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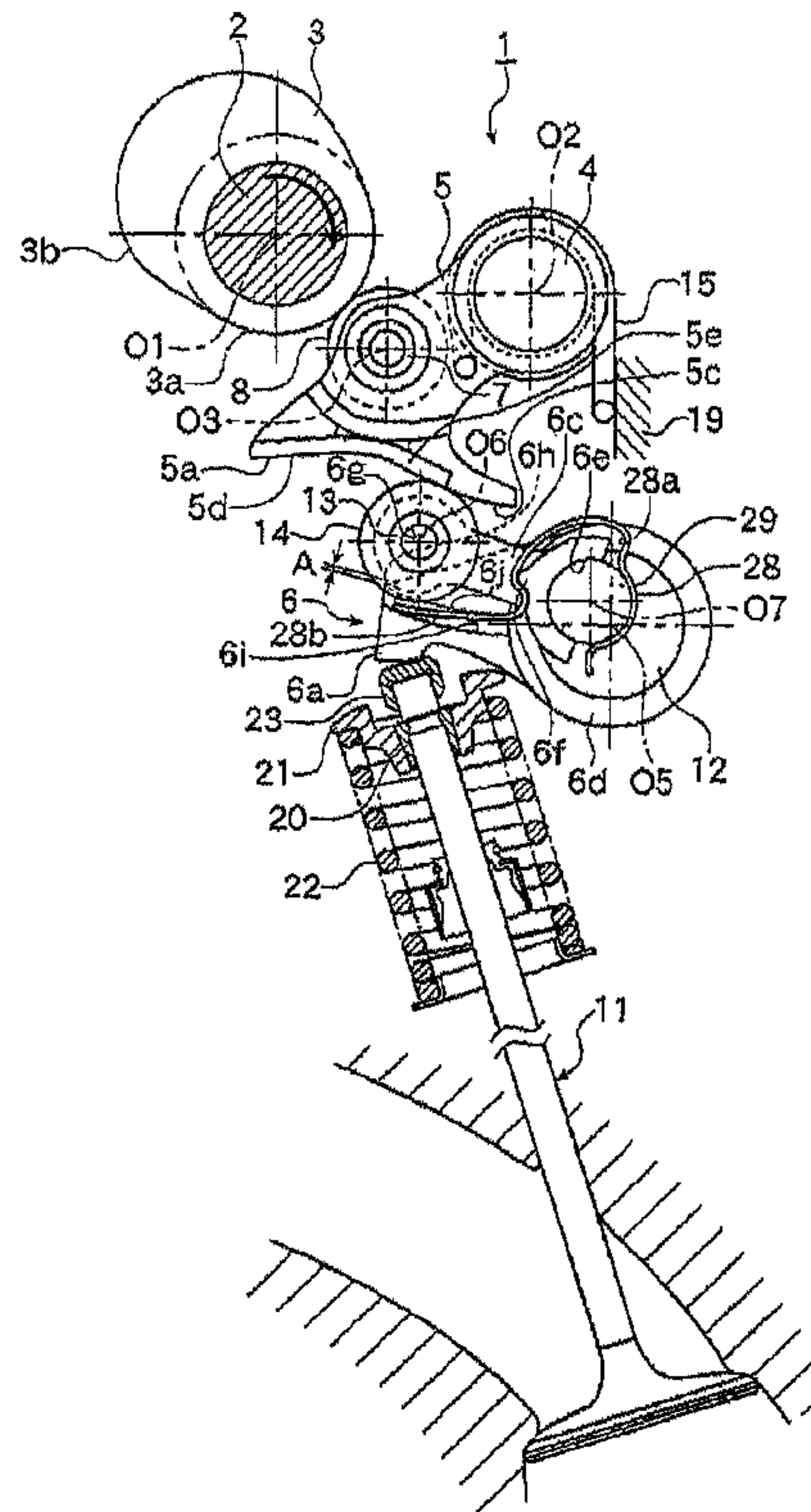
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(54) Title: VALVE MECHANISM FOR AN INTERNAL COMBUSTION ENGINE



(57) Abrégé/Abstract:

A valve gear of an internal combustion engine, wherein when a zone for one of the positive and negative accelerations of a rotating cam is set to be used by a ramp part, the ramp part is formed in a curved shape so that the lift amount of a swing cam per unit swing angle can generate the other positive or negative acceleration so that a valve lift speed at the portion of the valve corresponding to the ramp part is made generally constant.

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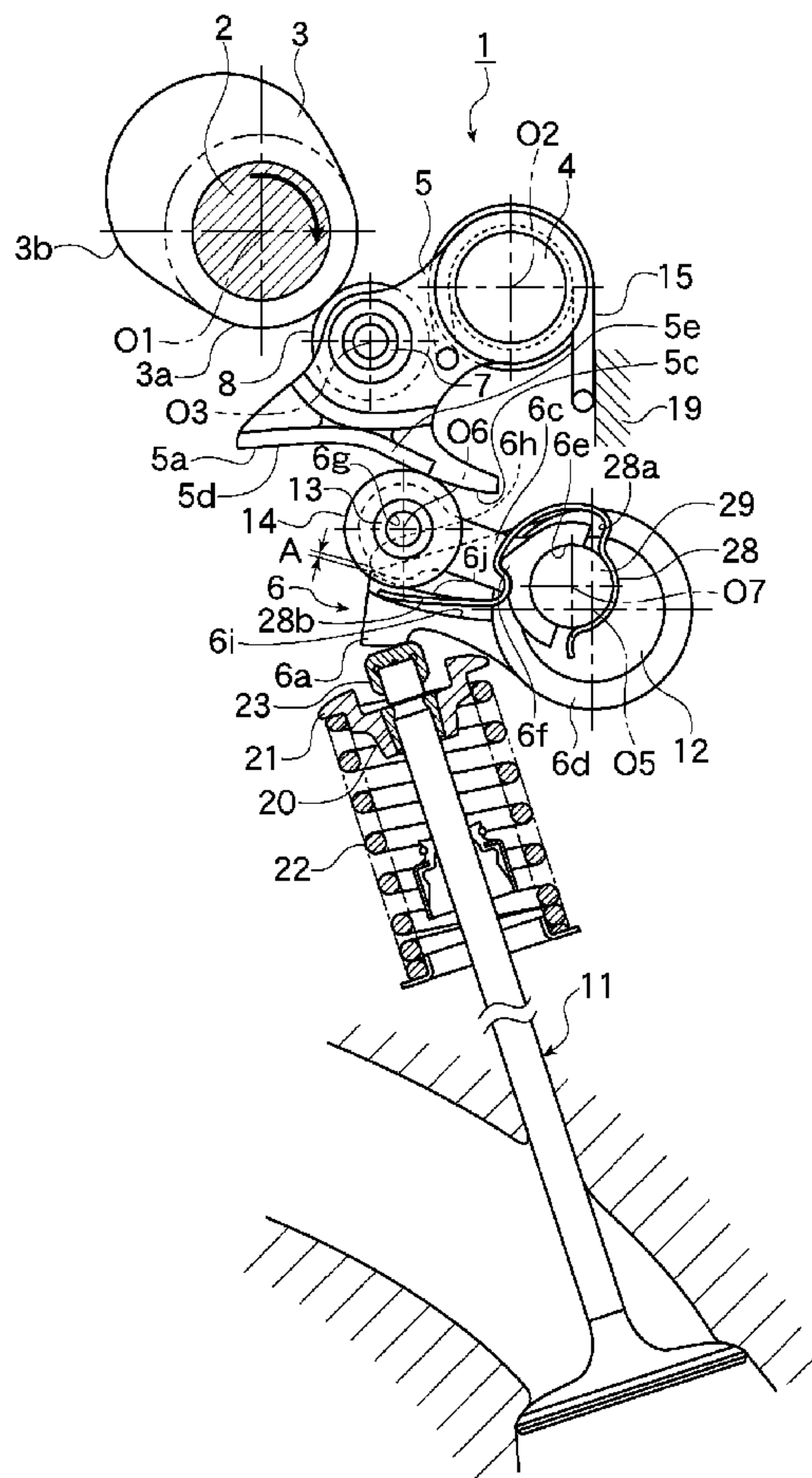
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(54) Title: VALVE GEAR OF INTERNAL COMBUSTION ENGINE

(54) 発明の名称: 内燃機関の動弁機構



(57) Abstract: A valve gear of an internal combustion engine, wherein when a zone for one of the positive and negative accelerations of a rotating cam is set to be used by a ramp part, the ramp part is formed in a curved shape so that the lift amount of a swing cam per unit swing angle can generate the other positive or negative acceleration so that a valve lift speed at the portion of the valve corresponding to the ramp part is made generally constant.

(57) 要約: 回転カムの正又は負の一方の加速度区間を、ランプ部が使用する設定において、ランプ部を揺動カムの単位揺動角あたりのリフト量が正又は負の他方の加速度を発生させるように曲線形状に形成し、ランプ部に対応する部分でのバルブリフト速度が略一定となるように構成した。

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SPECIFICATION

VALVE MECHANISM FOR AN INTERNAL COMBUSTION ENGINE

Technical Field

[0001]

The present invention relates to an improvement of a valve mechanism for opening and closing the intake valve or exhaust valve of an internal combustion engine.

Related Art

[0002]

Conventionally known examples of a valve mechanism of this type include one described in, for example, Patent Document 1. Patent Document 1 discloses an engine valve timing controller including: a drive cam having a tapered cam surface; and a rocking cam having a cam surface that comes into sliding contact with a valve and a cam follower that comes into sliding contact with the cam surface of the drive cam, in which the rocking cam is rocked by rotating the drive cam to thereby open/close the valve, and the valve timing is made variable by changing the relative axial positions of the drive cam and rocking cam.

[0003]

Further, the configurations of the cam surfaces of the drive cam and of the rocking cam are set in such a manner that a resultant acceleration of valve lift defined as the sum of the acceleration component due to the drive cam and the acceleration component due to the rocking cam does not change before and after the variable valve timing operation, and that a positive acceleration component in the cam surface of the rocking cam and a positive acceleration component in the cam surface of the drive cam do not overlap each other during the valve lift process but the positive acceleration component of the drive cam precedes the positive acceleration component of the rocking cam.

Patent Document 1: JP-B-3380582.

Disclosure of the Invention

Problem to be Solved by the Invention

[0004]

However, in the case of an arrangement which adopts the conventional structure as described above and which uses a shim, a screw, or the like to perform the positional adjustment of a manual lash adjustor, a valve clearance is set in advance, so a ramp portion (buffer section) becomes necessary at the time of valve lift. From the viewpoints of valve system noise and controllability of intake air amount, it is desired that the configuration of the ramp portion be set so as to exhibit a predetermined characteristic from large opening to small opening. However, since which range of the rotating cam is used differs between that at the time of large opening and that at the time of small opening, the range of the rotating cam to be used during use of the ramp portion also exhibits different characteristics between large opening and small opening settings. Accordingly, in cases where the ramp portion is used, it is difficult to impart the same valve opening/closing characteristic to the ramp portion of valve lift between the large opening and small opening settings.

[0005]

In view of this, it is an object of the present invention to provide a valve mechanism for an internal combustion engine which makes it possible to attain a desired characteristic even in the case of a setting in which the acceleration section of a rotating cam is used by the ramp portion of a rocking cam.

Means for Solving the Problem

[0006]

In order to solve the above-mentioned problem, the invention as described in Claim 1 provides a valve mechanism for an internal combustion engine, having a rotating cam rotated by a crankshaft of the internal combustion engine, and a rocking cam that is rockable by the rotating cam and has formed therein a cam surface for driving the intake valve or an exhaust valve, in which the cam surface of the rocking cam has a base circle portion, a lift portion, and a ramp portion connecting between the base circle portion and the lift portion, and wherein in a setting in which the ramp portion uses a section of one of positive and negative accelerations of the rotating cam, the ramp portion is formed in such a curved configuration allowing a lift amount per unit rocking angle of the rocking cam to

generate the other of positive and negative accelerations so that a lift speed of the valve in a portion corresponding to the ramp portion becomes substantially constant.

[0007]

The invention as described in Claim 2 provides a valve mechanism for an internal combustion engine, having a rotating cam rotated by a crankshaft of the internal combustion engine, and a rocking cam that is rockable by the rotating cam and has formed therein a cam surface for driving the intake valve or an exhaust valve, the valve mechanism being adapted to make a lift amount of the intake valve or the exhaust valve variable, in which the cam surface of the rocking cam has a base circle portion, a lift portion, and a ramp portion connecting between the base circle portion and the lift portion, and in a setting in which the ramp portion uses a section of one of positive and negative accelerations of the rotating cam, the ramp portion is formed in such a curved configuration allowing a lift amount per unit rocking angle of the rocking cam to generate the other of positive and negative accelerations so that a lift speed of the valve in a portion corresponding to the ramp portion becomes substantially constant.

[0008]

In the invention as described in Claim 3, in addition to the construction as described in Claim 2, in a setting in which the ramp portion uses a negative acceleration section of the rotating cam under a state where the lift amount is variably controlled to be within a minimum range, the ramp portion is formed in a curved configuration so as to generate positive acceleration so that the lift speed of the valve in the portion corresponding to the ramp portion becomes substantially constant.

[0009]

In the invention as described in Claim 4, in addition to the construction as described in Claim 2, in a setting in which the ramp portion uses a positive acceleration section of the rotating cam under a state where the lift amount is variably controlled to a maximum range, the ramp portion is formed in a curved configuration so as to generate negative acceleration so that the lift speed of the valve

in the portion corresponding to the ramp portion becomes substantially constant.

[0010]

The invention as described in Claim 5 provides a valve mechanism for an internal combustion engine, having a rotating cam rotated by a crankshaft of the internal combustion engine, and a rocking cam that is rockable by the rotating cam and has formed therein a cam surface for driving the intake valve or an exhaust valve, the valve mechanism being adapted to make a lift amount of the intake valve or the exhaust valve variable, in which the cam surface of the rocking cam has a base circle portion, a lift portion, and a ramp portion connecting between the base circle portion and the lift portion, and in a setting in which the ramp portion uses one of positive and negative acceleration sections of the rotating cam, a lever ratio of the rocking cam or a rocker arm pressed by the rocking cam increases as the lift amount is variably controlled to be within a minimum range.

[0011]

In the invention as described in Claim 6, in addition to the construction as described in any one of Claims 1 through 5, a nose surface of the rotating cam is formed in such a configuration allowing acceleration to be generated in all sections thereof.

[0012]

In the invention as described in Claim 7, in addition to the construction as described in any one of Claims 1 through 6, a clearance in the valve mechanism is produced on a downstream side in a drive force transmission path with respect to an abutting portion.

Effect of the Invention

[0013]

According to the above-mentioned invention as described in Claim 1, in a setting in which the ramp portion uses a section of one of positive and negative accelerations of the rotating cam, the ramp portion is formed in such a curved configuration allowing a lift amount per unit rocking angle of the rocking cam to generate the other of positive and negative accelerations so that a lift speed of the valve in a portion corresponding to the ramp portion becomes substantially constant. Accordingly, even when a change occurs in

valve clearance due to variations in the accuracy of finishing of components or due to changes in the dimensions of the components, variations in the valve opening/closing timing can be stabilized, and the intake air amount at small lift can be easily controlled. Thus, the combustion becomes stable, so it is possible to achieve stable output performance or exhaust gas performance, or to reduce the impact at the time of large lift, whereby the reliability of the valve system can be enhanced.

[0014]

According to the invention as described in Claim 2, in the valve mechanism for an internal combustion engine which can make the lift amount of the intake valve or exhaust valve of the internal combustion engine variable, as described above, the intake air amount at the time of small lift can be easily controlled or the impact at the time of large lift can be reduced, whereby a large variable range can be secured without adversely affecting the durability of the valve mechanism.

[0015]

According to the invention as described in Claim 3, in a setting in which the ramp portion uses a negative acceleration section of the rotating cam under a state where the lift amount is variably controlled to be within a minimum range, the ramp portion is formed in a curved configuration so as to generate positive acceleration so that the lift speed of the valve in the portion corresponding to the ramp portion becomes substantially constant. Accordingly, the noise of the valve system at the time of small lift can be reduced, and an improvement can be achieved in terms of the controllability of the intake air amount.

[0016]

According to the invention as described in Claim 4, in a setting in which the ramp portion uses a positive acceleration section of the rotating cam under a state where the lift amount is variably controlled to be within a maximum range, the ramp portion is formed in a curved configuration so as to generate negative acceleration so that the lift speed of the valve in the portion corresponding to the ramp portion becomes substantially constant. Accordingly, the

impact upon high speed rotation at the time of large opening can be suppressed as much as possible.

[0017]

According to the invention as described in Claim 5, there is provided a valve mechanism for an internal combustion engine which is capable of making a lift amount of an intake valve or an exhaust valve of the internal combustion engine variable, wherein in a setting in which the ramp portion uses one of positive and negative acceleration sections of the rotating cam, a lever ratio of the rocking cam or a rocker arm pressed by the rocking cam increases as the lift amount is variably controlled to be within a minimum range. Therefore, a decrease in speed in the portion corresponding to the ramp portion can be compensated for, whereby the valve lift speed can be readily made linear to thereby suppress variations in valve opening/closing timing.

[0018]

According to the invention as described in Claim 6, a nose surface of the rotating cam is formed in such a configuration allowing acceleration to be generated in all sections thereof. Accordingly, since no constant-speed section needs to be provided, by setting the negative acceleration section of the rotating cam long, and setting the maximum acceleration low, the top portion of the nose surface of the rotating cam can be made gentle (made to have a large radius of curvature), whereby the requisite force of the spring for bringing the rocking cam into abutment with the rotating cam can be reduced, and also the vibration of the rocking cam can be suppressed. Further, since the nose surface of the rotating cam has the positive and negative acceleration sections formed therein with no constant-speed section, when creating a cam profile, forming profiles for the two kinds of acceleration sections suffices, whereby the cam profile can be readily shaped.

Brief Description of the Drawings

[0019]

Fig. 1 is a longitudinal sectional view of the main portion of a valve mechanism for an internal combustion engine according to Embodiment 1 of the present invention when the maximum lift amount

is required, illustrating the state in which an intake valve is closed.

FIG. 2 is a longitudinal sectional view of the main portion of the valve mechanism for the internal combustion engine according to Embodiment 1 of the present invention when the minimum lift amount is required, illustrating the state in which the intake valve is closed.

FIGS. 3 are views showing a rocking cam according to Embodiment 1 of the present invention, of which FIG. 3(a) is a front view of the rocking cam, and FIG. 3(b) is a bottom view of the rocking cam.

FIG. 4 is a graph showing the relationship between rotating and rocking cams and valve lift according to Embodiment 1 of the present invention.

FIG. 5 is a graph showing a related art example and corresponding to FIG. 4, illustrating the relationship between rotating and rocking cams and valve lift.

FIG. 6 is a longitudinal sectional view of the main portion of the valve mechanism for the internal combustion engine according to Embodiment 2 of the present invention when the maximum lift amount is required, illustrating the state in which the intake valve is closed.

FIG. 7 is a longitudinal sectional view of the main portion of the valve mechanism for the internal combustion engine according to Embodiment 2 of the present invention when the maximum lift amount is required, illustrating the state in which the intake valve is open.

FIG. 8 is a longitudinal sectional view of the main portion of the valve mechanism for the internal combustion engine according to Embodiment 2 of the present invention when the minimum lift amount is required, illustrating the state in which the intake valve is closed.

FIG. 9 is a longitudinal sectional view of the main portion of the valve mechanism for the internal combustion engine according to Embodiment 2 of the present invention when the minimum lift amount is required, illustrating the state in which the intake valve is open.

FIGS. 10 are views showing a rocking cam according to Embodiment 2 of the present invention, of which FIG. 10(a) is a front view of

the rocking cam, and FIG. 10(b) is a bottom view of the rocking cam.

FIG. 11 is a graph showing the relationship between rotating and rocking cams and valve lift according to Embodiment 2 of the present invention.

Best Mode for Carrying Out the Invention

[0020]

Hereinbelow, embodiments of the present invention will be described with reference to the drawings.

[Embodiment 1 of the Invention]

[0021]

FIGs. 1 through 5 illustrate Embodiment 1 of the present invention.

[0022]

First, the construction will be described. In FIG. 1, reference numeral 1 denotes a valve mechanism for an intake valve 11 of a gasoline engine. The valve mechanism 1 has a camshaft 2 rotated by a crankshaft (not shown) of an internal combustion engine, a rotating cam 3 provided to the camshaft 2, a rocking shaft 4 provided in parallel to the camshaft 2, a rocking cam 5 supported on the rocking shaft 4 and adapted to be rockable by the rotating cam 3, and a rocker arm 6 that is rocked in synchronization with the rocking cam 5 to open/close the intake valve 11.

[0023]

It should be noted that the construction of the valve mechanism is the same between the intake valve 11 and exhaust valve of the gasoline engine. Accordingly, Embodiment 1 focuses on the mechanism on the intake valve side, and the description of the mechanism on the exhaust valve side is omitted.

[0024]

As shown in FIG. 1, the camshaft 2 is arranged with its longitudinal direction extending toward the front and back (i.e. in the direction perpendicular to the plane) of FIG. 1. The camshaft 2 is rotated about a center axis O1 at a half rotational speed of that of the crankshaft of the internal combustion engine.

[0025]

Further, the rotating cam 3 is fixed onto the outer peripheral surface of the camshaft 2 and, as shown in FIG. 1, the outer peripheral

portion thereof is configured with a base surface 3a that is arc-shaped as seen in side view, and a nose surface 3b projecting from the base surface 3a.

[0026]

As shown in FIG. 4, the nose surface 3b of the rotating cam 3 is configured with a positive acceleration section and a negative acceleration section.

[0027]

Further, a center axis O2 of the rocking shaft 4 is arranged in parallel to the center axis O1 of the camshaft 2.

[0028]

The rocking cam 5 is in fitting engagement with the outer peripheral surface of the rocking shaft 4, and is supported so as to be rockable about the center axis O2 of the rocking shaft 4. A cam surface 5a for rocking the rocker arm 6 is formed in the lower end portion of the rocking cam 5.

[0029]

As shown in FIGs. 1 through 5, in the cam surface 5a, there are formed an arc-shaped base circle portion 5c around the center axis O2, a lift portion 5d for pressing and rocking the rocker arm 6, and a ramp portion 5e connecting between the lift portion 5d and the base circle portion 5c.

[0030]

The configuration of the ramp portion 5e is set to a curved configuration as shown in FIG. 3(a) so that the valve lift speed becomes substantially constant in a setting in which the negative acceleration section of the rotating cam 3 is used by the ramp portion 5e as shown in FIG. 4.

[0031]

In this embodiment, the ramp portion 5e is formed in a curved configuration so as to generate positive acceleration so that the valve lift speed becomes constant in the setting in which the negative acceleration section of the rotating cam 3 is used by the ramp portion 5e under a state where the lift amount is variably controlled to be within a minimum range. The details in this regard is described later.

[0032]

Further, as shown in FIG. 3(b), a width L1 of the base circle portion 5c is formed smaller than a width L2 of the lift portion 5d.

[0033]

Further, a roller shaft 7 having a center axis O3 in parallel to the center axis O2 of the rocking shaft 4 is arranged at the longitudinally middle portion of the rocking cam 5. Provided to the roller shaft 7 is a roller 8 that contacts and operates in synchronization with the base surface 3a or the nose surface 3b of the rotating cam 3, for transmitting the drive force from the rotating cam 3 to the rocking cam 5.

[0034]

Further, a spring 15 for urging the rocking cam 5 toward the rotating cam 3 side is in fitting engagement with the rocking shaft 4. Thus, the rocking cam 5 is urged toward the rotating cam 3 side by the urging force of the spring 15, so that the outer peripheral surface of the roller 8 is in constant contact with the base surface 3a or nose surface 3b of the rotating cam 3.

[0035]

Furthermore, the valve mechanism 1 is provided with a variable abutment portion mechanism as described below that makes variable the relative distance between a roller 14 and a center axis O5 of a rocker arm shaft 12 which will be described later.

[0036]

That is, the rocker arm 6 has a rocker arm main body 6d provided so as to be turnable by the rocker arm shaft 12, and the roller 14 is supported on the rocker arm main body 6d through a roller arm 6c.

[0037]

Specifically, as shown in FIG. 1, an eccentric shaft 29 is fixedly provided to the rocker arm shaft 12 in such a manner that a center axis O7 of the eccentric shaft 29 is located in parallel and eccentrically to the center axis O5 of the rocker arm shaft 12. The roller arm 6c is rotatably locked onto the eccentric shaft 29 by means of a leaf spring 28.

[0038]

The roller arm 6c has an engaging portion 6e formed at its one end.

The engaging portion 6e engages with the outer peripheral surface of the eccentric shaft 29, and is so shaped as to be capable of sliding on the outer peripheral surface of the eccentric shaft 29. A fitting engagement portion 6f is projectingly disposed in the position adjacent to the engaging portion 6e to come into fitting engagement with the leaf spring 28 so as to prevent dislodging thereof.

[0039]

The leaf spring 28 is formed into a predetermined configuration by bending a planar spring at several locations. A locking portion 28a formed in the leaf spring 28 is brought into fitting engagement with the fitting engagement portion 6f and the eccentric shaft 29, whereby the roller arm 6c and the eccentric shaft 29 are integrally locked in place. Further, a distal end portion 28b of the leaf spring 28 is brought into elastic contact with a contact surface 6i of the rocker arm main body 6d. Accordingly, the roller arm 6c is urged clockwise in FIG. 1 by the leaf spring 28, causing the roller 14 to abut the cam surface 5a of the rocking cam 5. Further, a predetermined clearance A is provided between a pressing portion 6h of the roller arm 6c and a guide portion 6j of the rocker arm main body 6d.

[0040]

The roller 14 is rotatably supported on a roller shaft 13 that is in fitting engagement with a through-hole 6g at the distal end portion of the roller arm 6c.

[0041]

The pressing portion 6h is formed on the lower side of the distal end portion of the roller arm 6c. The guide portion 6j of the rocker arm main body 6d is pressed by the pressing portion 6h, causing the rocker arm main body 6d to turn downwardly.

[0042]

Further, the roller arm 6c is freely movable to a predetermined position. By changing the contact position between the roller 14 provided to the roller arm 6c and the cam surface 5a of the rocking cam 5, the life amount of each valve 11 or the like can be adjusted.

[0043]

Further, formed on the lower side of the distal end portion of the rocker arm main body 6d is a valve pressing portion 6a that presses

on the upper surface of a shim 23 fitted on the intake valve 11.

[0044]

As described above, the roller arm 6c is integrally locked onto the eccentric shaft 29 by means of the leaf spring 28 so that the roller arm 6c can slide on the outer peripheral surface of the eccentric shaft 29. Thus, when the rocking cam 5 is rocked, the roller arm 6c is rocked via the roller 14 and the roller shaft 13 toward the intake valve 11 side against the urging force of the leaf spring 28. Further, as the roller arm 6c is rocked toward the intake valve 11 side, the pressing portion 6h of the roller arm 6c presses on the guide portion 6j of the rocker arm main body 6d to cause the rocker arm main body 6d to rock toward the intake valve 11 side, thereby making it possible to open the intake valve 11.

[0045]

Further, an actuator (not shown) for rotating the rocker arm shaft 12 within a predetermined angle range about the center axis 05 is connected to one end portion of the rocker arm shaft 12. Connected to the actuator is control means (not shown) for controlling the angle of the actuator according to the operational state of the internal combustion engine.

[0046]

Thus, when the rocker arm shaft 12 is rotated by a predetermined angle by the actuator, the eccentric shaft 29 provided to the rocker arm shaft 12 is turned by a predetermined angle about the center axis 05 of the rocker arm shaft 12. Further, when the eccentric shaft 29 is turned by the predetermined angle, the roller arm 6c operating in synchronization therewith is moved, for example, from the position shown in FIG. 1 to a predetermined position shown in FIG. 2. Then, once the roller arm 6c has been moved to the predetermined position, the contact point where the cam surface 5a of the rocking cam 5 and the roller 14 provided to the roller arm 6c come into contact with each other changes. The rocking amount of the rocker arm main body 6d can be thus changed, which the lift amount or the like of the intake valve 11 that is vertically moved by the rocker arm 6 can be adjusted.

[0047]

Here, the lever ratio of the rocker arm 6 pressed on by the rocking

cam 5 is adapted to increase as the roller arm 6c is moved from the state shown in FIG. 1 to the state shown in FIG. 2 and as the lift amount is variably controlled to be within a minimum range. That is, while the rocker arm main body 6d turns about the center axis O5, the pressing portion 6h of the roller arm 6c approaches the center axis O5 as the lift amount is variably controlled to be within a minimum range. The lever ratio of the rocker arm 6 is adapted to increase with this approaching movement.

[0048]

Further, even in the case where a predetermined clearance is not provided between the valve pressing portion 6a of the rocker arm main body 6d and the intake valve 11, the predetermined clearance A provided between the pressing portion 6h and the guide portion 6j allows the intake valve 11 to be reliably opened and closed even when, due to a rise in the temperature of the internal combustion engine, the intake valve 11 undergoes thermal expansion to cause elongation of the valve.

[0049]

With the valve mechanism 1 for an internal combustion engine constructed as described above, in which the lift amount of each valve 11 or the like can be adjusted by making the roller arm 6c be freely movable to the predetermined position and changing the contact position between the roller 14 of the rocker arm 6 and the cam surface 5a of the rocking cam 5, the roller arm 6c is urged toward the rocking cam 5 side by the leaf spring 28. Accordingly, even when the roller arm 6c is moved to the predetermined position and the contact position between the roller 14 and the cam surface 5a changes, the roller 14 of the rocker arm 6 and the cam surface 5a of the rocking cam 5 come into contact with each other, thereby making it possible to prevent adhesive wear.

[0050]

Further, although the width L1 of the base circle portion 5c is small, since no large load acts on this portion, a requisite strength can be secured for the base circle portion 5c. Because a large load acts on the lift portion 5d, the width L2 thereof is made larger to secure a requisite strength.

[0051]

Further, the rocker arm 6 is disposed below the rocking cam 5 while being rockably supported on the rocker arm shaft 12.

[0052]

The intake valve 11 has a collet 20 and an upper retainer 21 that are provided in its upper portion. A valve spring 22 is arranged below the upper retainer 21. The intake valve 11 is urged toward the rocker arm 6 side by the urging force of the valve spring 22. Further, the shim 23 is fitted on the upper end portion of the intake valve 11.

[0053]

Accordingly, the intake valve 11 can be vertically moved by rocking the rocker arm 6 in synchronization with the rocking motion of the rocking cam 5. Thus, the maximum lift amount of the intake valve 11 can be made variable by making the relative distance between the center axis 05 of the rocker arm shaft 12 and the roller 14 variable.

[0054]

Incidentally, according to the present invention, as shown in FIG. 4, by forming the ramp portion 5e of the rocking cam 5 in a predetermined curved configuration and imparting positive acceleration to the ramp portion 5e of the rocking cam 5, the speed of the ramp portion 5e of the valve lift becomes substantially constant in the state where the lift amount is minimum. Accordingly, even when changes in valve clearance occur due to variations in the accuracy of finishing of the components or due to changes in the dimensions of the components resulting from thermal expansion, variations in valve opening/closing timing can be stabilized, and since combustion is stabilized, the output performance or exhaust gas performance can be made stable, and further the impact of the valve when it returns to the seat or the valve system vibration can be stabilized to thereby stabilize noise.

[0055]

In this regard, FIG. 4 is a graph illustrating the relationship among three components: the rotating and rocking cams and the valve lift, according to the first embodiment, and FIG. 5 is a graph illustrating the relationship among three components: the rotating

and rocking cams and the valve lift, according to the prior art.

[0056]

In those figures, corresponding points of two of the three components are shown by chain double-dashed lines. Turning now to the rotating cam, the horizontal axis represents the rotation angle of the rotating cam 3, and the vertical axis represents the lift amount of the rotating cam 3. The figures show a lift curve (A) of the rotating cam 3.

[0057]

Further, in the graph shown in FIG. 4, the foot portion (the foot portion of the nose surface 3b) of the lift curve (A) is curved, and as indicated by an acceleration curve (B) drawn in broken line, this portion serves as the positive acceleration section.

[0058]

Further, in the lift curve (A), the portion above the foot portion (the portion other than the foot of the nose surface 3b) is curved, and this portion serves as the negative acceleration section as indicated by a characteristic curve (H) drawn in broken line.

[0059]

Turning now to the rocking cam, the horizontal axis on the left represents the lift amount of the rocking cam. When, as described above, the valve lift is set at minimum opening, the rocking cam 5 exhibits a lift characteristic as indicated by a curve (D). In the figures, symbol (a) represents a characteristic at the ramp portion 5e, and symbol (b) represents a characteristic at the lift portion 5b.

[0060]

Turning now to the valve lift, the vertical axis on the lower side represents the lift amount. The lift curve (D) of the rocking cam 5 and the lift curve (A) of the rotating cam 3 are synthesized to obtain a lift curve (F) of the valve lift.

[0061]

In this case, the characteristic (a) of the ramp portion 5e generating positive acceleration and the characteristic (c) of the rotating cam 3 generating negative acceleration are synthesized, so a ramp portion characteristic (d) of the lift curve (F) at minimum

valve lift exhibits a straight line, that is, constant valve lift speed. Thus, even when a variation occurs in valve clearance in the state where the ramp portion 5e is in contact with the roller 14, the valve opening/closing timing is stable, thereby achieving enhanced controllability of the intake air amount.

[0062]

On the other hand, when, as described above, the valve lift is set at its maximum, the rotating cam 5 exhibits a characteristic indicated by a curve (E). In the figures, symbol (a) represents a characteristic at the ramp portion 5e, and symbol (b) represents a characteristic at the lift portion 5b.

[0063]

The lift curve (E) of the rocking cam 5 and the lift curve (A) of the rotating cam 3 are synthesized to obtain a valve lift characteristic curve (G).

[0064]

By synthesizing the characteristic (a) of the ramp portion 5e generating positive acceleration and the characteristic (e) of the rotating cam 3 generating positive acceleration, a ramp portion characteristic (f) of the lift curve (G) at maximum valve lift generates positive acceleration.

[0065]

It should be noted that in the prior art design shown in FIG. 5, the foot portion (the foot portion of the nose surface 3b) of the lift curve (A) is curved, and as indicated by the acceleration curve (B) drawn in broken line, this portion serves as the positive acceleration section.

[0066]

Further, the middle portion (the middle portion of the nose surface 3b) of the lift curve (A) is linear, and this portion serves as a constant speed section.

[0067]

Further, in the lift curve (A), the upper side portion (the portion near the top of the nose surface 3b) is curved, which serves as the negative acceleration section as indicated by a characteristic curve (H) drawn in broken like.

[0068]

Further, when, as described above, the valve lift is set at its minimum, the rocking cam 5 exhibits a characteristic as indicated by the lift curve (D). In the figures, symbol (a) represents a characteristic at the ramp portion 5e, and symbol (b) represents a characteristic at the lift portion 5d.

[0069]

The lift curve (D) of the rocking cam 5 and the lift curve (A) of the rotating cam 3 are synthesized to obtain the valve lift curve (F).

[0070]

The characteristic (a) of the ramp portion 5e exhibiting constant speed and the characteristic (c) of the rotating cam 3 having negative acceleration are synthesized, so the initial characteristic (d) of the lift curve (F) at small valve lift opening exhibits negative acceleration. Thus, when a variation occurs in the angle of the rotating cam 3 in the state where the ramp portion 5e is in contact with the roller 14, the valve opening/closing timing varies, leading to a deterioration in the controllability of the intake air amount.

[0071]

Further, in this embodiment, as the lift amount is variably controlled to be within a minimum range, the roller arm 6c and the roller 14 are moved from the state shown in FIG. 1 to that shown in FIG. 2, whereby the lever ratio of the rocker arm 6 pressed by the rocking cam 5 increases. Therefore, a decrease in speed at the valve lift characteristic d corresponding to the ramp portion 5e can be compensated for, whereby the valve lift speed can be readily made linear to thereby suppress variations in valve opening/closing timing.

[0072]

Further, the rotating cam 3 is formed in such a configuration allowing the nose surface 3b to generate acceleration in all the sections. Accordingly, by setting the negative acceleration section of the rotating cam 3 long, and setting the maximum acceleration low, the top portion of the nose surface 3b of the rotating cam 3 can be made gentle (made to have a large radius of curvature), whereby the

requisite force of the spring 15 for bringing the rocking cam 5 into abutment with the rotating cam 3 can be reduced, and also the vibration of the rocking cam 5 can be suppressed. Further, since the nose surface 3b of the rotating cam 3 has the positive and negative acceleration sections formed therein with no constant-speed section, when creating a cam profile, forming profiles for the two kinds of acceleration sections suffices, whereby the cam profile can be readily shaped.

[Embodiment 2 of the Invention]

[0073]

FIGs. 6 through 11 illustrate Embodiment 2 of the present invention.

[0074]

Embodiment 2 of the present invention is constructed such that the variable abutment portion mechanism for making the valve lift amount variable is provided on the rocking cam 5 side, and desired valve characteristics can be obtained when the opening at maximum lift amount is large.

[0075]

That is, as shown in FIGs. 6 through 11, in a cam surface 5a of a rotating cam 5 according to this embodiment, there are formed a base circle portion 5c having the shape of a circular arc drawn around a center axis O2, a lift portion 5d for pressing and rocking a rocker arm 6, and a ramp portion 5e connecting between the lift portion 5d and the base circle portion 5c.

[0076]

The ramp portion 5e has a curved configuration. The configuration of the ramp portion 5e is set to a curved configuration so that the valve lift speed becomes constant in a setting in which the positive acceleration section of the rotating cam 3 is used by the ramp portion 5e. Here, the ramp portion 5e is formed in a curved configuration so as to generate negative acceleration so that the valve lift speed becomes constant in the setting in which the positive acceleration section of the rotating cam 3 is used by the ramp portion 5e under a state where the lift amount is variably controlled to be within a maximum range.

[0077]

Further, as shown in FIG. 10, a width L1 of the base circle portion 5c is formed smaller than a width L2 of the lift portion 5d.

[0078]

Further, a guide portion 5b as an elongate through-hole is formed at the longitudinally middle portion of the rocking cam 5. A roller shaft 7, which has a center axis O3 in parallel to the center axis O2 of a rocking shaft 4, is movably inserted through the guide portion 5b. Provided to the roller shaft 7 is a roller 8 that contacts and operates in synchronization with a base surface 3a or a nose surface 3b of the rotating cam 3, for transmitting the drive force from the rotating cam 3 to the rocking cam 5.

[0079]

Further, the guide portion 5b is formed in the shape of an elongate hole so as to guide the roller shaft 7 along its longitudinal direction over a predetermined distance, and the guiding direction at this time is inclined with respect to the radial direction of the camshaft 2.

[0080]

Further, as shown in FIG. 6, the roller 8 is formed in a circular shape, and is arranged on the outer peripheral surface of the roller shaft 7 so that the center axis of the roller 8 becomes the same as the center axis O3 of the roller shaft 7. The outer peripheral surface of the roller 8 is capable of rolling on the base surface 3a and nose surface 3b of the rocking cam 3.

[0081]

Here, the roller 8 used is capable of rolling on the surface of the rotating cam 3. However, the present invention is not limited to this; the roller 8 used may be one capable of sliding on the surface of the rotating cam 3 as long as the drive force from the rotating cam 3 can be transmitted to the rocking cam 5.

[0082]

Further, a spring 15 for urging the rocking cam 5 toward the rotating cam 3 side is in fitting engagement with the rocking shaft 4. Thus, the rocking cam 5 is urged toward the rotating cam 3 side by the urging force of the spring 15, so that the outer peripheral surface of the roller 8 is in constant contact with the base surface 3a or nose surface 3b of the rotating cam 3.

[0083]

Furthermore, the valve mechanism 1 is provided with a variable abutment portion mechanism for making variable the relative distance between the roller 8 and the center axis 02 of the rocking shaft 4.

[0084]

The variable abutment portion mechanism has a drive shaft 9 fixedly provided onto the rocking shaft 4, and an arm 10 whose one end portion 10a is connected to the roller shaft 7 and whose other end portion 10b is connected to the drive shaft 9.

[0085]

The drive shaft 9 is provided to the rocking shaft 4 in such a manner that a center axis 04 thereof is located in parallel and eccentrically to the center axis 02 of the rocking shaft 4.

[0086]

Further, an actuator (not shown) for rotating the rocking shaft 4 within a predetermined angle range about the center axis 02 is connected to one end portion of the rocking shaft 4. Connected to the actuator is control means (not shown) for controlling the angle of the actuator according to the operational state of the internal combustion engine.

[0087]

Thus, when the rocking shaft 4 turns by a predetermined angle, the drive shaft 9 turns by a predetermined angle about the center axis 02 of the rocking shaft 4, whereby the position of the center axis 04 changes relative to the center axis 02 of the rocking shaft 4.

[0088]

The arm 10 is capable of keeping the distance between the center axis 03 of the roller shaft 7 and the center axis 04 of the drive shaft 9 constant. A through-hole 10c, with which the roller shaft 7 is fitted, is formed at the one end portion 10a of the arm 10, and an insertion portion 10d, into which the drive shaft 9 is inserted and which is partially open, is formed at the other end portion 10b thereof. Accordingly, the roller shaft 7 is rotatably fitted with the through-hole 10c at the one end portion 10a, and the drive shaft 9 is rotatably fitted with the insertion portion 10d at the other end portion 10b and mounted in place with a pin 16 so as to prevent

dislodging thereof.

[0089]

Thus, when the rocking shaft 4 is rotated by a predetermined angle by the actuator, the drive shaft 9 provided to the rocking shaft 4 is turned by a predetermined angle about the center axis 02 of the rocking shaft 4, and the roller shaft 7 is operated in synchronization with this turning movement through the arm 10. The roller shaft 7 can be thus moved within the guide portion 5b while keeping the distance between the center axis 03 of the roller shaft 7 and the center axis 04 of the drive shaft 9 constant with the arm 10, whereby the relative distance between the center axis 02 of the rocking shaft 4 and the roller 8 can be made variable.

[0090]

Here, the lever ratio of the rocker arm 6 pressed on by the rocking cam 5 is adapted to increase as the roller arm 6c is moved from the state shown in FIG. 6 to the state shown in FIG. 8 and as the lift amount is variably controlled to be within a minimum range. That is, while the rocking cam 5 turns about the center axis 02, the roller shaft 7 pressing on the guide portion 5b approaches the center axis 02 as the lift amount is variably controlled to be within a minimum range. The lever ratio of the rocking cam 5 is adapted to increase with this approaching movement.

[0091]

Further, the rocker arm 6 is disposed below the rocking cam 5 while being rockably supported on the rocker arm shaft 12.

[0092]

Further, a valve pressing portion 6a is formed at the distal end portion of the rocker arm 6 for pressing on the upper surface of a shim 23 fitted on an intake valve 11 which will be described later.

[0093]

A roller 14 is rotatably provided to the roller shaft 13, and the outer peripheral surface of the roller 14 is capable of rolling on the cam surface 5a of the rocking cam 5.

[0094]

Further, a spring 17 for urging the rocker arm 6 toward the rocking cam 5 side is in fitting engagement with the rocker arm shaft 12.

Thus, the rocker arm 6 is urged toward the rocking cam 5 side by means of the spring 17, so that the outer peripheral surface of the roller 14 is in constant contact with the cam surface 5a of the rocking cam 5.

[0095]

Further, the intake valve 11 pressed by the valve pressing portion 6a is arranged below the valve pressing portion 6a of the rocker arm 6 so as to be vertically movable.

[0096]

The intake valve 11 has a collet 20 and an upper retainer 21 that are provided in its upper portion. A valve spring 22 is arranged below the upper retainer 21. The intake valve 11 is urged toward the rocker arm 6 side by the urging force of the valve spring 22. Further, the shim 23 is fitted on the upper end portion of the intake valve 11.

[0097]

Accordingly, the intake valve 11 can be vertically moved by rocking the rocker arm 6 in synchronization with the rocking motion of the rocking cam 5. Thus, by making the relative distance between the center axis O2 of the rocking cam 4 and the roller 8 variable to adjust the rocking start position of the rocking cam 5, the maximum lift timing of the intake valve 11 can be adjusted and made variable through the rocker arm 6.

[0098]

Next, the operation of the valve mechanism 1 constructed as described above will be described.

[0099]

First, detailed description will be made on the operation of the valve mechanism 1 for an internal combustion engine when the maximum lift amount is required.

[0100]

Here, FIG. 6 is a longitudinal sectional view of the main portion of valve mechanism 1 of the internal combustion engine according to Embodiment 1 of the present invention when the maximum lift amount is required, illustrating the state in which the intake valve 11 is closed. FIG. 7 is a longitudinal sectional view of the main portion

of the valve mechanism 1 of the internal combustion engine according to Embodiment 2 of the present invention when the maximum lift amount is required, illustrating the state in which the intake valve is open.

[0101]

First, as shown in FIG. 6, the roller shaft 7 is moved to the rotating cam 3-side end portion of the guide portion 5b, thereby changing the relative distance between the center axis O2 of the rocking shaft 4 and the roller 8. That is, the rocking shaft 4 is turned by a predetermined angle by the actuator, causing the drive shaft 9 to move in the circumferential direction of the rocking shaft 4. Thus, the roller shaft 7 is operated in synchronization with this movement via the arm 10 so as to be moved to the rotating cam 3-side end portion of the guide portion 5b, whereby the relative distance between the center axis O2 of the rocking shaft 4 and the roller 8 changes.

[0102]

Further, as shown in FIG. 6, while the roller 8 provided to the rocking cam 5 is in contact with the base surface 3a of the rotating cam 3, the rocking cam 5 is not rocked to the intake valve 11 side, the rocker arm 6 is urged to the rocking cam 5 side by the urging force of the spring 17, and also the intake valve 11 is urged to the rocker arm 6 side by the urging force of the valve spring 22. Thus, the lift of the intake valve 11 does not occur and the intake valve 11 is brought into a closed state.

[0103]

In this state, the roller 14 is located at the position corresponding to the base circle portion 5c of the cam surface 5a of the rocking cam 5. Since no large abutment force acts between the roller 14 and the base circle portion 5c in the valve closure state, a sufficient durability can be secured even through the width L1 of the base circle portion 5c is small.

[0104]

Then, when the rotating cam 3 is rotated via the camshaft 2 due to the rotation of the crankshaft of the internal combustion engine, as shown in FIG. 7, the roller 8 is pressed on by the nose surface 3b. As the roller 8 is further pressed, the rocking cam 5 is pressed via the roller shaft 7, causing the rocking cam 5 to rock

counterclockwise in FIG. 6 against the urging force of the spring 15.

[0105]

Through the rocking movement of the rocking cam 5, the portion of the cam surface 5a of the rocking cam 5 which presses the roller 14 changes from the base circle portion 5c to the lift portion 5d via the ramp portion 5e, and the rocker arm 6 is turned via the roller shaft 13 to the intake valve 11 side. In this way, a relative distance M between the center axis O2 of the rocking shaft 4 and the roller 14 in contact with the cam surface 5a of the rocking cam 5 as shown in FIG. 6 is largely changed to a relative distance N between the center axis O2 of the rocking shaft 4 and the roller 14 in contact with the cam surface 5a of the rocking cam 5 as shown in FIG. 7. The rocker arm 6 thus undergoes large rocking movement to the intake valve 11 side.

[0106]

Then, the valve pressing portion 6a formed at the distal end portion of the rocker arm 6 that has thus undergone large rocking movement to the intake valve 11 side presses on the upper surface of the shim 23 to push down the intake valve 11 by a large distance. As described above, by moving the roller shaft 7 to the end portion of the guide portion 5b in the rotating cam 3 side to make the relative distance between the center axis O2 of the rocking shaft 4 and the roller 8 variable, the relative distance between the center axis O2 of the rocking shaft 4 and the roller 14 in contact with the cam surface 5a of the rocking cam 5 can be largely changed, whereby the intake valve 11 can be pushed down by a large distance to bring the intake valve 11 into an open state at the maximum lift amount.

[0107]

In the case where the intake valve 11 is opened in this way, the width L2 of the lift portion 5d is made large because a large reaction force acts on the cam surface 5a of the rocking cam 5, thereby making it possible to secure strength.

[0108]

Next, detailed description will be made on the operation of the valve mechanism 1 of the internal combustion engine when the minimum

lift amount is required.

[0109]

Here, FIG. 8 is a longitudinal sectional view of the main portion of the valve mechanism for the internal combustion engine according to Embodiment 2 of the present invention when the minimum lift amount is required, illustrating the state in which the intake valve is closed. FIG. 9 is a longitudinal sectional view of the main portion of the valve mechanism for the internal combustion engine according to Embodiment 1 of the present invention when the minimum lift amount is required, illustrating the state in which the intake valve is open.

[0110]

First, as shown in FIG. 8, in the state as shown in FIG. 6 where the roller shaft 7 is retained at the rotating cam 3-side end portion, the roller shaft 7 is moved to the rocking shaft 4-side end portion of the guide portion 5b, thereby changing the relative distance between the center axis O2 of the rocking shaft 4 and the roller 8.

[0111]

That is, the rocking shaft 4 is turned within a predetermined angle range by the actuator, and the drive shaft 9 is moved in the circumferential direction of the rocking shaft 4. Accordingly, the roller shaft 7 is operated in synchronization with this movement via the arm 10 so that the roller shaft 7 is moved to the rocking shaft 4-side end portion of the guide portion 5b from the state where it is retained at the rotating cam 3-side end portion, whereby the relative distance between the center axis O2 of the rocking shaft 4 and the roller 8 decreases. Then, the rocking cam 5 turns from the position as shown in FIG. 6 to the position as shown in FIG. 8 due to the urging force of the spring 15.

[0112]

Further, as shown in FIG. 8, while the roller 8 provided to the rocking cam 5 is in contact with the base surface 3a of the rotating cam 3, the rocking cam 5 is not rocked to the intake valve 11 side, the rocker arm 6 is urged to the rocking cam 5 side by the urging force of the spring 17, and also the intake valve 11 is urged to the rocker arm 6 side by the urging force of the valve spring 22. Thus, the lift of the intake valve 11 does not occur and the intake valve

11 is brought into a closed state.

[0113]

When the rotating cam 3 is rotated via the camshaft 2 due to the rotation of the crankshaft of the internal combustion engine, as shown in FIG. 9, the roller 8 is pressed on by the nose surface 3b, and the rocking cam 5 is pressed via the roller shaft 7, causing the rocking cam 5 to rock counterclockwise in FIG. 8 against the urging force of the spring 15.

[0114]

As the rocking cam 5 is further rocked, the roller 14 in contact with the rocking shaft 4-side distal end portion of the cam surface 5a of the rocking cam 5 is pushed down to the intake valve 11 side by using the range of the cam surface 5a from the rocking shaft 4-side distal end portion to the center portion thereof, whereby the rocker arm 6 is rocked to the intake valve 11 side via the roller shaft 13. In this way, a relative distance P between the center axis O2 of the rocking shaft 4 and the roller 14 in contact with the cam surface 5a of the rocking cam 5 as shown in FIG. 8 undergoes a small change to become a relative distance Q between the center axis O2 of the rocking shaft 4 and the roller 14 in contact with the cam surface 5a of the rocking cam 5 as shown in FIG. 9. The rocker arm 6 thus undergoes small rocking movement to the intake valve side.

[0115]

Then, the valve pressing portion 6a formed at the distal end portion of the rocker arm 6 that has thus undergone small rocking movement to the intake valve 11 side presses on the upper surface of the shim 23 to push down the intake valve 11 by a small distance. In this way, by moving the roller shaft 7 to the rocking shaft 4-side end portion of the guide portion 5b to make the relative distance between the center axis O2 of the rocking shaft 4 and the roller 8 variable, the relative distance between the center axis O2 of the rocking shaft 4 and the roller 14 in contact with the cam surface 5a of the rocking cam 5 can be subjected to a small change to push down the intake valve 11 by a small distance, whereby, in Embodiment 1, the intake valve 11 can be brought into an open state at the minimum lift amount.

[0116]

In the valve mechanism 1 of the internal combustion engine constructed as described above, the rocking cam 5 is provided with the roller 8 that comes into contact with the rotating cam 3 to transmit the drive force from the rotating cam to the rocking cam 5. The valve mechanism 1 is provided with the variable abutment portion mechanism for making the relative distance between the roller 8 and the center axis O2 of the rocking shaft 4 variable by making the roller 8 movable; the lift amount or the like of each valve is made variable by thus making the relative distance variable, whereby the structure can be simplified to achieve low-cost construction.

[0117]

Further, the load from the rotating cam 3 is input to the roller 8, and the load is directly transmitted from the roller 8 to the guide portion 5a of the rocking cam 5. Then, the load is transmitted from the rocking cam 5 to the intake valve 11 via the rocker arm 6. Thus, no large load acts on the arm 10 that supports the roller 8, and since the arm 10 serves the sole function of moving the roller 8 along the guide portion 5b, not so large strength is required for the arm 10.

[0118]

Incidentally, according to the present invention, the lift portion 5d of the rocking cam 5 is formed in the predetermined curved configuration, and the ramp portion 5e of the rocking cam 5 is imparted with negative acceleration. Thus, at the initial valve lift stages in a large valve lift opening state, the valve speed becomes constant, thereby reducing the impact at the time of large lift opening.

[0119]

In this connection, FIG. 11 shows a lift curve (A) of the rotating cam 3, in which the horizontal axis represents the rotation angle of the rotating cam 3, and the vertical axis represents the lift of the rotating cam 3. The foot portion (the foot portion of the nose surface 3b) of the lift curve (A) is curved, and as indicated by an acceleration curve (B) drawn in broken line, this portion serves as the positive acceleration section.

[0120]

Further, in the lift curve (A), the portion above the foot portion

(the portion other than the foot of the nose surface 3b) is curved, and this portion serves as the negative acceleration section as indicated by a characteristic curve (H) drawn in broken line.

[0121]

Further, when, as described above, the valve lift is set at large opening, the rocking cam 5 exhibits a lift characteristic as indicated by a curve (E). In the figure, symbol (a) represents a characteristic at the ramp portion 5e, and symbol (b) represents a characteristic at the lift portion 5b.

[0122]

The lift curve (E) of the rocking cam 5 and the lift curve (A) of the rotating cam 3 are synthesized to obtain a valve lift curve (G).

[0123]

The characteristic (a) of the ramp portion 5e having negative acceleration and a characteristic (e) of the rotating cam 3 having positive acceleration are synthesized, so an initial characteristic (f) of the lift curve (G) at large valve lift opening exhibits substantially constant speed. Thus, a reduction in impact can be achieved in the state where the ramp portion 5e is in contact with the roller 14.

[0124]

On the other hand, when, as described above, the valve lift is set at small opening, the rotating cam 5 exhibits a characteristic indicated by a curve (E).

[0125]

The characteristic (a) of the ramp portion 5e having negative acceleration and the characteristic (b) of the rotating cam 3 having negative acceleration are synthesized, so the initial characteristic (d) of the lift curve (F) at large valve lift opening has negative acceleration, which means that variations may occur in the valve opening/closing timing. However, when, at the time of large valve lift opening, the engine is rotating at high speed and the noise impact at the ramp portion 5e presents a greater problem than such variations in valve timing, it is desirable to adopt Embodiment 2 described above.

[0126]

Further, in this embodiment, as the lift amount is variably controlled to be within a minimum range, the arm 10 and the roller 8 are moved as shown in FIGs. 6 through 8, whereby the lever ratio of the rocking cam 5 increases. Therefore, the speed at the valve lift characteristic (d) corresponding to the ramp portion 5e can be increased, whereby variations in valve opening/closing timing can be suppressed.

[0127]

It should be noted that while in above-described embodiments the structure shown in FIG. 1 and the like exhibits the characteristics shown in FIG. 4, and the structure shown in FIG. 6 and the like exhibits the characteristics shown in FIG. 11, this should not be construed restrictively. It is also possible for the structure shown in FIG. 1 and the like to exhibit the characteristics shown in FIG. 11, and for the structure shown in FIG. 6 and the like to exhibit the characteristics shown in FIG. 4.

Description of Symbols

[0128]

- 1: valve mechanism
- 2: camshaft
- 3: rotating cam
- 3a: base surface
- 3b: nose surface
- 4: rocking shaft
- 5: rocking cam
- 5a: cam surface
- 5b: guide portion
- 5c: base circle portion
- 5d: lift portion
- 5e: ramp portion
- 6: rocker arm
- 7: roller shaft
- 8: roller (rotating cam abutting portion)
- 9: drive shaft (variable abutment portion mechanism)
- 10: arm (variable abutment portion mechanism)
- 11: intake valve

01, 02, 03, 04: center axis

CLAIMS

1. A valve mechanism for an internal combustion engine, having a rotating cam rotated by a crankshaft of the internal combustion engine, and a rocking cam that is rockable by the rotating cam and has formed therein a cam surface for driving an intake valve or an exhaust valve,

wherein the cam surface of the rocking cam has a base circle portion, a lift portion, and a ramp portion connecting between the base circle portion and the lift portion, and

wherein in a setting in which the ramp portion uses a section of one of positive and negative accelerations of the rotating cam, the ramp portion is formed in such a curved configuration allowing a lift amount per unit rocking angle of the rocking cam to generate the other of positive and negative accelerations so that a lift speed of the intake valve or the exhaust valve in a portion corresponding to the ramp portion becomes substantially constant.

2. A valve mechanism for an internal combustion engine, having a rotating cam rotated by a crankshaft of the internal combustion engine, and a rocking cam that is rockable by the rotating cam and has formed therein a cam surface for driving an intake valve or an exhaust valve, the valve mechanism being adapted to make a lift amount of the intake valve or the exhaust valve variable,

wherein the cam surface of the rocking cam has a base circle portion, a lift portion, and a ramp portion connecting between the base circle portion and the lift portion, and

wherein in a setting in which the ramp portion uses a section of one of positive and negative accelerations of the rotating cam, the ramp portion is formed in such a curved configuration allowing a lift amount per unit rocking angle of the rocking cam to generate the other of positive and negative accelerations so that a lift speed of the intake valve or the exhaust valve in a portion corresponding to the ramp portion becomes substantially constant.

3. The valve mechanism for an internal combustion engine according to Claim 2, wherein in a setting in which the ramp portion uses a negative acceleration section of the rotating cam under a state where the lift amount is variably controlled to be within a minimum range, the ramp portion is formed in a curved configuration so as to generate

positive acceleration so that the lift speed of the valve in the portion corresponding to the ramp portion becomes substantially constant.

4. The valve mechanism for an internal combustion engine according to Claim 2, wherein in a setting in which the ramp portion uses a positive acceleration section of the rotating cam under a state where the lift amount is variably controlled to be within a maximum range, the ramp portion is formed in a curved configuration so as to generate negative acceleration so that the lift speed of the valve in the portion corresponding to the ramp portion becomes substantially constant.

5. A valve mechanism for an internal combustion engine, having a rotating cam rotated by a crankshaft of the internal combustion engine, and a rocking cam that is rockable by the rotating cam and has formed therein a cam surface for driving an intake valve or an exhaust valve, the valve mechanism being adapted to make a lift amount of the intake valve or the exhaust valve variable,

wherein the cam surface of the rocking cam has a base circle portion, a lift portion, and a ramp portion connecting between the base circle portion and the lift portion, and

wherein in a setting in which the ramp portion uses one of positive and negative acceleration sections of the rotating cam, a lever ratio of the rocking cam or a rocker arm pressed by the rocking cam increases as the lift amount is variably controlled to be within a minimum range.

6. The valve mechanism for an internal combustion engine according to any one of Claims 1 through 5, wherein the rotating cam has a base surface, and a nose surface projecting from the base surface, and the nose surface of the rotating cam is formed in such a configuration allowing acceleration to be generated in all sections thereof.

7. The valve mechanism for an internal combustion engine according to any one of Claims 1 through 6, wherein a clearance in the valve mechanism is produced on a downstream side in a drive force transmission path with respect to an abutting portion.

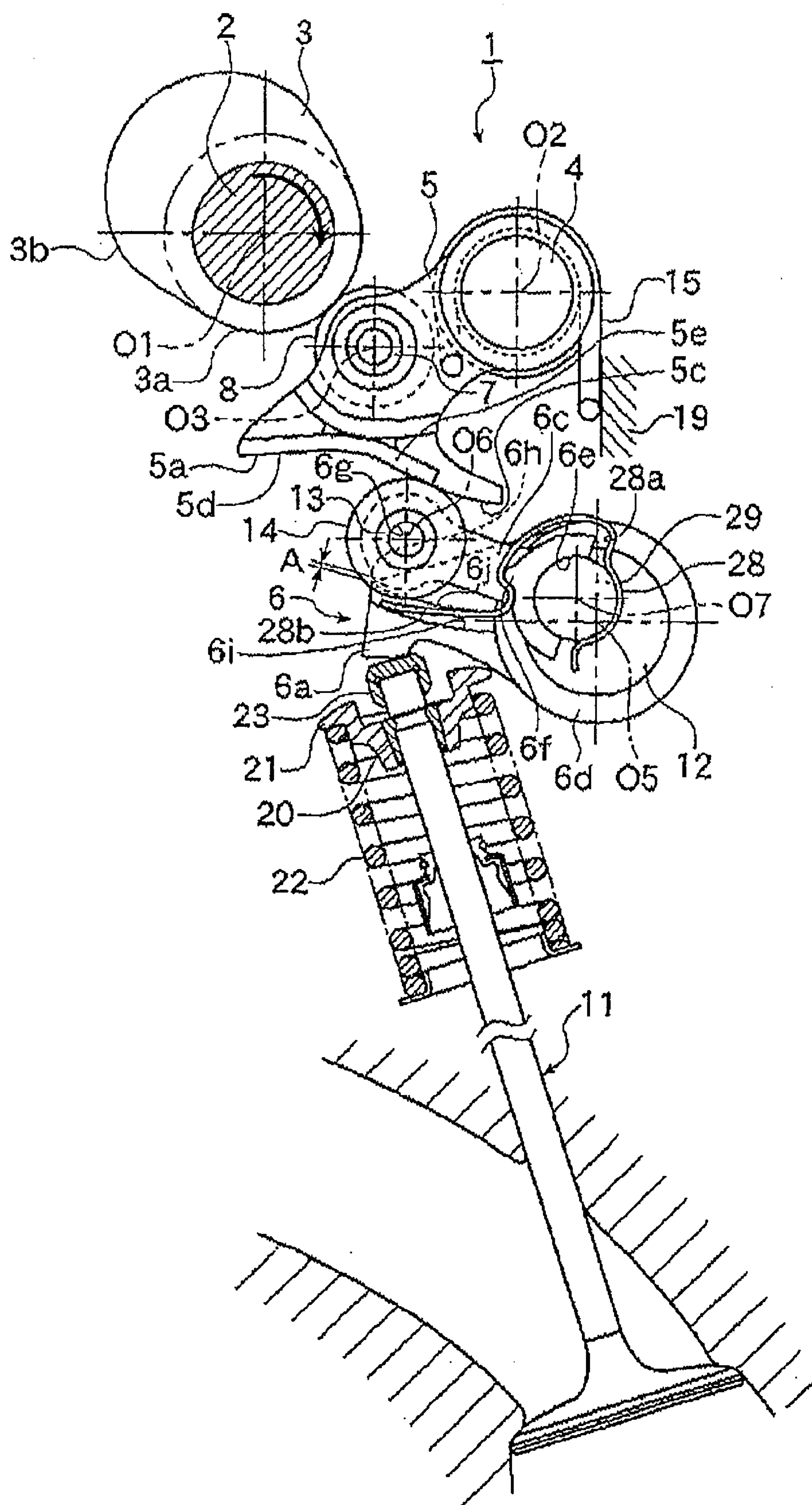


FIG. 1

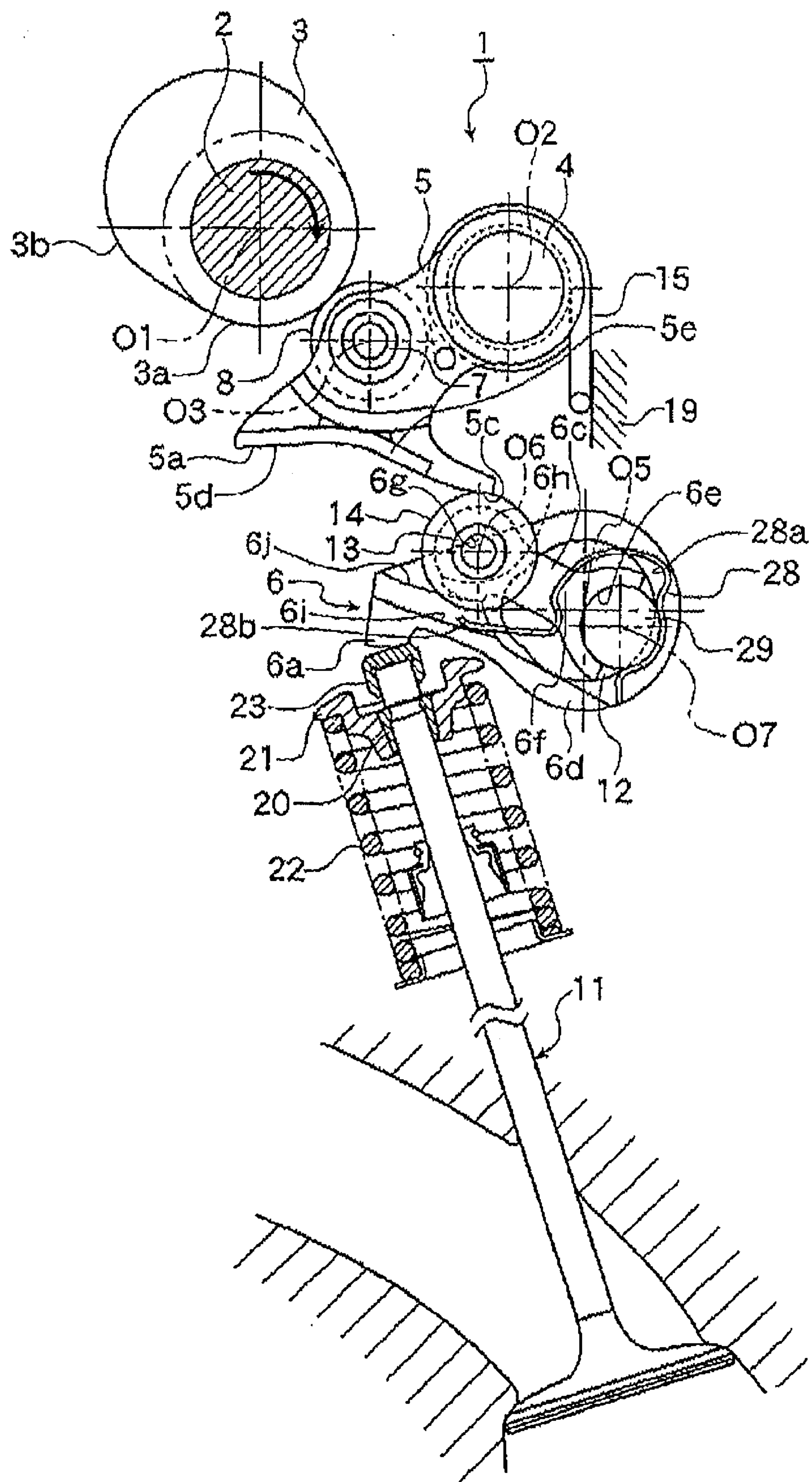
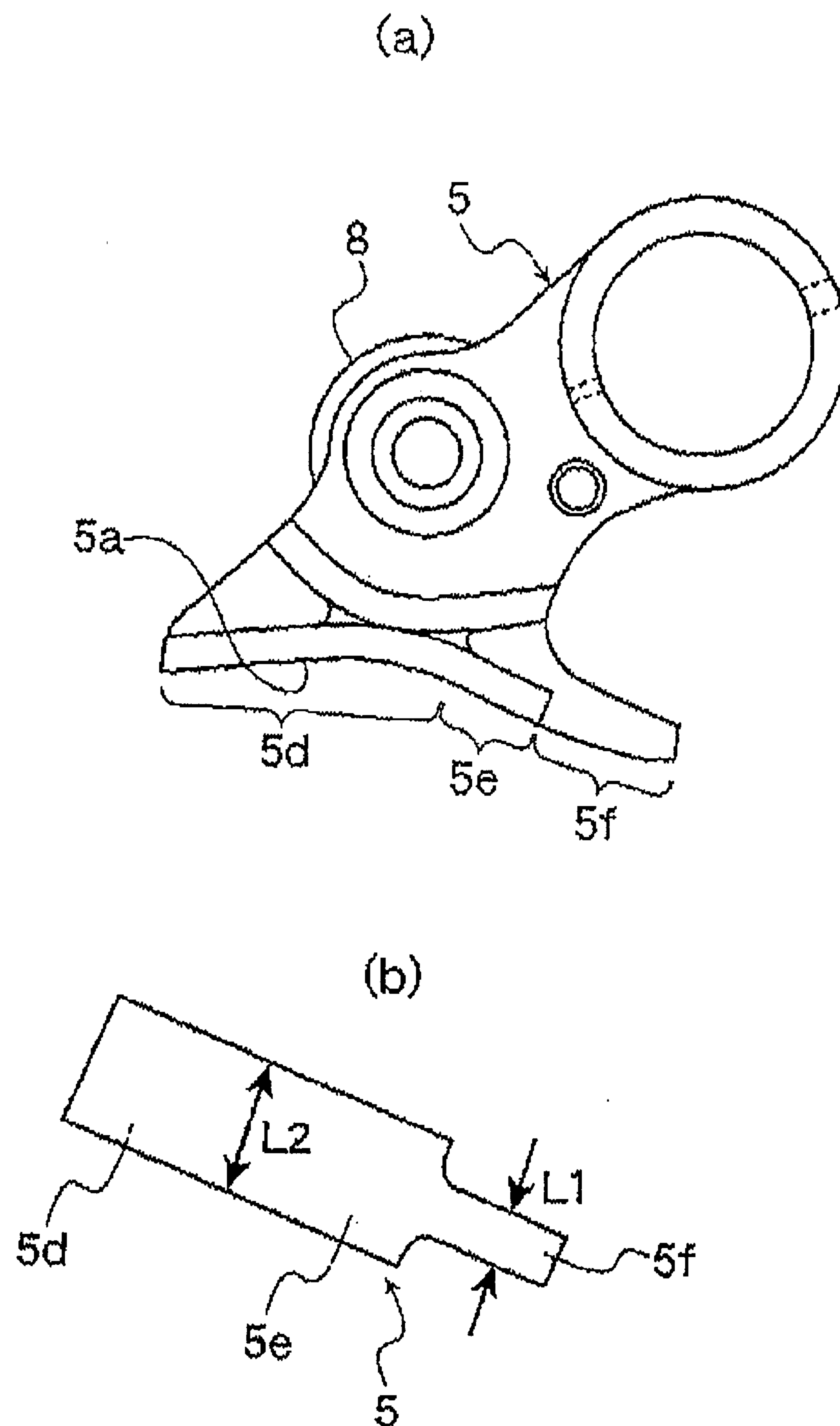


FIG. 2

**FIG. 3**

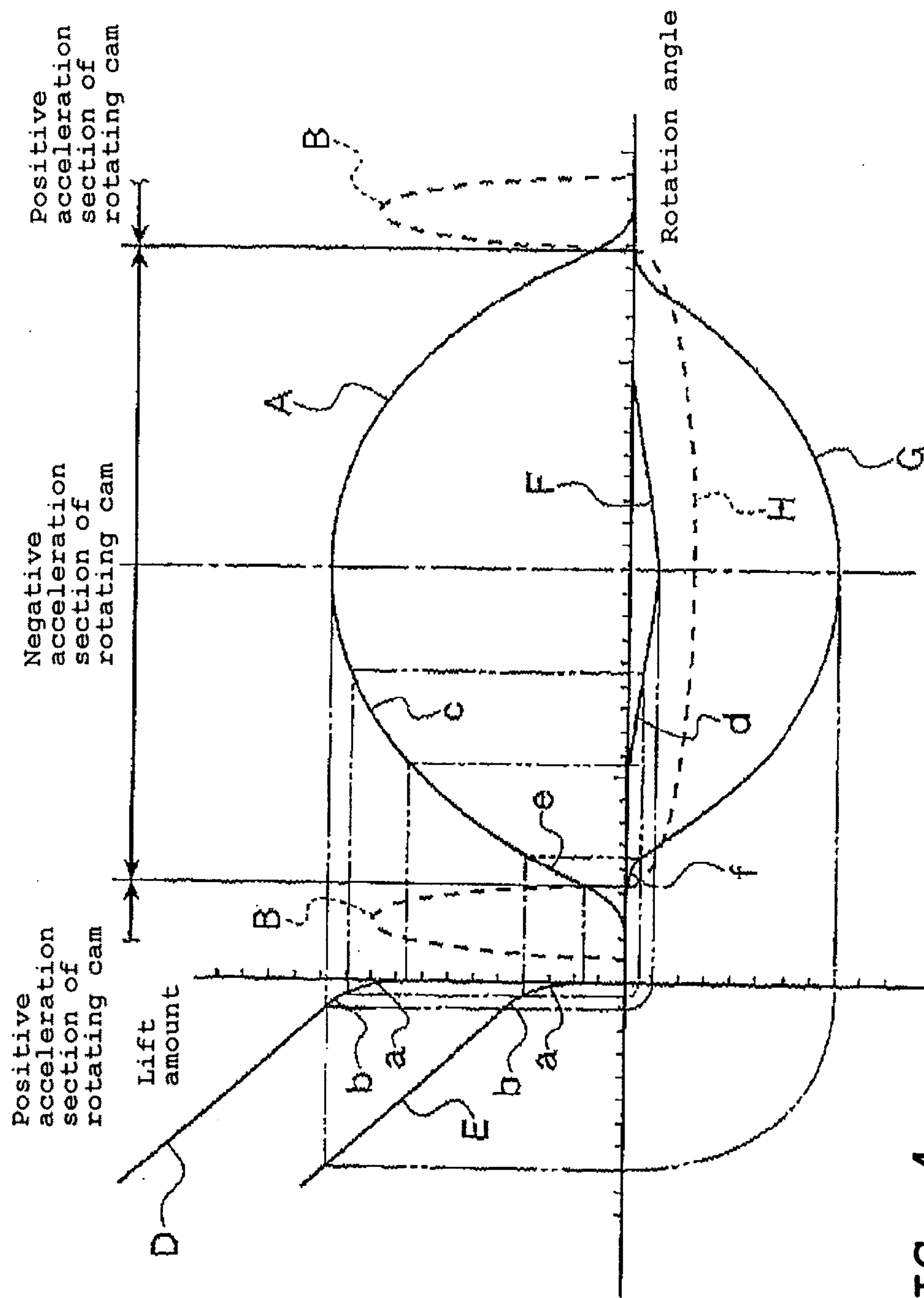


FIG. 4

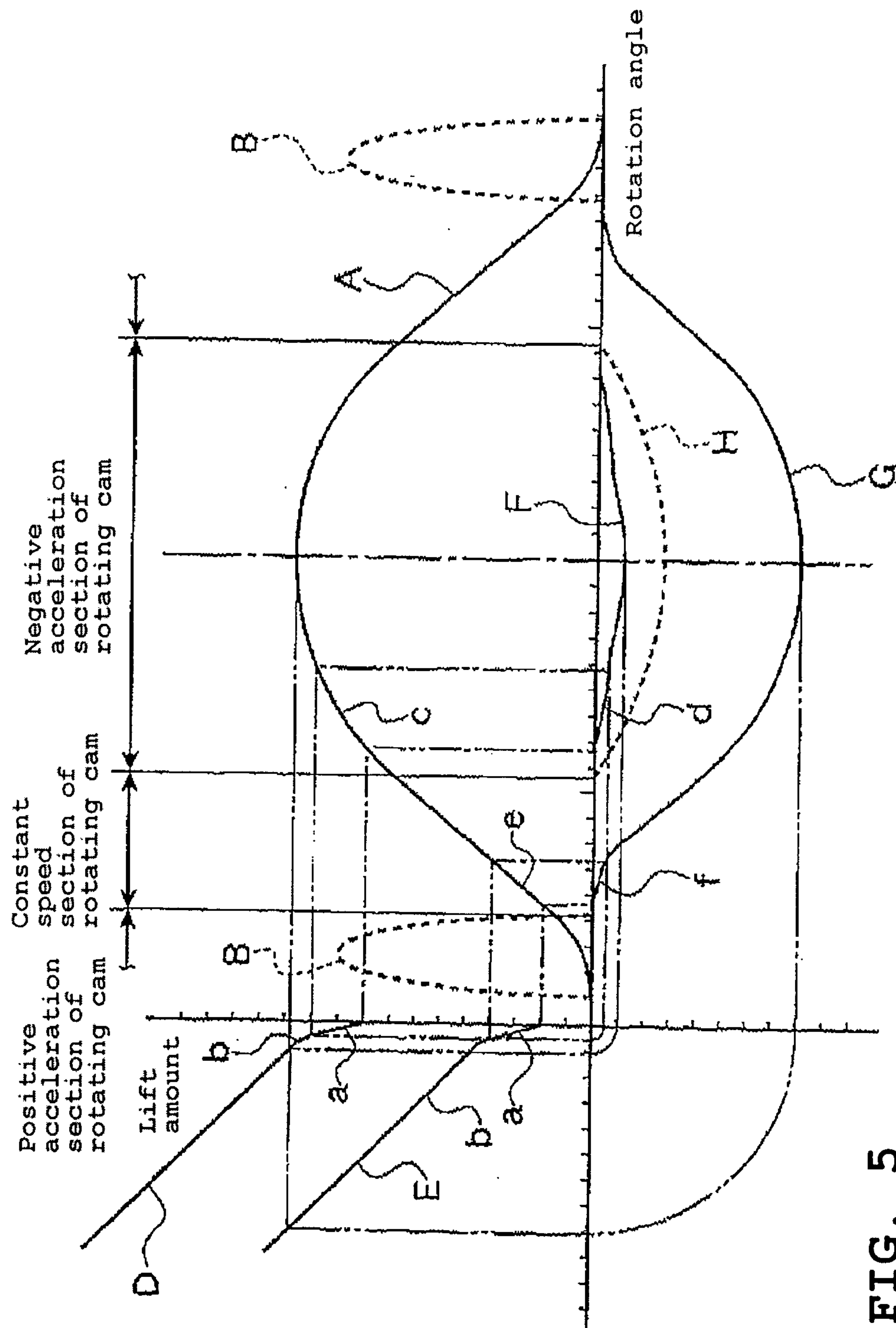


FIG. 5

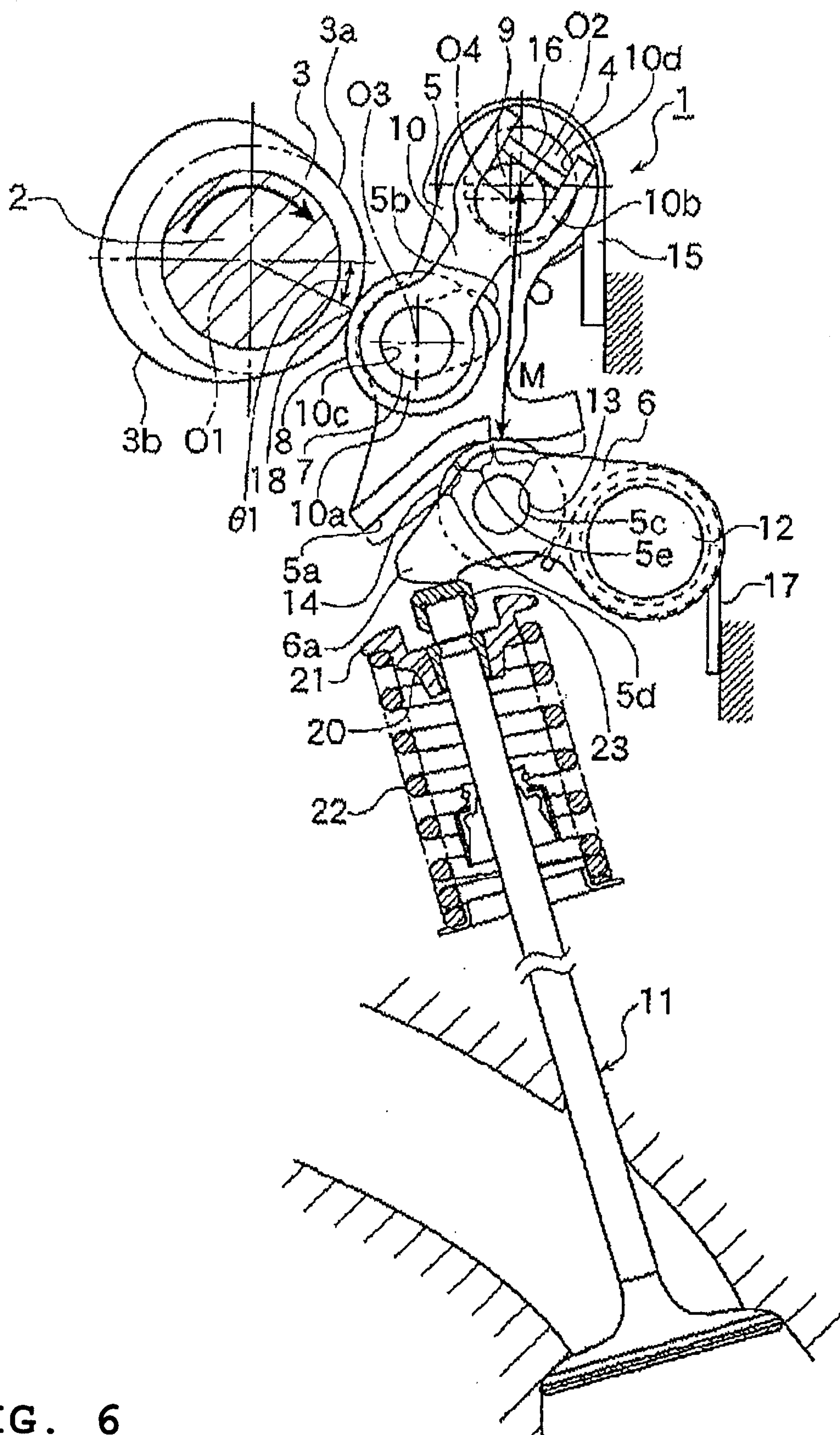


FIG. 6

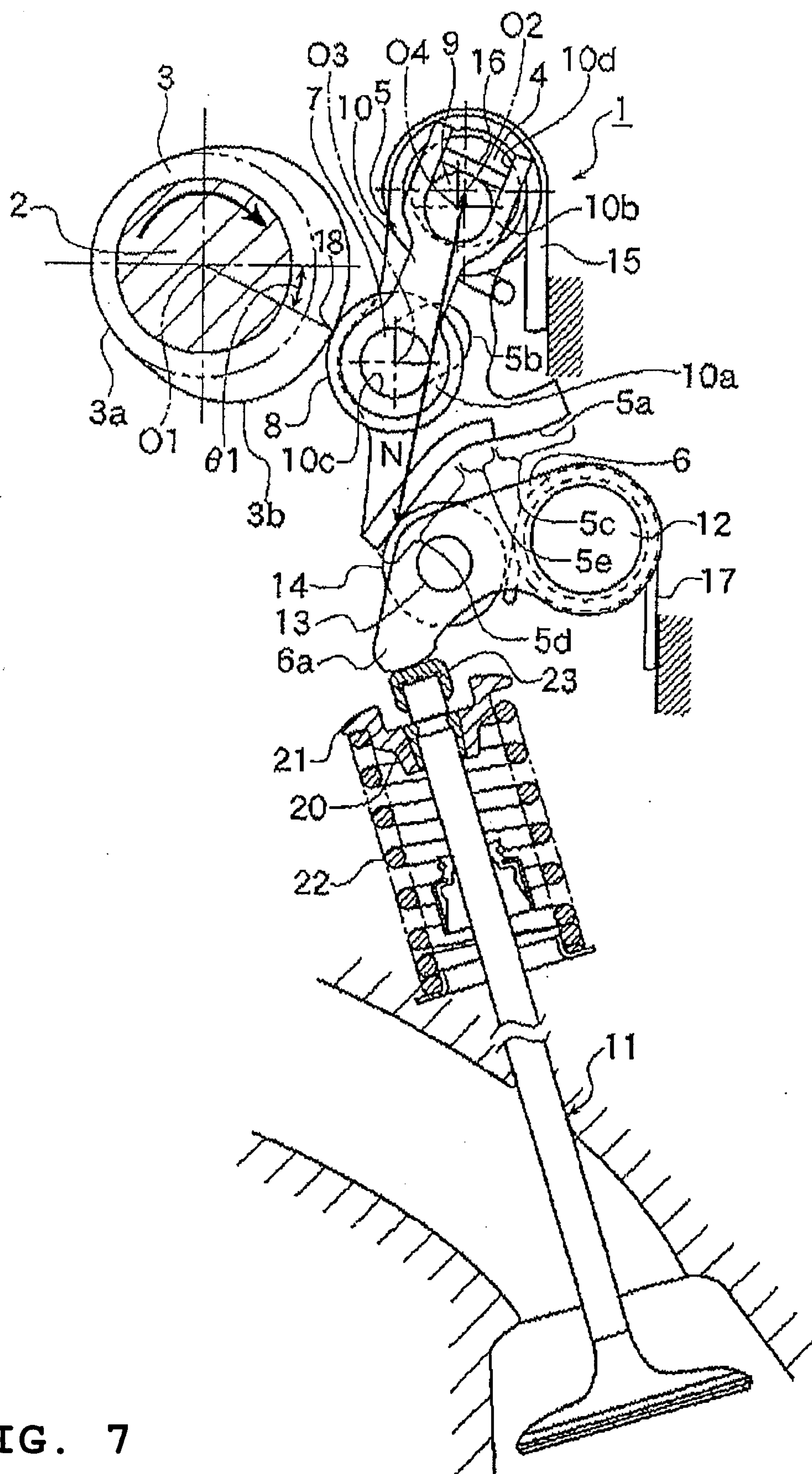


FIG. 7

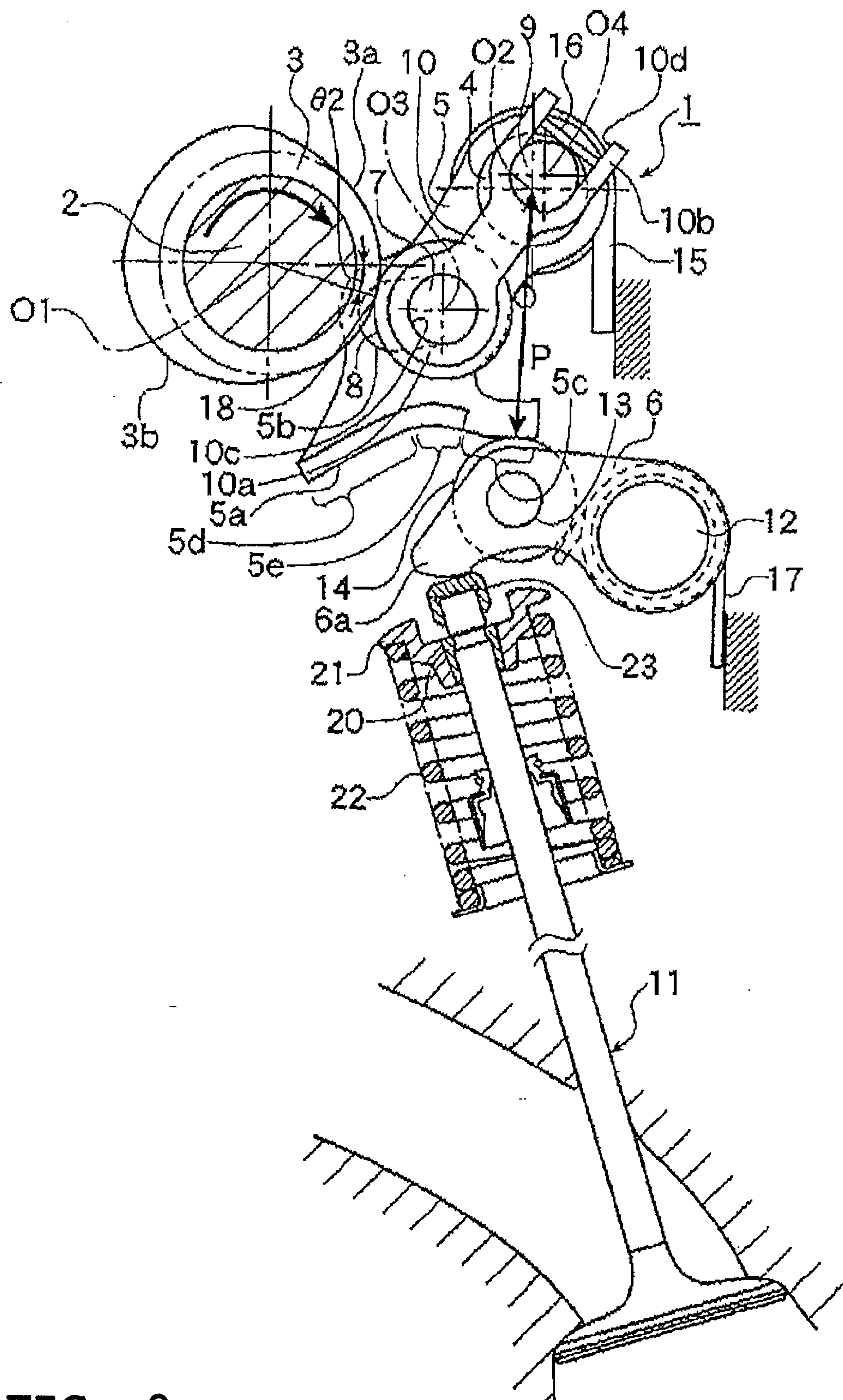


FIG. 8

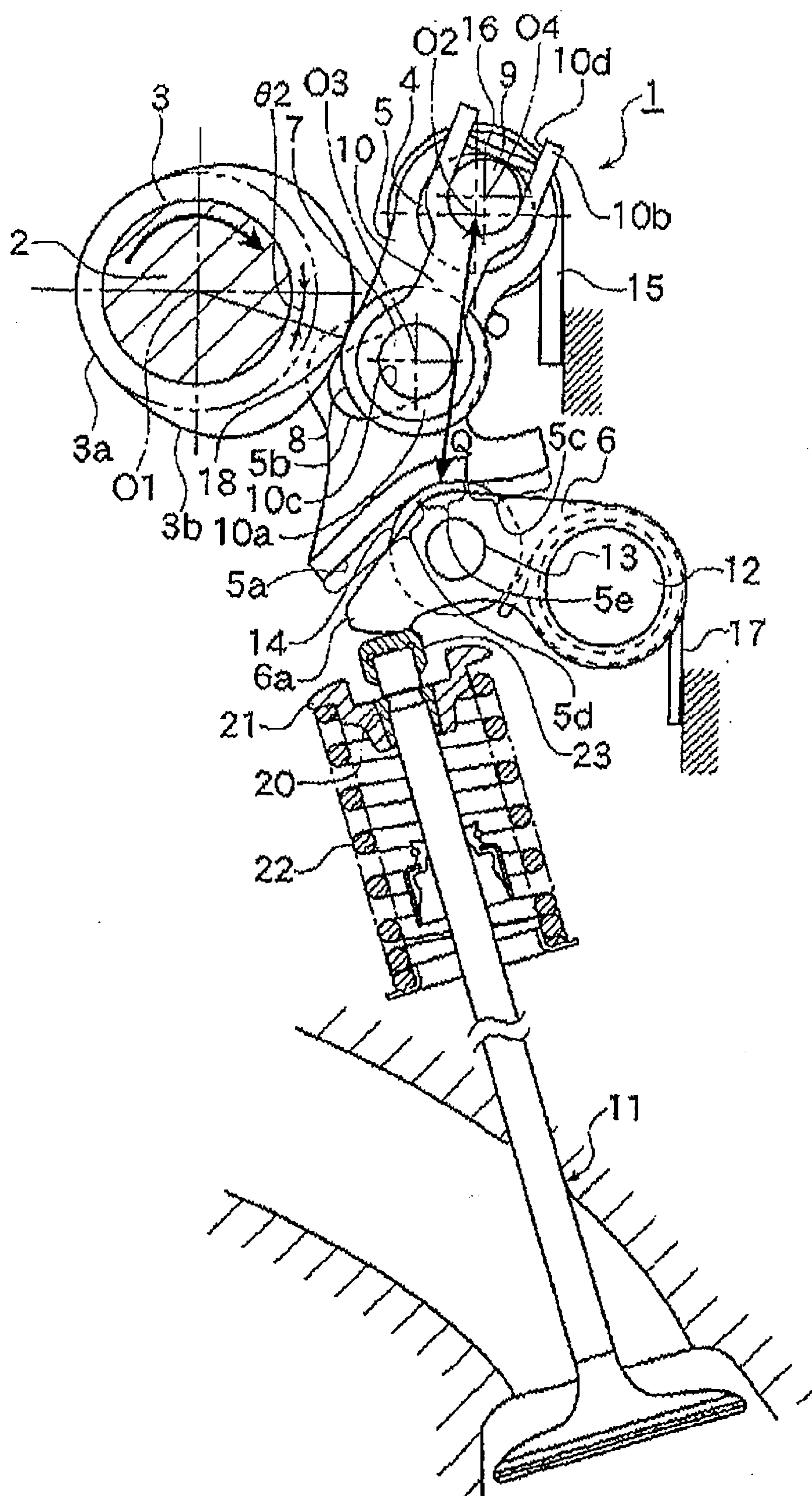


FIG. 9

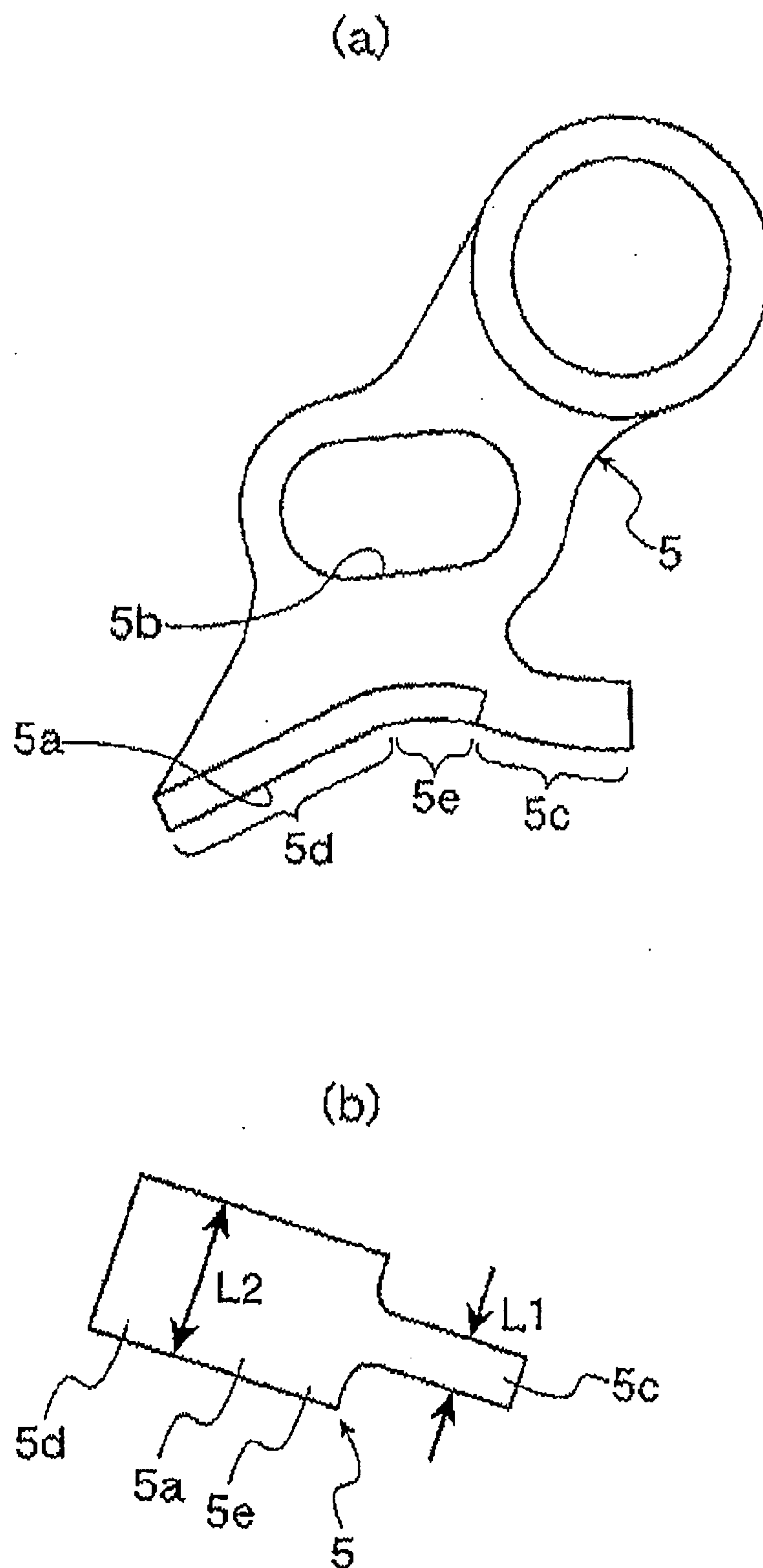


FIG. 10

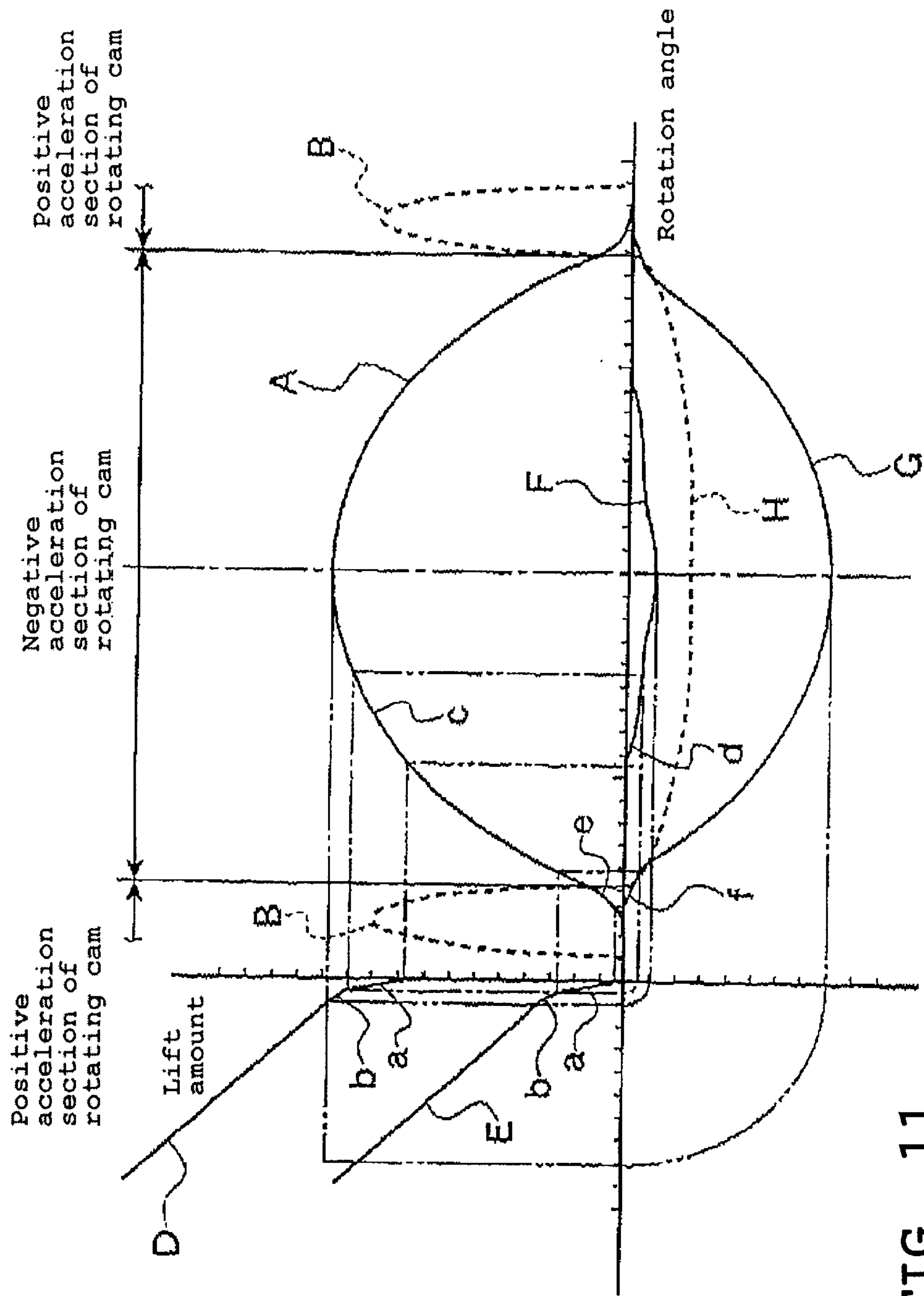


FIG. 11

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