[0037] The slide portion 32 is formed from the slider 31 through which the rocker shaft 6 extends, and a plurality of functional portions (to be described later in detail)

provided on the slider 31. As shown in Fig. 4, the slider 31 is inserted between the two proximal portions of the two arm main bodies 25 in a state in which it is in slidable contact with the proximal portions, and is also supported by the rocker shaft 6 to be pivotal and movable in the axial direction. When the slider 31 moves in the axial direction of the rocker shaft 6, the rocker arm 5 integrally moves in the same direction as the slider 31.

[0038] A cam follower 34 contacting the above-described synchronous cam 24 is formed integrally with the slider 31 according to this embodiment. As shown in Fig. 3, the cam follower 34 is formed into a lever shape extending in a direction crossing the longitudinal direction of the rocker arm 5 viewed from the axial direction of the rocker shaft 6. The distal end of the cam follower 34 extends up to a position adjacent to the camshaft 3. When the camshaft 3 rotates in a state in which the cam follower 34 is close to the camshaft 3, the synchronous cam 24 presses the cam follower 34, and the cam follower 34 and the slider 31 swing about the rocker shaft 6 in a swing direction indicated by an arrow A in Figs. 5B to 5D.

[0039] As shown in Fig. 4, the axial-direction length of the synchronous cam 24 according to this embodiment is larger than the width (the width in the horizontal direction n Fig. 4, or the width in the axial direction of the rocker shaft 6) of the cam follower 34. This aims at preventing the cam follower 34 from disengaging from the synchronous cam 24 when the cam follower 34 moves in the axial direction together with the slider 31.

[0040] The synchronous cam 24 is formed into such a shape that presses the cam follower 34 when the rocker arm 5 contacts the base circle portion 22a of the first cam 22 or the base circle portion 23a of the second cam 23, as shown in Fig. 9A. In other words, when the intake valve 4 is closed, the cam follower 34 is pressed by the synchronous cam 24 and swings.

[0041] The plurality of functional portions provided on the slider 31 are a first inclined cam face 35 (see Fig. 4) and a second inclined cam face 36, which are located on the slider 31 on the opposite side of the cam follower 34, and a first concave groove 37 (see Fig. 2) and a second concave groove 38.

[0042] As shown in Figs. 5B and 5D, the first inclined cam face 35 and the second inclined cam face 36 are formed on a convex portion 39 provided on the slider 31. The convex portion 39 projects in a direction different from the direction in which the cam follower 34 projects from the slider 31. In the assembled state shown in Fig. 3, the convex portion 39 according to this embodiment projects in a direction opposite to the direction in which the rocker arm 5 extends. As shown in Fig. 5C, the convex portion 39 is formed to have a mountain-shaped section projecting to the opposite side of the cam follower 34. The first inclined cam face 35 and the second inclined cam face 36 are provided on the surface (lower surface) of the convex portion 39 on the opposite side of the cam follower 34.

[0043] The first inclined cam face 35 and the second inclined cam face 36 according to this embodiment are formed by flat surfaces that are inclined in directions opposite to each other in the axial direction of the rocker shaft 6, as shown in Figs. 4 and 5B to 5G. As shown in Fig. 5C, the first inclined cam face 35 and the second inclined cam face 36 extend from the center of the convex portion 39 in the axial direction of the rocker shaft 6 to one end side and the other end side. The first inclined cam face 35 is inclined to gradually lower from the center of the convex portion 39 to one end side.

[0044] The second inclined cam face 36 is inclined to gradually lower from the center of the convex portion 39 to the other end side. Note that the first inclined cam face 35 and the second inclined cam face 36 can also be formed by concave curved surfaces, although not illustrated.

[0045] As shown in Fig. 5F, the first concave groove 37 and the second concave groove 38 are formed at an end of the slider 31 on the opposite side of the cam follower 34 at positions adjacent to the first inclined cam face 35 and the second inclined cam face 36 in the longitudinal direction of the convex portion 39. The first concave groove 37 and the second concave groove 38 are formed side by side in the axial direction of the rocker shaft 6, and extend in a direction orthogonal to the axial direction of the rocker shaft 6.

[0046] As shown in Figs. 3 an 4, the switching portion 33 of the thrust generation mechanism 11 includes a first pin 41 facing the above-described first inclined cam face 35, a second pin 42 facing the second inclined cam face 36, a moving member 43 in contact with the pins 41 and 42, and a third pin 44 to be engageably inserted in the above-described first concave groove 37 or second concave groove 38. In this embodiment, the first pin 41 corresponds to a "first switching member" in the invention according to claim 2, and the second pin 42 corresponds to a "second switching member" in the invention according to claim 2.

[0047] As shown in Fig. 3, the first pin 41 and the second pin 42 are supported by the cylinder head 2 to be movable in the longitudinal direction in a state in which they are parallel to the valve stem 4b of the intake valve 4. As shown in Fig. 4, the first pin 41 and the second pin 42 are provided at predetermined positions spaced part from each other at a predetermined interval in the axial direction of the rocker shaft 6. The predetermined positions are positions associated with the first inclined cam face 35 and the second inclined cam face 36.

[0048] As shown in Fig. 6C, the first pin 41 is provided at a position facing the projecting end of the first inclined cam face 35 in a state in which the slider 31 has moved to one end side with the first inclined cam face 35 in the axial direction of the rocker shaft 6. The projecting end is a portion near the top formed by the first inclined cam face 35 and the second inclined cam face 36.

[0049] On the other hand, as shown in Fig. 4, the second pin 42 is provided at a position facing the projecting end of the second inclined cam face 36 in a state in which

the slider 31 has moved to the other end side with the second inclined cam face 36 in the axial direction of the rocker shaft 6.

[0050] The first pin 41 and the second pin 42 can move between an advancing position to advance toward the slider 31 and a retreating position to retreat in a direction opposite to the slider 31. When the slider 31 swings integrally with the cam follower 34, the first pin 41 and the second pin 42 that advance to the advancing position are brought into contact with the first inclined cam face 35 or the second inclined cam face 36. In a state in which the first pin 41 and the second pin 42 move to the retreating position, the movement of the first inclined cam face 35 or the second inclined cam face 36 is not impeded even if the slider 31 swings. Fig. 4 shows a state in which the first pin 41 is located at the advancing position, and the second pin 42 is located at the retreating position. The advancing position and the retreating position are regulated by the moving member 43 that comes into contact with the first pin 41 and the second pin 42.

[0051] The moving member 43 is formed into a columnar shape and is movably fitted in an oil hole 45 of the cylinder head 2. The oil hole 45 is formed in parallel to the rocker shaft 6. For this reason, the moving member 43 moves in a direction orthogonal to the direction in which the first pin 41 and the second pin 42 move.

[0052] The moving member 43 according to this embodiment forms a piston that moves in the oil hole 45. A helical compression spring 46 is inserted on one end side (the left side in Fig. 4) of the oil hole 45. The helical compression spring 46 biases the moving member 43 to the other end side of the oil hole 45. Note that both the spring force of the helical compression spring 46 and an oil pressure may be applied to one end of the moving member 43. The end of the moving member 43 close to the helical compression spring 46 will simply be referred to as "one end" and the end on the opposite side as the "other end" hereinafter.

[0053] The other end of the oil hole 45 is connected to an oil pressure supply device (not shown). Hence, an oil pressure propagated from the oil pressure supply device is applied to the other end (the end on the right side in Fig. 4) of the moving member 43.

[0054] A first pin cam 47 configured to move the first pin 41 between the advancing position and the retreating position and a second pin cam 48 configured to move the second pin 42 between the advancing position and the retreating position are formed in the moving member 43. The cams 47 and 48 are formed to be symmetrical to each other with respect to a plane of symmetry formed by a virtual plane orthogonal to the axis of the moving member 43.

[0055] The first pin cam 47 and the second pin cam 48 are formed by curved surfaces extending from concave portions 49 and 50 in which the ends of the first pin 41 and the second pin 42 are inserted to the outer surface of the moving member 43. The first pin 41 and the second pin 42 are inserted in the concave portions 49 and 50 and thus located at the retreating position.

[0056] The first pin cam 47 is provided at one end of the moving member 43. When the moving member 43 moves to one end side (the left side in Fig. 6C) of the oil hole 45 from a state in which the first pin 41 is stored in the concave portion 49 and located at the retreating position (see Fig. 6C), the first pin cam 47 pushes the first pin 41 out of the concave portion 49 and places the first pin 41 on the outer surface of the moving member 43, as shown in Fig. 7C. The first pin 41 that has moved to the advancing position comes into contact with the first inclined cam face 35 when the slider 31 swings.

[0057] The second pin cam 48 is provided at the other end of the moving member 43. The second pin cam 48 is formed into a shape that moves the second pin 42 to the advancing position (see Fig. 6C) when the moving member 43 moves to the other end side (the light side in Fig. 4) from a state in which the second pin 42 is stored in the concave portion 50 and located at the retreating position (see Fig. 4). The second pin 42 that has moved to the advancing position comes into contact with the second inclined cam face 36 when the slider 31 swings.

[0058] That is, the first pin 41 and the second pin 42 selectively come into contact with the slide portion 32 (slider 31) when the moving member 43 moves to one end side or the other end side.

[0059] The first pin cam 47 and the second pin cam 48 employ an arrangement capable of, when one of the first pin 41 and the second pin 42 is located at the advancing position, moving the other to the retreating position. That is, when the moving member 43 moves to one end side, the first pin 41 moves to the advancing position, and the second pin 42 can return to the retreating position, as shown in Fig. 7C. In addition, when the moving member 43 moves to the other end side that is the other side in the longitudinal direction, the first pin 41 can return to the retreating position, and the second pin 42 moves to the advancing position, as shown in Fig. 6C.

[0060] As shown in Figs. 2 and 3, the third pin 44 is arranged at a position facing the first concave groove 37 or the second concave groove 38 of the slider 31 and movably supported by the cylinder head 2 in parallel to the valve stem 4b of the intake valve 4. The direction in which the third pin 44 moves is the direction parallel to the valve stem 4b of the intake valve 4. The distal end of the third pin 44 is formed into a hemispherical shape.

[0061] In addition, the third pin 44 is pressed against the first concave groove 37 or the second concave groove 38 by the spring force of a helical compression spring 51 provided between the third pin 44 and the cylinder head 2. For this reason, the slider 31 is biased by the spring force of the helical compression spring 51 in a direction in which the cam follower 34 separates from the camshaft 3 about the rocker shaft 6. When biased by the spring force of the helical compression spring 51, the slider 31 swings in the swing direction A about the rocker shaft 6 until the first inclined cam face 35 or the second inclined cam face 36 comes into contact with the first pin 41 or

the second pin 42. For this reason, the slider 31 and the cam follower 34 are kept in a state in which the first inclined cam face 35 or the second inclined cam face 36 is in contact with the first pin 41 or the second pin 42 when the cam follower 34 is not pressed by the synchronous cam 24.

[0062] The first concave groove 37 and the second concave groove 38 are each formed to have a V-shaped section, as shown in Fig. 2. For this reason, for example, if the slider 31 moves in a direction (the right side in Fig. 2) opposite to the second concave groove 38 in a state in which the third pin 44 engages with the first concave groove 37, as shown in Fig. 2, the inclined side wall of the first concave groove 37 pushes the third pin 44, and the third pin 44 moves in a direction opposite to the slider 31 against the spring force of the helical compression spring 51.

[0063] Then, the third pin 44 moves across the top serving as the boundary between the first concave groove 37 and the second concave groove 38 and enters the second concave groove 38. The third pin 44 that has entered the second concave groove 38 presses the side wall of the second concave groove 38 by the spring force of the helical compression spring 51. Since this side wall is inclined as well, the movement of the slider 31 is assisted by the spring force of the helical compression spring 51. The slider 31 stops when the third pin 44 advances to the deepest point of the second concave groove 38. The operation of the third pin 44 is performed similarly even if the slider 31 moves in a direction opposite to the above-described direction.

[0064] In a state in which the third pin 44 is inserted in the first concave groove 37, as shown in Fig. 2, the slider 31 and the rocker arm 5 according to this embodiment are located at a first position at which the rocker arm 5 contacts the first cams 22. When the rocker arm 5 is located at the first position, a first operation mode in which the intake valve 4 is driven by the first cams 22 is implemented.

[0065] In a state in which the third pin 44 is inserted in the second concave groove 38, as shown in Fig. 6B, the slider 31 and the rocker arm 5 are located at a second position at which the rocker arm 5 contacts the second cams 23. When the rocker arm 5 is located at the second position, a second operation mode in which the intake valve 4 is driven by the second cams 23 is implemented.

[0066] The operation of the valve gear 1 having the above-described arrangement will be described next with reference to Figs. 6A to 9C. An operation performed when shifting from the second operation mode in which the intake valve 4 is driven by the second cams 23 to the first operation mode will be explained here.

[0067] When the second operation mode is employed, the rocker arm 5 is located at a position where it is pressed by the second cams 23, as shown in Fig. 6A, and the third pin 44 is inserted in the second concave groove 38, as shown in Fig. 6B. The moving member 43 moves to the other end side, as shown in Fig. 6C. The first pin 41 is located at the retreating position, and the second pin 42 is located at the advancing position.

[0068] When switching from the second operation mode to the first operation mode, the moving member 43 is moved from the other end side to the one end side, as shown in Fig. 7C. When the moving member 43 moves from the other end side to the one end side, the first pin 41 is placed on the outer surface of the moving member 43 and moves to the advancing position to press the first inclined cam face 35. When the first inclined cam face 35 is pressed by the first pin 41, as shown in Fig. 7A, the slider 31 and the cam follower 34 swing in a direction (counterclockwise in Fig. 7A) opposite to the swing direction A, and the cam follower 34 approaches the camshaft 3. At this time, the movement (movement in the axial direction of the rocker shaft 6) of the slider 31 is regulated by the third pin 44. Additionally, at this time, the concave portion 50 of the moving member 43 is located at a position facing the second pin 42.

[0069] When the camshaft 3 rotates in this state, the cam follower 34 is pressed by the synchronous cam 24 in a state in which the rocker arm 5 is in contact with the base circle portions 23a of the second cams 23, and the slider 31 swings in the swing direction A integrally with the cam follower 34, as shown in Fig. 8A. When the slider 31 swings, the projecting end of the first inclined cam face 35 is pressed against the first pin 41, as shown in Fig. 8C. In a state in which the first pin 41 is located at the advancing position, the first pin 41 cannot move (retreat) even if the slider 31 swings to bring the first inclined cam face 35 into contact with the first pin 41.

[0070] As described above, when the projecting end of the first inclined cam face 35 is pressed against the first pin 41, the first inclined cam face 35 receives a thrust. The direction in which the thrust acts is the direction in which the low portion of the first inclined cam face 35 approaches the first pin 41. As a result, the slider 31 moves to the other end side (the right side in Fig. 8C) integrally with the rocker arm 5. When the slider 31 starts moving, the third pin 44 is pressed by the side wall of the second concave groove 38 and retreats against the spring force of the helical compression spring 51, as shown in Fig. 8B.

[0071] As shown in Figs. 9A and 9B, the third pin 44 moves from the second concave groove 38 into the first concave groove 37 during a time until the top (the distal end portion where the nose portion 24b projects most) of the synchronous cam 24 presses the cam follower 34. When the top of the synchronous cam 24 passes through the cam follower 34, the thrust disappears because the cam follower 34 is not pressed by the synchronous cam 24. Note that when the slider 31 moves in accordance with the swing motion of the cam follower 34, the second pin 42 is pressed by the second inclined cam face 36 and returns to the retreating position.

[0072] When the top of the synchronous cam 24 passes through the cam follower 34, the third pin 44 is in a state in which it presses the side wall of the first concave

groove 37. For this reason, although the first inclined cam face 35 separates from the first pin 41, the side wall of the first concave groove 37 is pressed by the third pin 44 according to the spring force of the helical compression spring 51, and the slider 31 further moves to the other end side. The slider 31 stops when the third pin 44 advances to the deepest point of the first concave groove 37. When the slider 31 stops in this way, the rocker arm 5 is located at the first position at which the rocker arm 5 contacts the first cams 22, as shown in Figs. 9B and 9C, and the operation mode shifts to the first operation mode in which the intake valve 4 is driven by the first cams 22.

[0073] A shift from this operation mode to second operation mode in which the intake valve 4 is driven by the second cams 23 can be made by moving the moving member 43 to the other end side (the right side in Fig. 9C) from a state shown in Fig. 9C. When the moving member 43 moves in this way, the second pin 42 moves to the advancing position, and the cam follower 34 comes into contact with the synchronous cam 24. The cam follower 34 swings, the second pin 42 comes into contact with the second inclined cam face 36 to generate a thrust, and the slider 31 moves. At this time, the slider 31 moves to the left side in Fig. 9C from the position shown in Fig. 9C to the position shown in Fig. 6C. In addition, the first inclined cam face 35 presses the first pin 41 in accordance with the movement of the slider 31, and the first pin 41 returns to the retreating position.

[0074] The synchronous cam 24 used in the valve gear 1 for an engine having the above-described arrangement can be formed to be short in the axial direction, as compared to conventional advancing and retreating cams formed from helical grooves. This means that the camshaft 3 can be formed to be short. In addition, the synchronous cam 24 can be formed by the same manufacturing method as the first cam 22 and the second cam 23. That is, the synchronous cam 24 can be formed using a cam processing machine used to form the first cam 22 and the second cam 23.

[0075] In the valve gear 1 according to this embodiment, the switching speed when switching the operation mode is determined depending on the profile (shape) and the cam rotational speed of the synchronous cam 24. For this reason, the switching speed changes in proportion to the cam rotational speed. As compared to a case in which the spring load of a spring member is increased when increasing the switching speed, reliability in switching in a high rotation state becomes high, and the operation sound in low rotation becomes small.

[0076] In the valve gear 1 according to this embodiment, the main operation sound generated when switching the operation mode includes the sound of friction between the first inclined cam face 35 or the second inclined cam face 36 and the first pin 41 or the second pin 42, and the sound of friction between the third pin 44 and the slider 31. Such a sound is smaller than the sound of collision between metal members.

[0077] Hence, according to this embodiment, it is possible to provide a valve gear for an engine, which can make the camshaft 3 compact at low cost and also increases the reliability of the operation and reduces the operation sound.

[0078] The slide portion 32 of the thrust generation mechanism 11 according to this embodiment includes the first inclined cam face 35 and the second inclined cam face 36, and moves in the axial direction of the rocker shaft 6 when the cam follower 34 swings to press the cam face 35 or 36 against the first pin 41 or the second pin 42.

[0079] For this reason, the thrust generation mechanism 11 according to this embodiment can be formed small and can have a simple structure, as compared to a case in which a link or gear is used to convert the swing motion of the cam follower 34 into a thrust in the axial direction. Hence, according to this embodiment, it is possible to provide a valve gear for an engine capable of implementing both downsizing and cost reduction.

[0080] As for the first pin 41 and the second pin 42 according to this embodiment, when one is located at the advancing position, the other can move to the retreating position. Hence, according to this embodiment, since the first pin 41 and the second pin 42 never simultaneously move to the advancing position, it is possible to provide a valve gear for an engine whose thrust generation mechanism 11 has high operation reliability.

(Second Embodiment)

[0081] A valve gear for an engine according to the second embodiment of the present invention will be described in detail with reference to Figs. 10 to 12. The same reference numerals as in Figs. 1 to 9C denote the same or similar members in Figs. 10 to 12, and a detailed description thereof will appropriately be omitted.

[0082] A valve gear 61 (see Fig. 11) for an engine according to this embodiment is different from the valve gear 1 described in the first embodiment only in the structures of a cam follower 34 and a slider 31. The rest of the arrangement of the valve gear 61 is the same as in the valve gear 1 described in the first embodiment.

[0083] As shown in Fig. 10, the cam follower 34 according to this embodiment is formed separately from the slider 31. A proximal portion 34a of the cam follower 34 is inserted into a concave portion 62 of the slider 31. A through hole 63 to pass a rocker shaft 6 (see Fig. 11) is formed in the proximal portion 34a. The rocker shaft 6 passes through the through hole 63 and two through holes 64 formed at the two ends of the slider 31.

[0084] A swing end 34b of the cam follower 34 is swingably inserted into a concave groove 66 of a stopper 65 fixed to a cylinder head (not shown). Each side wall of the concave groove 66 is formed at a position to contact the cam follower 34 when the cam follower 34 is going to move in the axial direction of the rocker shaft 6. That is, the cam follower 34 according to this embodiment is

regulated by the side walls of the concave groove 66 and cannot therefore move in the axial direction of the rocker shaft 6.

[0085] To allow the slider 31 to move relative to the cam follower 34 in the axial direction of the rocker shaft 6, the concave portion 62 of the slider 31 is formed to be longer than the cam follower 34 by a predetermined length in the axial direction of the rocker shaft 6. The predetermined length is a length that allows the slider 31 to move relative to the cam follower 34 between a position at which a rocker arm 5 contacts first cams 22, as shown in Fig. 11, and a position at which the rocker arm 5 contacts second cams 23, as shown in Fig. 12.

[0086] The proximal portion 34a of the cam follower 34 is provided with a first convex portion 67 and a second convex portion 68 to regulate a swing relative to the slider 31. The first convex portion 67 and the second convex portion 68 are provided at positions apart to one side and the other side in the radial direction of the rocker shaft 6. The first convex portion 67 comes into contact with a pressure receiving portion 69 of the slider 31, and the second convex portion 68 comes into contact with a transmitting portion 70 of the slider 31. That is, when the cam follower 34 is pressed by a synchronous cam 24 and swings, the pressing force is transmitted from the cam follower 34 to the slider 31 via the contact portion between the first convex portion 67 and the pressure receiving portion 69. When the slider 31 is pressed by a third pin 44 and swings, the pressing force is transmitted from the slider 31 to the cam follower 34 via the contact portion between the second convex portion 68 and the transmitting portion 70.

[0087] In the valve gear 61 according to this embodiment, even if the slider 31 moves in the axial direction of the rocker shaft 6, the position of the cam follower 34 does not change. For this reason, as compared to a case in which the cam follower 34 moves in the axial direction of the rocker shaft 6, the synchronous cam 24 configured to press the cam follower 34 can be formed small in the axial direction. Hence, according to this embodiment, since the placement portion to provide the synchronous cam 24 on a camshaft 3 is narrow, the camshaft 3 can be formed to be shorter.

(Third Embodiment)

[0088] A valve gear according to the present invention can be formed as shown in Figs. 13 to 19. The same reference numerals as in Figs. 1 to 9C denote the same or similar members in Figs. 13 to 19, and a detailed description thereof will appropriately be omitted.

[0089] A valve gear 71 for an engine according to this embodiment is different from the valve gear 1 described in the first embodiment in the structures of a camshaft 3, a rocker arm 5, a cam follower 34, and a thrust generation mechanism 11. As for the cam follower 34 according to this embodiment, the movement in the axial direction is regulated, as in a case in which the second embodiment is employed. The rest of the arrangement of the valve gear 71 is the same as in the valve gear 1 described in the first embodiment.

[0090] As shown in Fig. 15, two first cams 22 of the camshaft 3 according to this embodiment are provided at positions adjacent to a synchronous cam 24. Second cams 23 are provided at positions to sandwich the first cams 22 from both sides. As shown in Fig. 14, each second cam 23 has no nose portion and is formed from only a base circle portion 23a. That is, the valve gear 71 according to this embodiment can switch between a first operation mode in which an intake valve 4 is driven by the first cams 22 and a second operation mode in which the intake valve 4 does not open.

[0091] As shown in Fig. 13, the rocker arm 5 according to this embodiment is provided for each intake valve 4 (see Fig. 15). That is, the rocker arm 5 according to this embodiment is formed from only an arm main body 25, and has no connecting portion 26 used when employing the first embodiment.

[0092] A slide portion 32 of the thrust generation mechanism 11 according to this embodiment is formed from a first slider 72 and a second slider 73, which are formed separately from the cam follower 34, and a plurality of functional portions provided on each of the sliders 72 and 73. The first slider 72 and the second slider 73 are formed to be symmetrical to each other with respect to a plane of symmetry formed by a virtual plane orthogonal to the axis of the rocker arm 5. Through holes 74 to pass the rocker shaft 6 (see Fig. 15) are formed in the first slider 72 and the second slider 73. The first slider 72 and the second slider 73 are supported by a rocker shaft 6 to be pivotal and movable in the axial direction.

[0093] The functional portions provided on the first slider 72 and the second slider 73 are a first inclined cam face 35 and a second inclined cam face 36 (see Fig. 16), and a first concave groove 37 and a second concave groove 38 (see Fig. 15). In this embodiment, inclined cam faces and concave grooves located on laterals of the first slider 72 and the second slider 73 close to each other will be referred to as the first inclined cam faces 35 and the first concave grooves 37 for the descriptive convenience. In addition, inclined cam faces and concave grooves located on the other laterals of the first slider 72 and the second slider 73 will be referred to as the second inclined cam faces 36 and the second concave grooves 38.

[0094] As shown in Fig. 13, an outer concave portion 75 configured to hold the rocker arm 5 and an inner concave portion 77 configured to receive a boss 76 of the cam follower 34 (to be described later) are formed in each of the first slider 72 and the second slider 73 according to this embodiment.

[0095] The outer concave portion 75 is formed into such a shape that allows the swing of the rocker arm 5 and regulate the movement of the rocker arm 5 in the axial direction relative to the first slider 72 and the second slider 73.

[0096] The rocker arms 5 are swingably supported by the first slider 72 and the second slider 73 via the rocker shaft 6 by inserting the rocker shaft 6 into the through holes 74 of the sliders 72 and 73 and shaft holes 78 of the rocker arms 5 in a state in which the proximal portions are inserted in the outer concave portions 75. The rocker arm 5 supported by the first slider 72 moves in the axial direction of the rocker shaft 6 together with the first slider 72. The rocker arm 5 supported by the second slider 73 moves in the axial direction of the rocker shaft 6 together with the second slider 73.

[0097] As shown in Fig. 13, the cam follower 34 according to this embodiment includes the cylindrical boss 76 through which the rocker shaft 6 passes, a lever 79 extending from the boss 76 in the radial direction of the rocker shaft 6, and a first connecting piece 80 and a second connecting piece 81 which extend from the lever 79 in the axial direction of the rocker shaft 6. The boss 76, the lever 79, the first connecting piece 80, and the second connecting piece 81 are integrally formed by integral molding.

[0098] The hollow portion of the boss 76 is formed into a shape that allows the rocker shaft 6 to be rotatably fitted in. The length of the boss 76 in the axial direction is larger than the width (the width in the axial direction of the rocker shaft 6) of the lever 79. The lever 79 is located at the center of the boss 76 in the axial direction. For this reason, the two ends of the boss 76 project from the lever 79 in the axial direction. As shown in Fig. 18, the projecting portions are stored in the inner concave portions 77 of the first slider 72 and the second slider 73 when the first slider 72 and the second slider 73 approach each other.

[0099] The first connecting piece 80 and the second connecting piece 81 are configured to regulate the swing motion of the cam follower 34 relative to the sliders 72 and 73, and provided at different positions in the swing direction of the cam follower 34. As shown in Fig. 14, the first connecting piece 80 is located on the downstream side of the lever 79 in the swing direction of the cam follower 34. Here, the downstream side is the downstream side in a swing direction A when the cam follower 34 is pressed by the synchronous cam 24 and swings. The first connecting piece 80 comes into contact with pressure receiving portions 82 provided on the first slider 72 and the second slider 73 from the upstream side in the above-described swing direction. That is, when the cam follower 34 is pressed by the synchronous cam 24 and swings, the pressing force is transmitted from the cam follower 34 to the first slider 72 and the second slider 73 via the contact portions between the first connecting piece 80 and the pressure receiving portions 82.

[0100] The second connecting piece 81 is located on the upstream side of the first connecting piece 80 in the above-described swing direction A. The second connecting piece 81 comes into contact with transmitting portions 83 provided on the first slider 72 and the second slider 73 from the downstream side in the above-described swing direction A. That is, when the first slider 72 and the second slider 73 are pressed by third pins 44 (to be described later) and swing, the pressing force is transmitted from the first slider 72 and the second slider 73 to the cam follower 34 via the contact portions between the second connecting piece 81 and the transmitting portions 83.

[0101] As shown in Fig. 16, each of the first connecting piece 80 and the second connecting piece 81 has a length to contact the pressure receiving portion 82 or transmitting portion 83 in a state in which the first slider 72 and the second slider 73 move to maximum moving positions in a direction in which they are separated from each other. Hence, the cam follower 34, the first slider 72, and the second slider 73 always integrally swing.

[0102] As shown in Figs. 15 and 16, a switching portion 33 of the thrust generation mechanism 11 according to this embodiment includes a first pin 41 and a second pin 42 for each slider, one moving member 43 including first pin cams 47 and second pin cams 48 configured to drive the pins 41 and 42, and a third pin 44 for each slider.

[0103] The first pin 41 is arranged at a position facing the first inclined cam face 35, and the second pin 42 is arranged at a position facing the second inclined cam face 36.

[0104] The first pin cam 47 and the second pin cam 48 of the moving member 43 are provided for each slider. The first pin cam 47 and the second pin cam 48 according to this embodiment employ an arrangement for moving the first slider 72 and the second slider 73 in directions opposite to each other. More specifically, when the moving member 43 moves from the position on the other end side shown in Fig. 19 to the position on the one end side shown in Fig. 16, the first pin cam 47 moves the first pin 41 from the retreating position to the advancing position.

[0105] When the moving member 43 moves from the position on the one end side shown in Fig. 16 to the position on the other end side shown in Fig. 19, the second pin cam 48 moves the second pin 42 from the retreating position to the advancing position. In this embodiment as well, the first pin cam 47 and the second pin cam 48 employ an arrangement capable of, when one of the first pin 41 and the second pin 42 is located at the advancing position, moving the other pin to the retreating position.

[0106] In the valve gear 71 for an engine according to this embodiment, when the moving member 43 moves from the position on the one end side shown in Fig. 16 to the position on the other end side shown in Fig. 19, the second pin 42 moves from the retreating position to the advancing position, and the first slider 72 and the second slider 73 are moved to positions at which they are in contact with each other, as shown in Fig. 19, by a thrust acting on the second inclined cam faces 36. At this time, the third pins 44 move from the first concave grooves 37 of the first slider 72 and the second slider 73 into the second concave grooves 38.

[0107] When the first slider 72 and the second slider 73 move in this way, the rocker arms 5 contact the first cams 22, and the intake valves 4 are driven by the first

cams 22, as shown in Figs. 17 and 18.

[0108] On the other hand, when the moving member 43 moves from the position on the other end side shown in Fig. 19 to the position on the one end side shown in Fig. 16, the first pin 41 moves to the advancing position, and the first slider 72 and the second slider 73 are moved in directions in which they separate from each other, as shown in Fig. 16, by a thrust acting on the first inclined cam faces 35. At this time, the third pins 44 move from the second concave grooves 38 of the sliders 72 and 73 into the first concave grooves 37. When the first slider 72 and the second slider 73 move in this way, the rocker arms 5 contact the second cams 23, and the intake valves 4 are kept in the closed state, as shown in Figs. 14 and 15.

[0109] For this reason, according to this embodiment, it is possible to provide a valve gear for an engine capable of switching between the first operation mode in which the intake valves 4 operate and the second operation mode in which the intake valves 4 are at rest.

(Fourth Embodiment)

[0110] A slider and a cam follower in a valve gear according to the present invention can be formed as shown in Figs. 20 to 23. The same reference numerals as in Figs. 1 to 12 denote the same or similar members in Figs. 20 to 23, and a detailed description thereof will appropriately be omitted.

[0111] A valve gear 91 for an engine according to this embodiment is different from the valve gear 61 described in the second embodiment (Figs. 10 to 12) in the structures of a cam follower 34 and a slider 31. The rest of the arrangement of the valve gear 91 is the same as in the valve gear 61 described in the second embodiment. As for the cam follower 34 according to this embodiment, the movement in the axial direction is regulated by a stopper 65 (see Fig. 21). Two rocker arms 5 per cylinder are arranged on both sides of a slider 92 (see Fig. 23) according to this embodiment, and swingably supported by one tubular shaft 93 together with the slider 92.

[0112] The tubular shaft 93 is inserted into shaft holes 94 of the two rocker arms 5 and through holes 64 of the slider 92 and extends through these members. A rocker shaft 6 is fitted in the hollow portion of the tubular shaft 93. The tubular shaft 93 is supported by the rocker shaft 6 to be rotatable and movable in the axial direction. The two rocker arms 5 and the slider 92 are mounted on the tubular shaft 93 in a state in which they are in contact with each other in the axial direction of the tubular shaft 93. Circlips 95 are attached to the two ends of the tubular shaft 93 in a state in which the circlips 95 are in contact with the rocker arms 5. That is, the two rocker arm 5, the slider 92, and the tubular shaft 93 can integrally move relative to the rocker shaft 6 in the axial direction.

[0113] Each rocker arm 5 according to this embodiment includes a roller 96 that contacts a first cam 22 or a second cam 23.

[0114] The slider 92 according to this embodiment is different from the slider 31 described in the second embodiment in the position of a convex portion 39 including a first inclined cam face 35, a second inclined cam face 36, a first concave groove 37, and a second concave groove 38. The convex portion 39 extends almost in parallel to a cylinder axis C (see Fig. 1) to the opposite side of a combustion chamber 18, and is formed into a shape conforming to the cam follower 34. The first inclined cam face 35, the second inclined cam face 36, the first concave groove 37, and the second concave groove 38 are formed on the lateral side of the convex portion 39 opposite to the cam follower 34. For this reason, a switching portion 33 of a thrust generation mechanism 11 is disposed at the same position as the cam follower 34 in the axial direction (the vertical direction in Fig. 21) of the cylinder.

[0115] The slider 92 includes a pressure receiving portion 97 (see Figs. 21 and 23) and a transmitting portion 98 to regulate a swing relative to the cam follower 34. The pressure receiving portion 97 contacts an intermediate portion 34c (see Fig. 23) located between a swing end 34b and the swing center of the cam follower 34 (the axis of the rocker shaft 6). The transmitting portion 98 contacts the other swing end 34d (see Fig. 23) located on the opposite side of the swing end 34b with respect to the swing center of the cam follower 34.

[0116] In the valve gear 91 for an engine according to this embodiment, since the switching portion 33 of the thrust generation mechanism 11 is provided at the same position as the cam follower 34 in the axial direction of the cylinder, a wide space to arrange other members is formed between the rocker arm 5 and the combustion chamber 18.

Explanation of the Reference Numerals and Signs

[0117] 1, 61, 71, 91...valve gear, 2...cylinder head, 3...camshaft, 4...intake valve, 5...rocker arm, 6...rocker shaft, 11...trust generation mechanism, 12...exhaust valve, 22...first cam, 23...second cam, 24...synchronous cam, 31, 93...slider, 32...slide portion, 33...switching portion, 34...cam follower, 35...first inclined cam face, 36...second inclined cam face, 41...first pin (first switching member), 42...second pin (second switching member), 43...moving member, 47...first pin cam, 43...second pin cam, 72...first slider, 73...second slider.

Claims

1. A valve gear for an engine, comprising:

a camshaft rotatably supported by a cylinder head;

a first cam provided on the camshaft and configured to drive one of an intake valve and an exhaust valve;

a second cam provided on the camshaft to be

arranged with the first cam in an axial direction, and configured to drive one of the intake valve and the exhaust valve, the second cam formed into a shape with a cam profile different from the first cam;
a synchronous cam provided on the camshaft and configured to rotate in synchronism with the first cam and the second cam;
a rocker shaft parallel to the camshaft;
a rocker arm supported by the rocker shaft to be swingable and movable in the axial direction and configured to convert a rotation of one of the first cam and the second cam into a reciprocal motion and transmit the reciprocal motion to one of the intake valve and the exhaust valve;
a cam follower swingably supported by the rocker shaft and configured to come into contact with the synchronous cam; and
a thrust generation mechanism configured to convert swing motion of the cam follower into a thrust in the axial direction and move the rocker arm to one of one side and the other side in the axial direction.

2. The valve gear for the engine according to claim 1, wherein the thrust generation mechanism comprises:

a slide portion configured to swing integrally with the cam follower and move in the axial direction integrally with the rocker arm; and
a switching portion supported by the cylinder head and including a first switching member and a second switching member, wherein the first switching member and the second switching member configured to selectively come into contact with the slide portion, and

the slide portion comprises:

a first inclined cam face that receives a force in one side thereof in the axial direction, wherein the fore is generated by one switching member of the first switching member and the second switching member is in contact with the first inclined cam face; and
a second inclined cam face that receives a force in the other side thereof in the axial direction, wherein the force is generated by the other switching member of the first switching member and the second switching member is in contact with the second inclined cam face.

3. The valve gear for the engine according to claim 2, wherein a movement of the cam follower in the axial direction is regulated, and
the slide portion is formed separately from the cam follower and is movable in the axial direction relative to the cam follower.

4. The valve gear for the engine according to claim 2 or 3, wherein each of the first switching member and the second switching member is formed by a pin configured to move between an advancing position at which one end of the pin comes into contact with the slide portion and a retreating position at which the one end of the pin separates from the slide portion, the other end of the pin abuts against a pin cam of a moving member configured to move in a direction orthogonal to a direction in which the pin moves, and the pin cam is formed into a shape with which when the moving member moves to one side, the first switching member moves to the advancing position, and the second switching member moves to the retreating position, and when the moving member moves to the other side, the first switching member moves to the retreating position, and the second switching member moves to the advancing position.

FIG.1

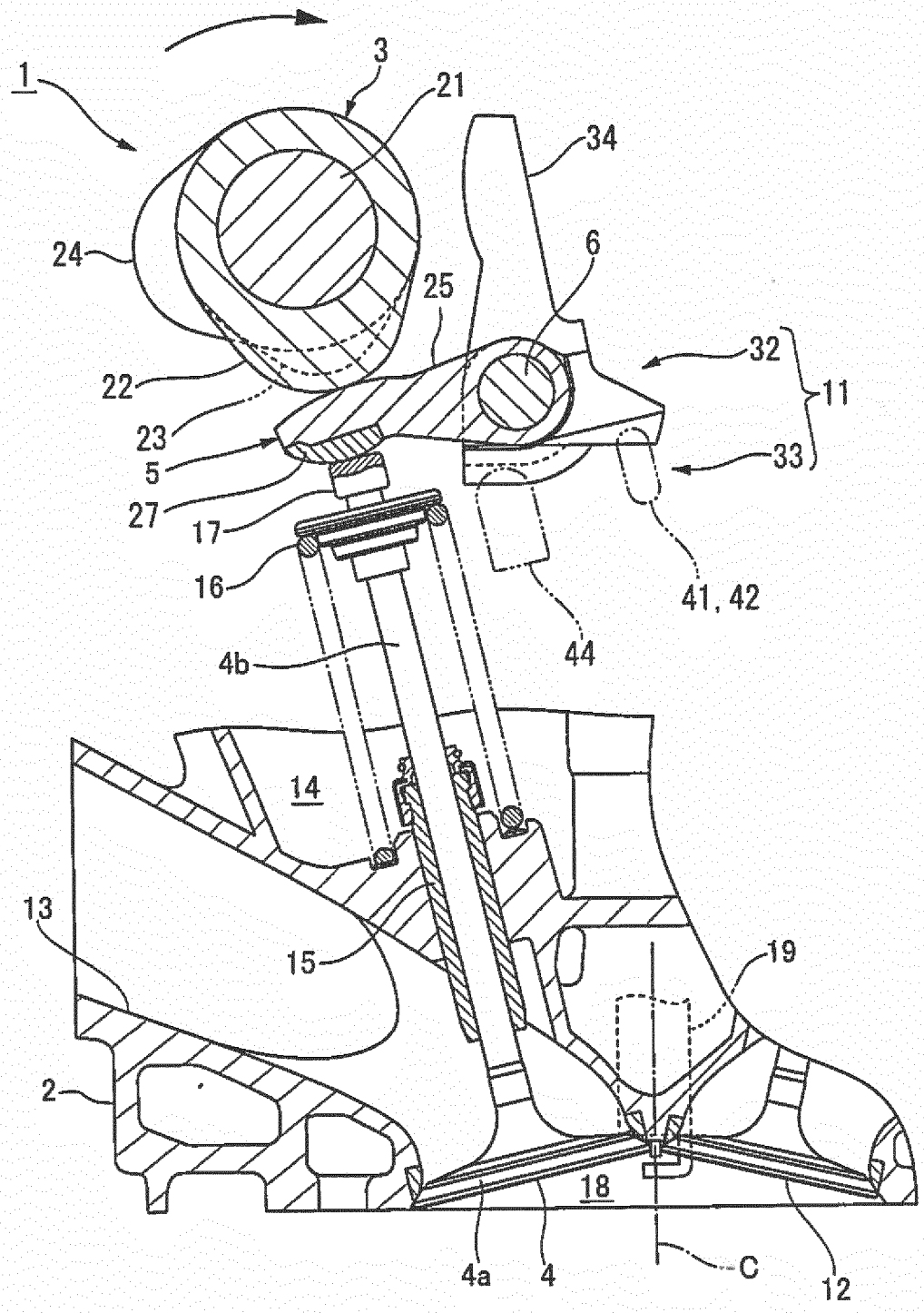

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FIG.2

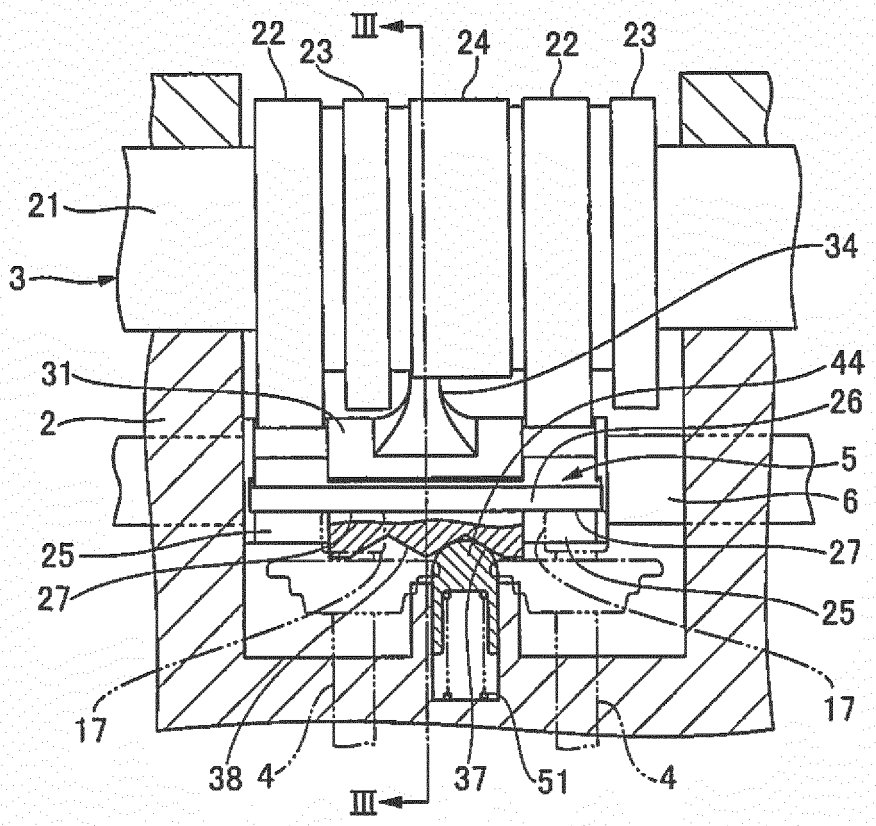

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III

FIG.3

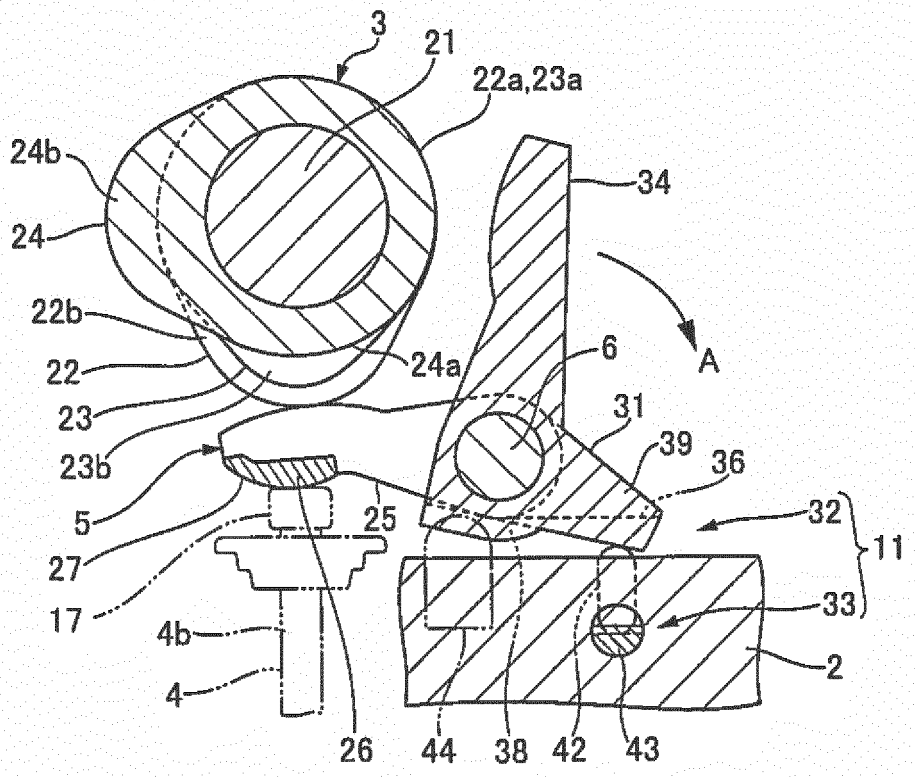

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FIG.4

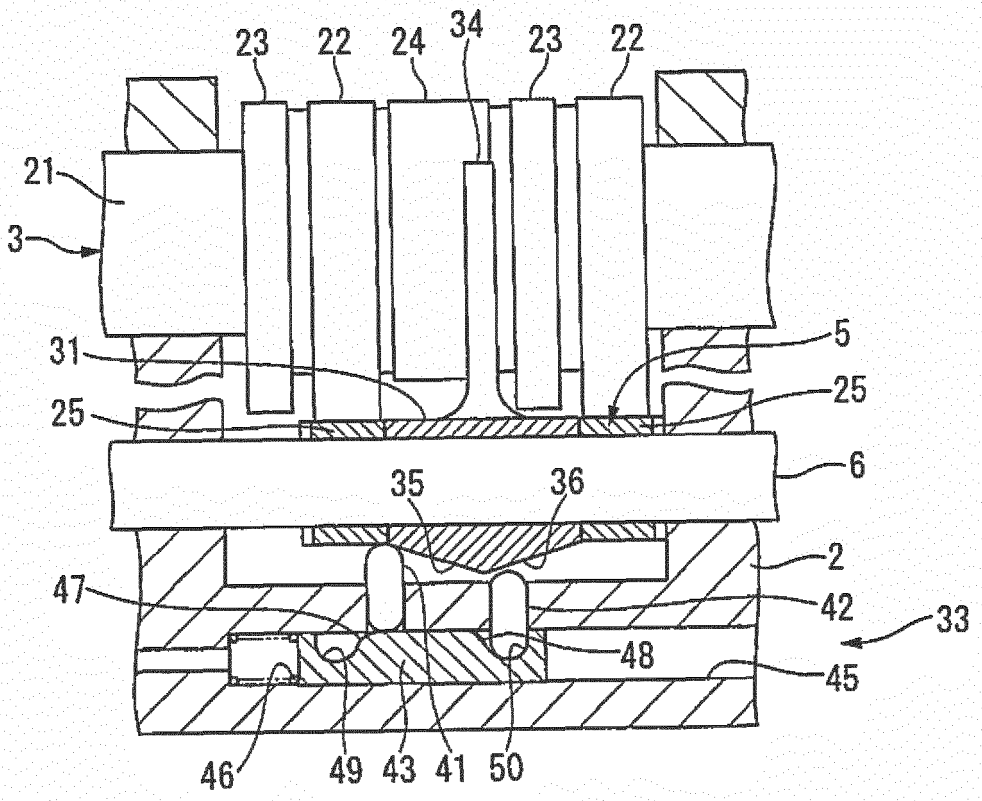


FIG.5A

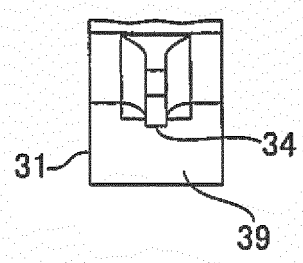


FIG.5B

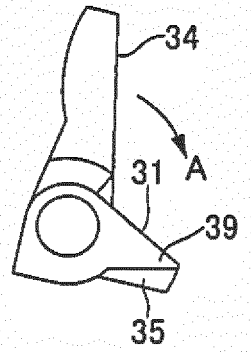


FIG.5C

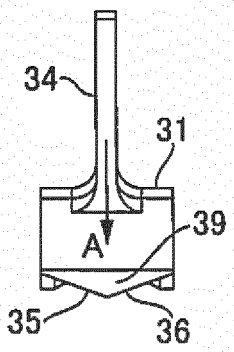


FIG.5D

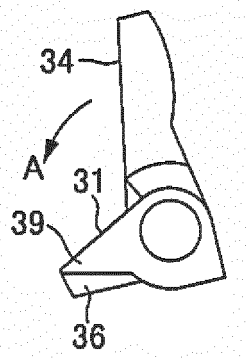


FIG.5E

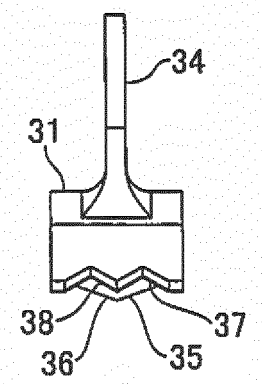


FIG.5F

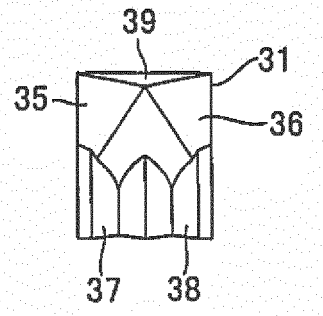


FIG.5G

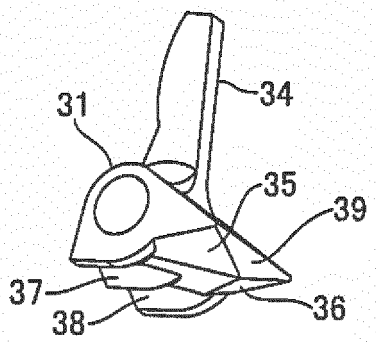


FIG.6A

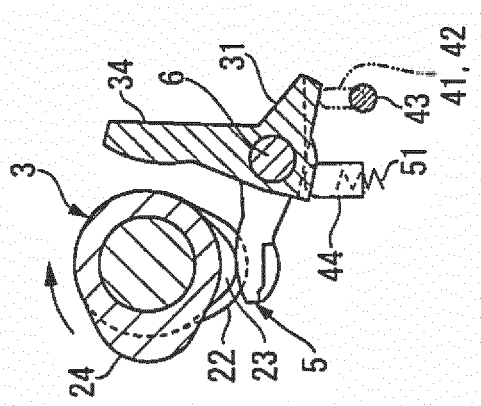


FIG.6B

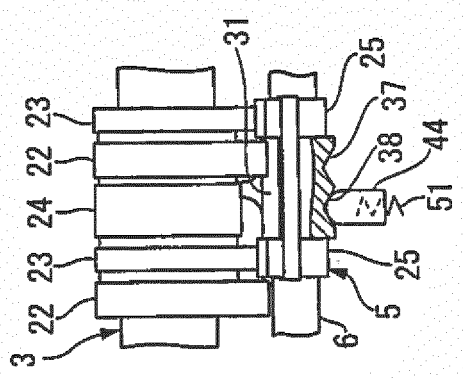


FIG.6C

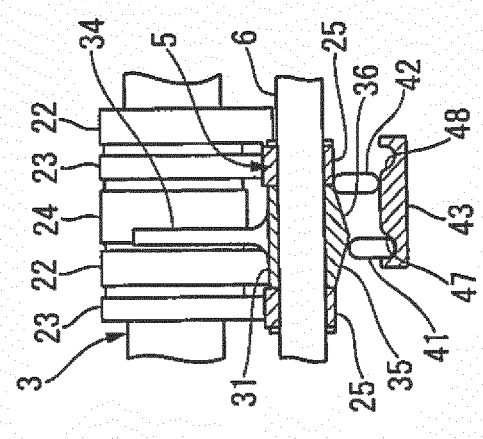


FIG.7A

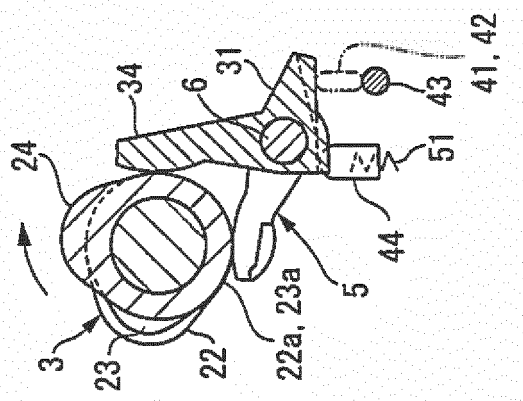


FIG.7B

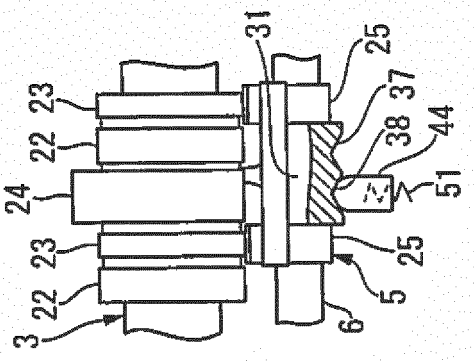


FIG.7C

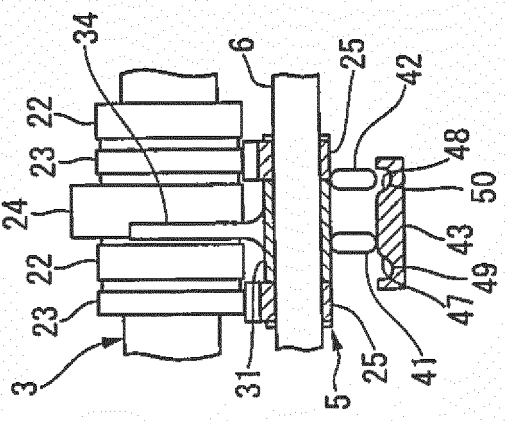


FIG.8A

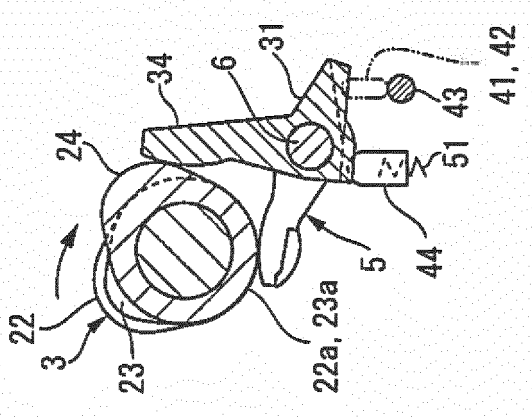


FIG.8B

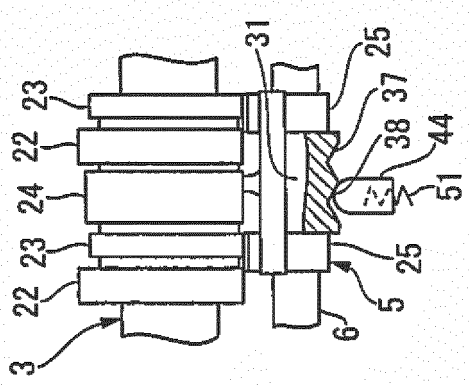


FIG.8C

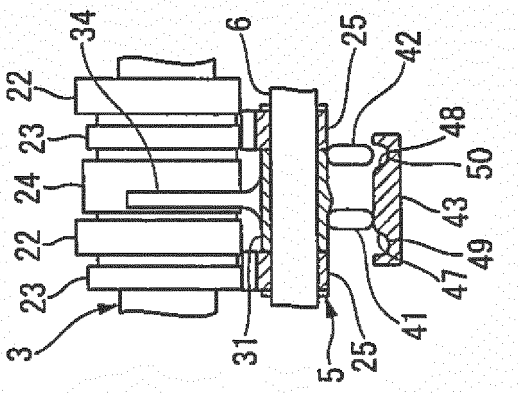


FIG.9A

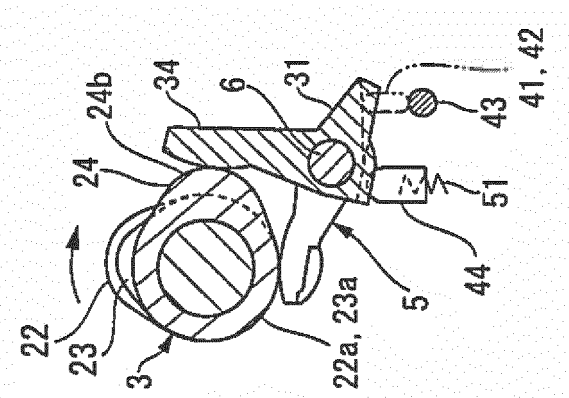


FIG.9B

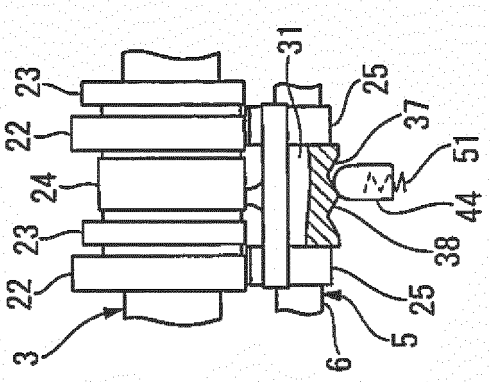


FIG.9C

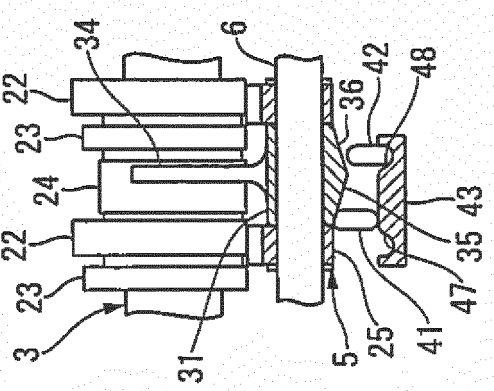


FIG.10

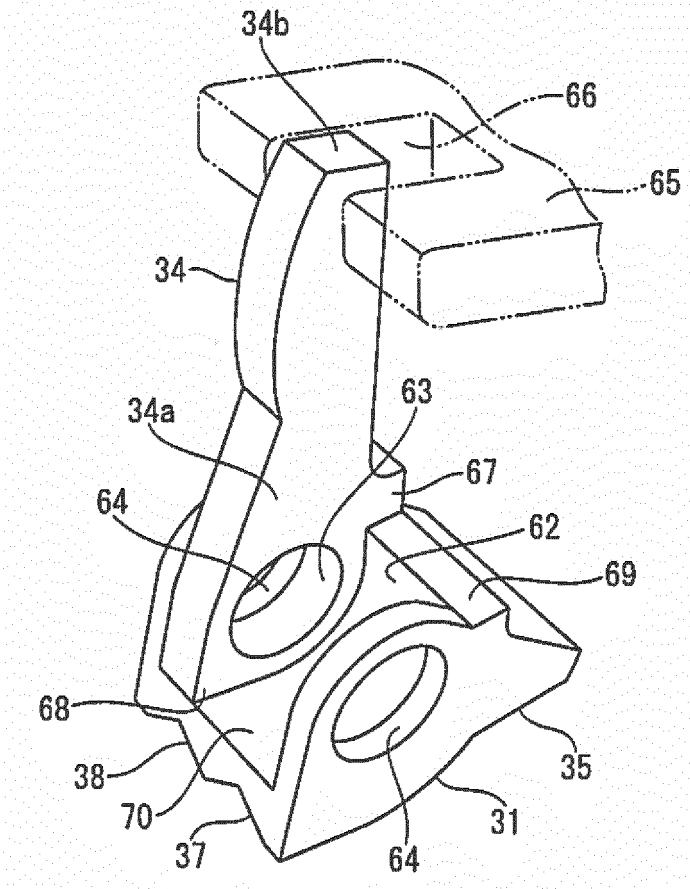


FIG.11

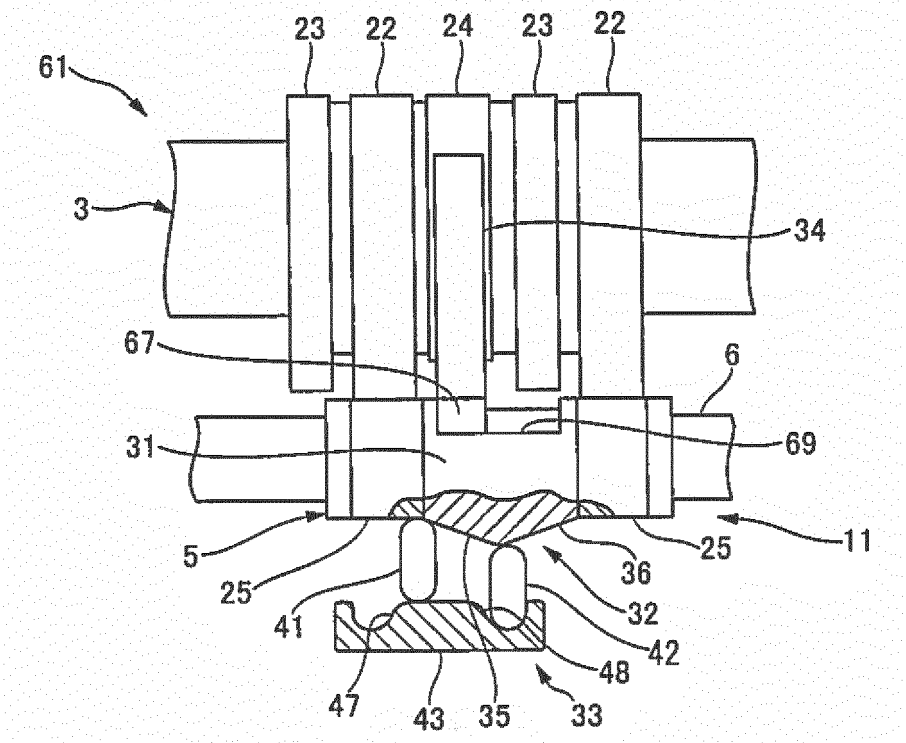


FIG.12

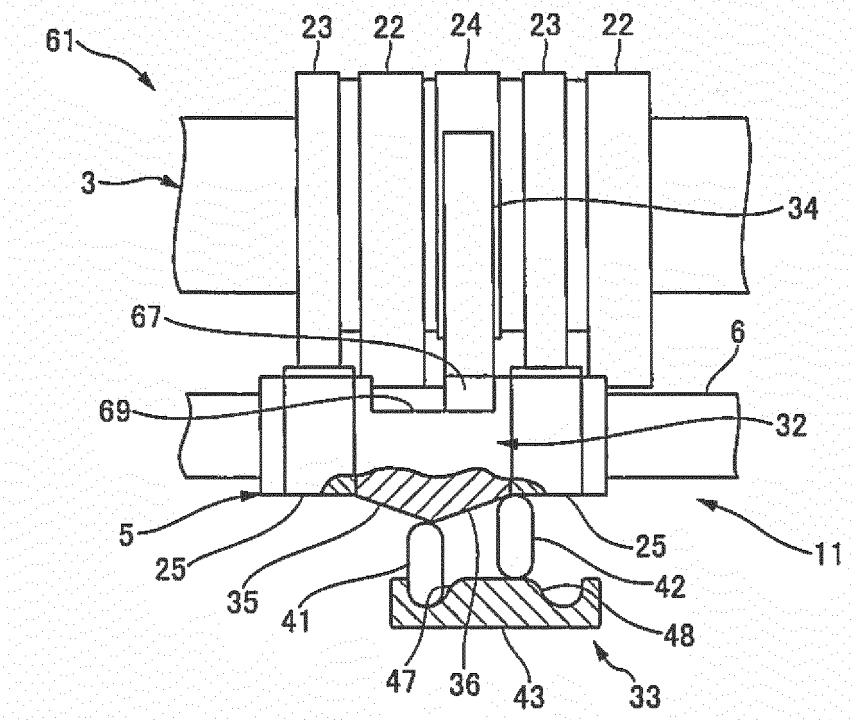


FIG.13

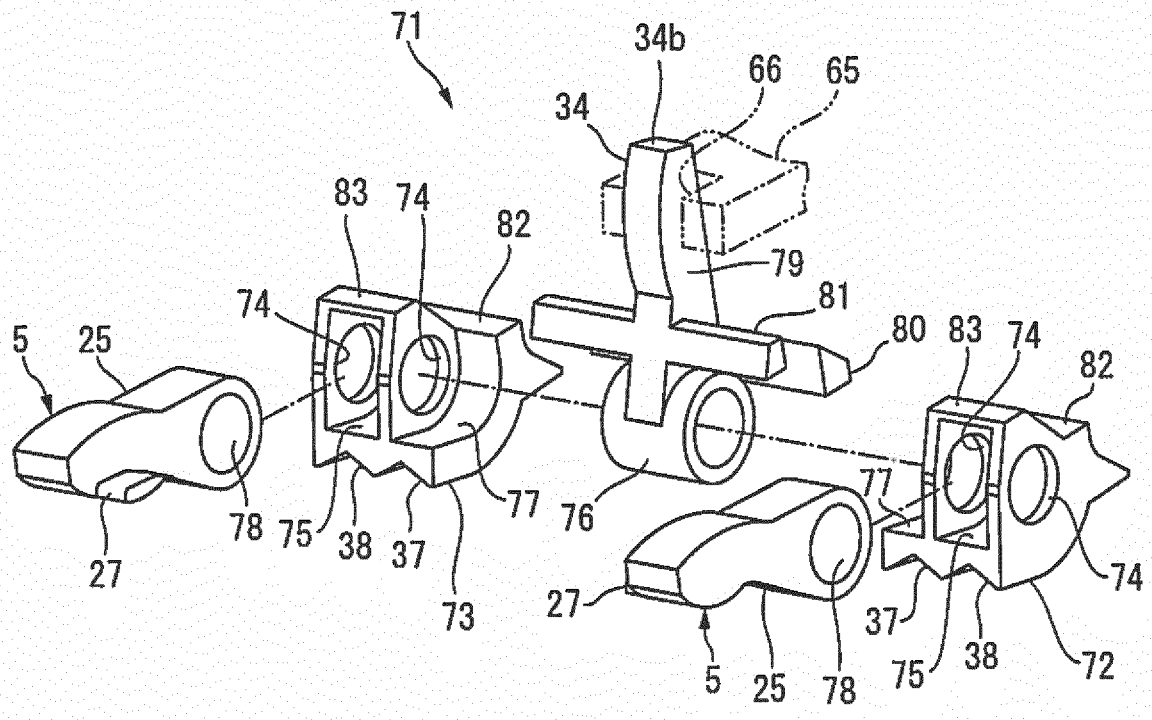

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FIG.14

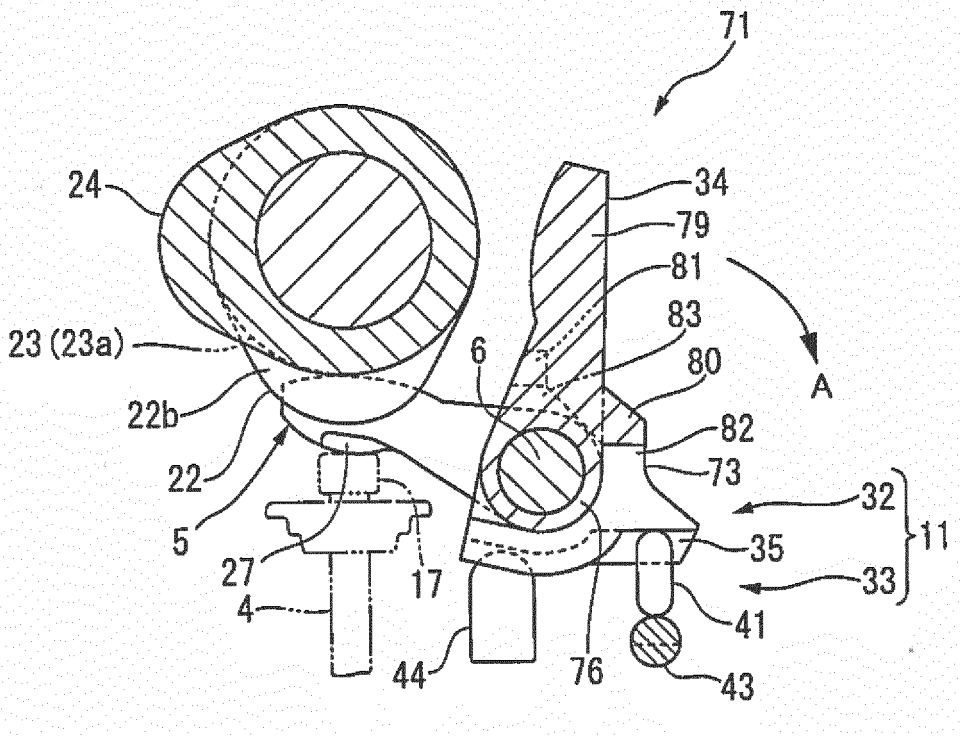

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FIG.15

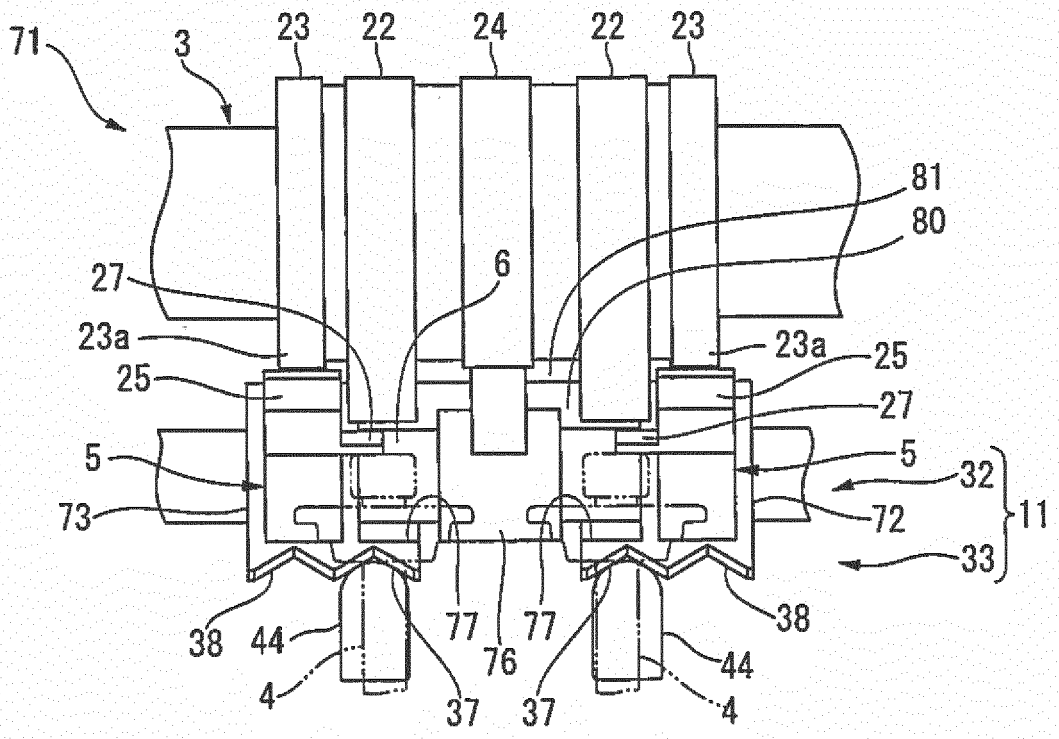

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FIG.16

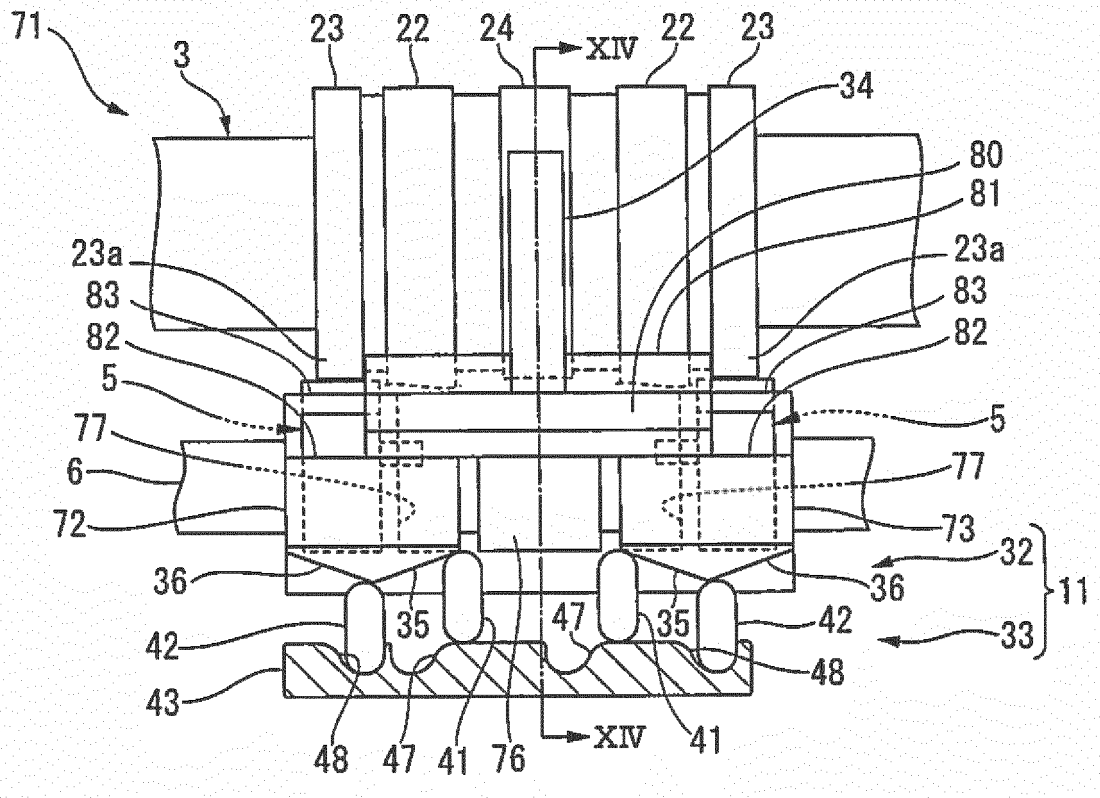

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FIG.17

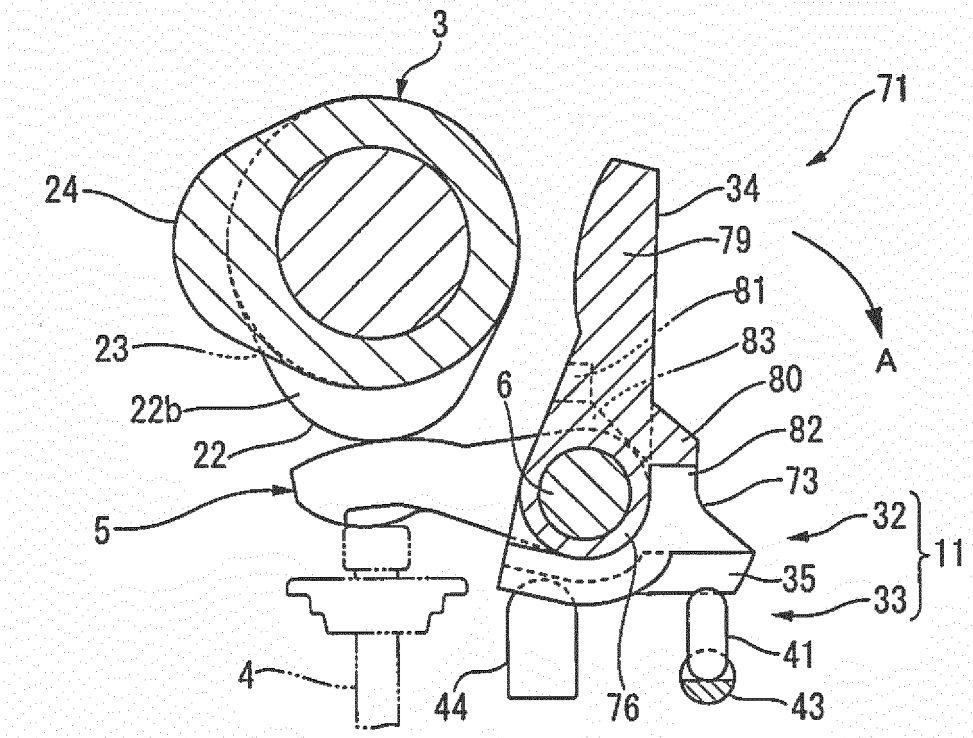


FIG.18

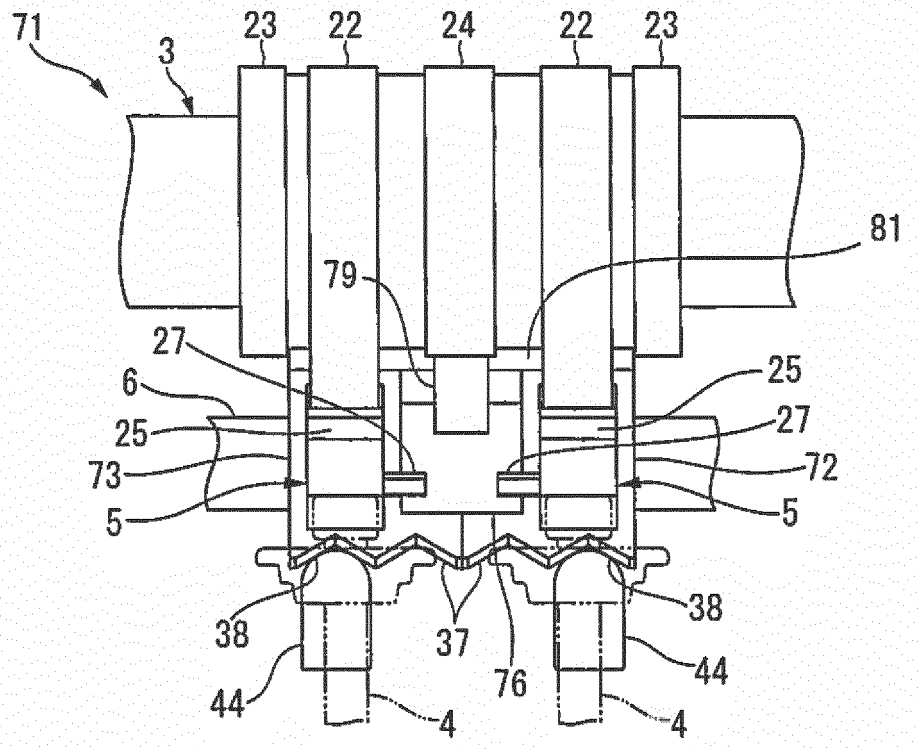


FIG.19

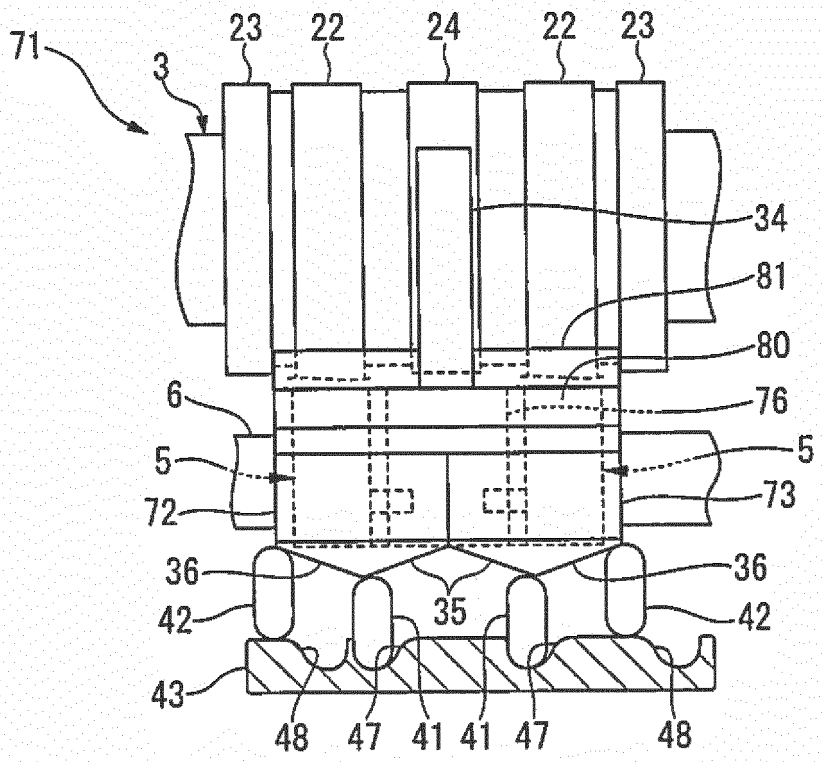

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FIG.20

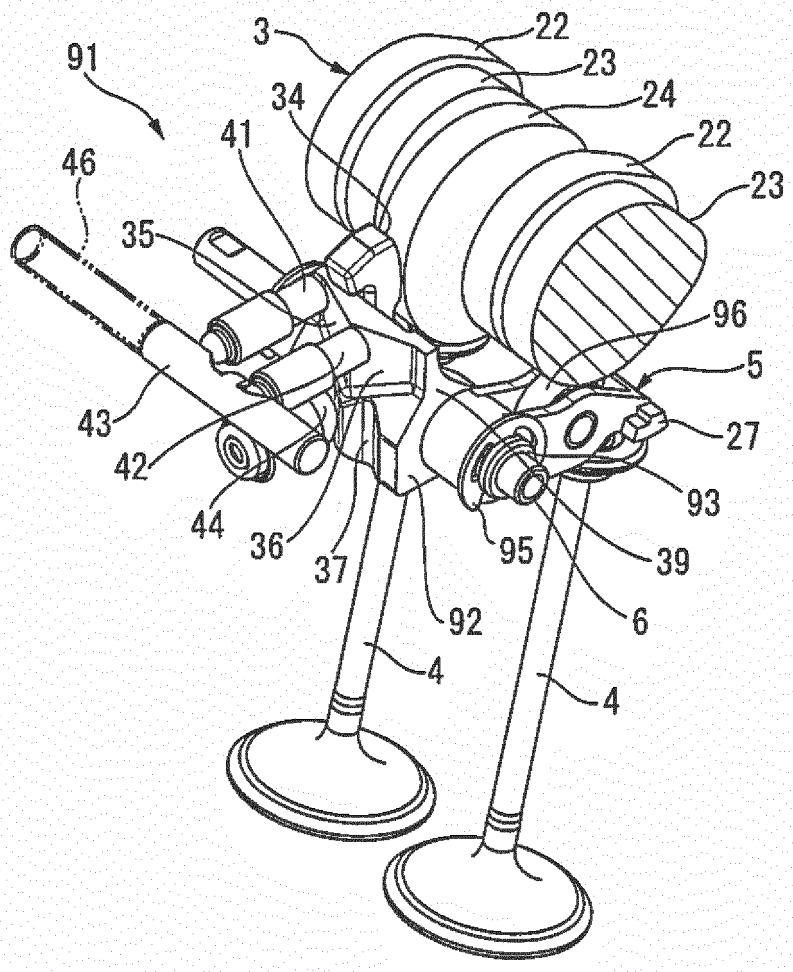


FIG.21

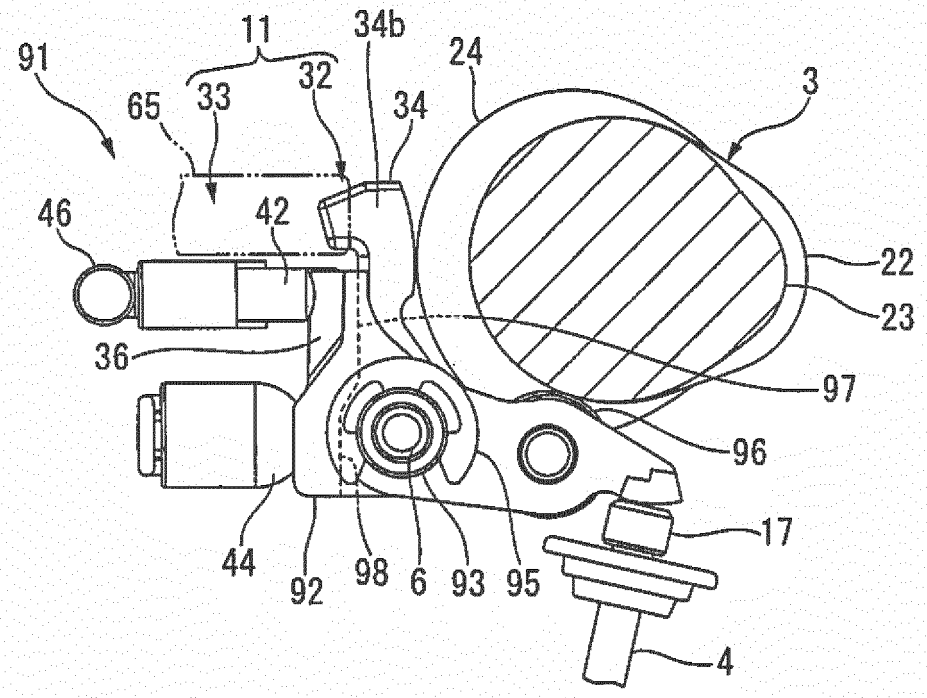


FIG.22

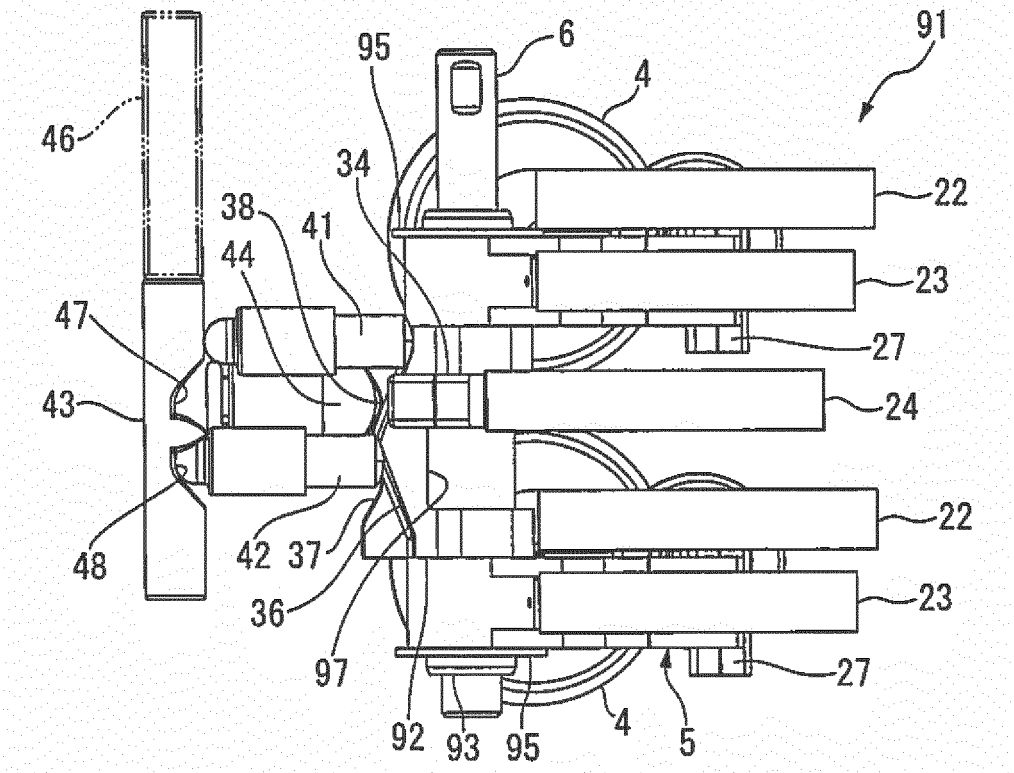
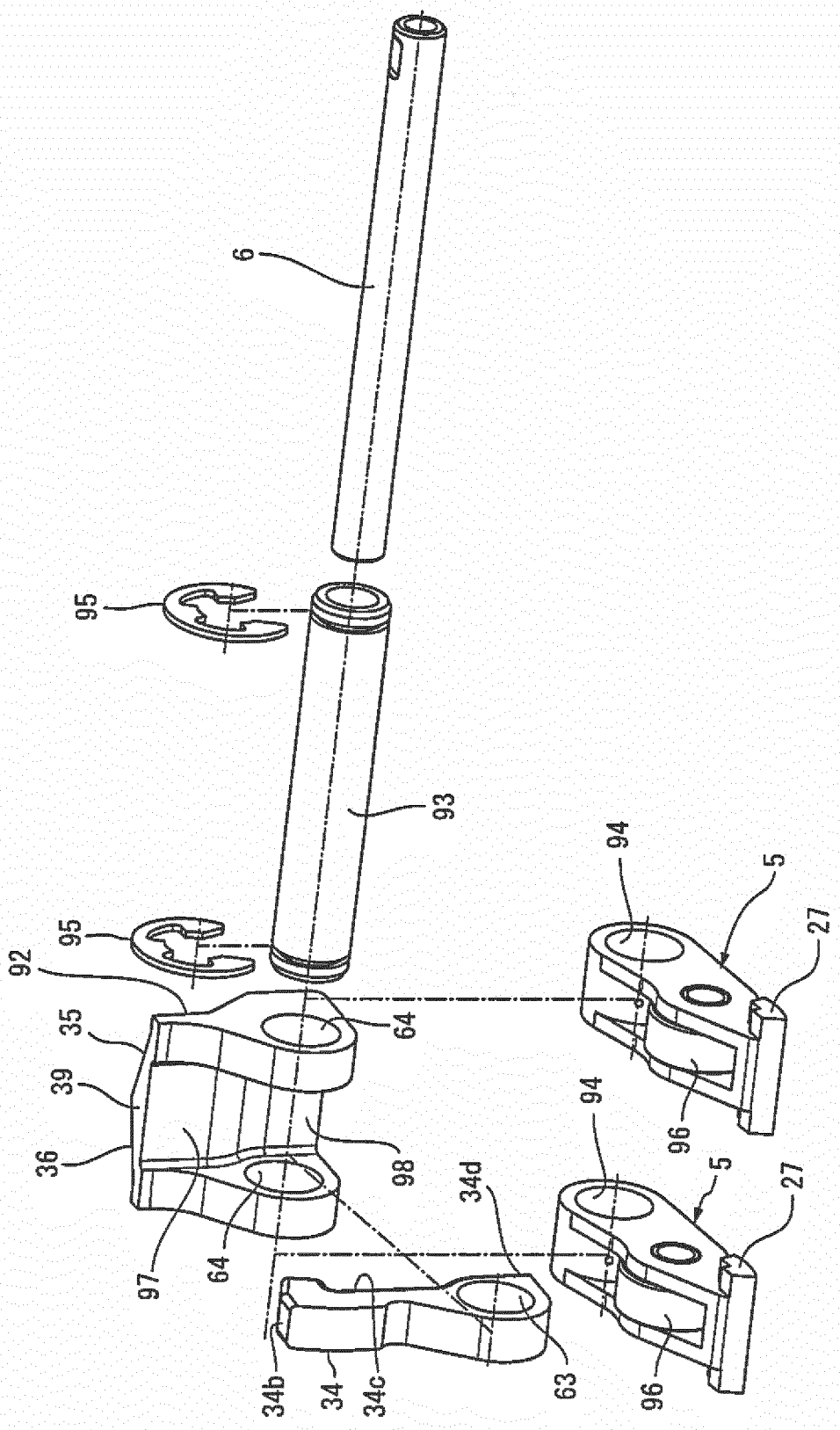

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FIG.23


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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/081966

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 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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.
A	JP 2008-248872 A (Honda Motor Co., Ltd.), 16 October 2008 (16.10.2008), claims; paragraphs [0013] to [0084]; fig. 1 to 7 & US 2008/0236531 A1 claims; paragraphs [0027] to [0127]; fig. 7B & DE 102008015216 A1	1-4
A	JP 60-62613 A (Nippon Soken, Inc.), 10 April 1985 (10.04.1985), claims; page 4, lower left column, line 15 to page 5, lower right column, line 1; page 5, lower right column, line 19 to page 6, upper left column, line 2; fig. 1 to 6 (Family: none)	1-4

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

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2016 (12.01.16)	26 January 2016 (26.01.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/081966

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2011/043301 A1 (Yamaha Motor Co., Ltd.), 14 April 2011 (14.04.2011), claims; paragraphs [0023] to [0077]; fig. 1 to 9 & JP 5615828 B2 & US 2012/0204824 A1 claims; paragraphs [0050] to [0124]; fig. 1 to 9 & EP 2487341 A1	1-4

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Patent documents cited in the description

- JP 2010249123 A **[0010]**