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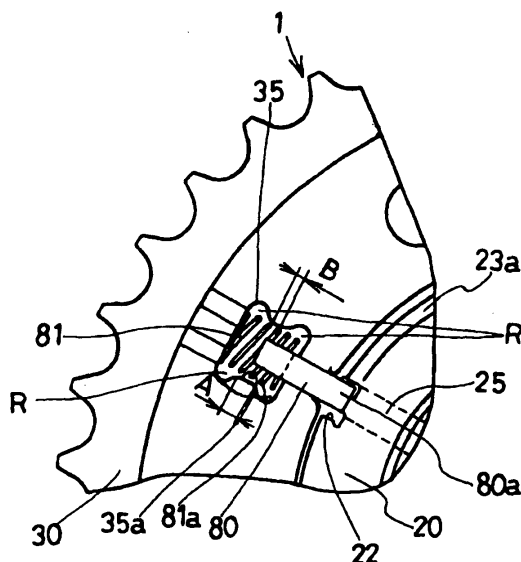
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(54) **Vane type phaser with locking pin**

(57) A variable valve timing control device (1) includes a retracting portion (34) accommodating a lock member (80) biased by a spring (81). The variable valve timing control device further includes a spring receiving bore (35) connected to the retracting portion for accommodating the spring and including a guide portion (35a) for guiding the spring in the axial direction, a receiving

portion into which a head portion (80a) of the lock member is inserted at a predetermined relative rotation phase, and a fluid passage (25) through which the operation fluid is supplied to or discharged from the receiving portion. A length of the guide portion in the axial direction is larger than each distance formed between windings of the spring adjacent to each other in the axial direction.

FIG. 4



Description

FIELD OF THE INVENTION

[0001] This invention generally relates to a variable valve timing control device. More particularly, the present invention pertains to a variable valve timing control device for controlling an opening and closing timing of an intake valve and exhaust valve of an internal combustion engine.

BACKGROUND

[0002] A known variable valve timing control device is disclosed in Japanese Patent Laid-Open Publication No. 2003-13713. The disclosed variable valve timing control device includes a rotating member integrally connected to a camshaft for opening and closing a valve, and a rotation transmitting member to which a rotation force from a crankshaft is transmitted. The rotation transmitting member is assembled to the rotating member so as to be rotatable relative thereto within a predetermined range. The variable valve timing control device also includes vanes each assembled to the rotating member and dividing a fluid chamber defined within the rotation transmitting member into an advanced angle chamber and a retarded angle chamber. The variable valve timing control device further includes a first fluid passage and a second fluid passage through which an operation fluid is supplied to or discharged from the advanced angle chamber and the retarded angle chamber, respectively. The rotating member and the rotation transmitting member are relatively rotated to each other by the operation fluid to be supplied to or discharged from each fluid pressure chamber. The rotation transmitting member includes a retracting groove portion for receiving a lock member biased towards the rotating member by a spring. The rotation transmitting member also includes a spring receiving bore connected to the retracting groove portion for receiving the spring, and formed with a guide portion for guiding the spring in an axial direction of the spring. The rotating member includes a receiving portion into which a head portion of the lock member is inserted when a relative rotation phase between the rotating member and the rotation transmitting member is positioned at a predetermined phase. The relative rotation of the rotation transmitting member to the rotating member is restricted by engaging the lock member and the receiving portion with each other.

[0003] According to the above-mentioned variable valve timing control device, an appropriate clearance is provided between an outer circumference of a winding portion of the spring and an inner circumference of the spring receiving bore for forming a guide portion that guides the spring so that the winding portion of the spring is prohibited to be bent when the spring is compressed or extended along with the operation of a lock

plate (lock member). In addition, concave comers R are formed at connecting portions between an inner circumferential face of the guide portion and the both end portions of the spring receiving bore in the radial direction thereof to which the both end portions of the spring contact respectively, i.e. end portions of the guide portion in the axial direction, for assuring contact faces for both end portions of the spring and also preventing stress occurring when the rotation force is added in the rotating direction in case that the relative rotation between the rotating member and the rotation transmitting member is restricted.

[0004] According to the above-mentioned structure, when the spring is assembled to the spring receiving bore or the head portion of the lock member is inserted into the receiving portion and thus the spring is extended, the winding portion of the spring may climb over the end portion of the guide portion (concave comer R) and impossible to be compressed. Therefore, the lock member may be not received in the retracting groove portion, thereby causing the malfunction of the variable valve timing control device.

[0005] Thus, a need exists for a variable valve timing control device wherein a winding portion of a spring biasing a lock member is prevented from climbing over a guide portion during a valve timing control.

SUMMARY OF THE INVENTION

[0006] According to an aspect of the present invention, a variable valve timing control device comprising, a rotating member integrally connected to a camshaft for opening and closing a valve and rotatably assembled to a cylinder head of an internal combustion engine, a rotation transmitting member assembled to the rotating member so as to be rotatable relative thereto within a predetermined range and to which a rotation force from a crankshaft is transmitted, a retracting portion formed on either one of the rotation transmitting member and the rotating member and accommodating a lock member biased towards either one of the rotation transmitting member and the rotating member by a spring. The spring including a winding portion formed by a plurality of windings and both end portions in an axial direction of the spring, a spring receiving bore connected to the retracting portion for accommodating the spring and including a guide portion for guiding the spring in the axial direction of the spring, a receiving portion formed on either one of the rotating member and the rotation transmitting member and into which a head portion of the lock member is inserted when a relative rotation phase between the rotating member and the rotation transmitting member is positioned at a predetermined phase. A length of the guide portion in the axial direction is larger than each distance formed between the windings of the spring adjacent to each other in the axial direction.

[0007] According to the aforementioned embodiment, the length of the guide portion in the axial direction is

defined larger than each distance formed between the windings of the spring adjacent to each other in the axial direction. Therefore, when the spring is assembled to the spring receiving bore or the spring is extended since the head portion of the lock member is positioned within the receiving portion, the lock member is prevented from being disabled to be received in the retracting portion due to the windings climbing over the end portion of the guide portion (i.e. concave corner) and the winding portion not being compressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The foregoing and additional features and characteristics of the present invention will become more apparent from the following detailed description considered with reference to the accompanying drawings, wherein:

[0009] Fig. 1 is a longitudinal sectional view of a variable valve timing control device taken along the line A-A of Fig. 2 according to an embodiment of the present invention;

[0010] Fig. 2 is a cross-sectional view of the variable valve timing control device in a retarded angle phase, taken along the line B-B of Fig. 1 according to the embodiment of the present invention;

[0011] Fig. 3 is a cross-sectional view of the variable valve timing control device in an intermediate angle phase, taken along the line B-B of Fig. 1 according to the embodiment of the present invention; and

[0012] Fig. 4 is a longitudinal sectional view of the variable valve timing control device and also an enlarged view of D portion of Fig. 2 according to the embodiment of the present invention.

DETAILED DESCRIPTION

[0013] An embodiment of the present invention is explained referring to attached drawings.

[0014] A variable valve timing control device 1 shown in Figs. 1 to 4 includes a rotating member 2 for opening/closing a valve, which includes a camshaft 10 rotatably supported on a cylinder head 100 of an internal combustion engine and an inner rotor 20 integrally fixed to a tip end portion of the camshaft 10. The variable valve timing control device 1 also includes a rotation transmitting member 3 having an outer rotor 30 being rotatable relative to the inner rotor 20 within a predetermined range, a front plate 40, and a rear plate 50. A timing sprocket 31 is integrally formed on an outer periphery of the outer rotor 30. Further, the variable valve timing control device 1 includes a torsion spring 60 disposed between the inner rotor 20 and the front plate 40, four vanes 70 assembled to the inner rotor 20, and a lock plate 80 (see Fig. 2) assembled to the outer rotor 30.

[0015] The timing sprocket 31 receives the rotation force in the clockwise direction thereof, which is shown as a rotation direction of camshaft in Fig. 2. The rotation

force is transmitted from a crankshaft (not shown) via a crank sprocket (not shown) and a timing chain (not shown).

[0016] The camshaft 10 includes a known cam (not shown) for opening/closing an intake valve (not shown). An advanced angle fluid passage (first fluid passage) 11 and a retarded angle fluid passage (second fluid passage) 12 extending in an axial direction of the camshaft 10 are provided inside of the camshaft 10. The advanced angle fluid passage 11 is connected to a first connecting port 201 of a switching valve 200 via a passage 71 provided on the camshaft 10 in the radial direction thereof, an annular groove 14, and a connecting passage 16 provided on the cylinder head 100. In addition, the retarded angle fluid passage 12 is connected to a second connecting port 202 of the switching valve 200 via a passage 72 provided on the camshaft 10 in the radial direction thereof, an annular groove 13, and a connecting passage 15 provided on the cylinder head 100.

[0017] The switching valve 200 is a known type wherein a spool 204 is moved against a biasing force of a spring (not shown) by energizing a solenoid 203. When the solenoid 203 is de-energized, a supply port 206 connected to an oil pump 205 that is driven by the internal combustion engine communicates with the second connecting port 202. At the same time, the first connecting port 201 communicates with a discharge port 207. When the solenoid 203 is energized, the supply port 206 communicates with the first connecting port 201 and at the same time the second connecting port 202 communicates with the discharge port 207 as shown in Fig. 1. Therefore, in case that the solenoid 203 of the switching valve 200 is de-energized, the operation fluid (fluid pressure) is supplied to the retarded angle fluid passage 12. In case that the solenoid 203 is energized, the operation fluid is supplied to the advanced angle fluid passage 11. Energization of the solenoid 203 of the switching valve 200 is duty-controlled by which a ratio of energization/de-energization per unit time is changed. For example, when the switching valve 200 is duty-controlled at 50%, the first and second ports 201 and 202, and the supply and discharge ports 206 and 207 are not connected to each other.

[0018] The inner rotor 20 is integrally fixed to the camshaft 10 via an installation bolt 91. As shown in Fig. 2, four vane grooves 21 and a receiving portion 22 are formed on the inner rotor 20. In addition, three first fluid passages 23 extending in the radial direction of the inner rotor 20, a fluid groove 23a, four second fluid passages 24 extending in the radial direction of the inner rotor 20, and a third fluid passage 25 for connecting a bottom portion of the receiving portion 22 to the advanced angle fluid passage 11.

[0019] As shown in Fig. 2, the vanes 70 are positioned in the vane grooves 21 respectively, being movable in the radial direction of the inner rotor 20. The four vanes 70 are movable within four fluid pressure chambers R0

respectively, which are each defined between the outer rotor 30 (to be explained later) and the inner rotor 20 and arranged, dividing each fluid pressure chamber R0 into an advanced angle chamber R1 and a retarded angle chamber R2. Each vane 70 is biased in the radially outward direction by a vane spring 73 (see Fig. 1) disposed between the bottom portion of each vane groove 21 and the bottom face of each vane 70.

[0020] In a state shown in Fig. 2, i.e. when a relative phase between the camshaft 10 and the inner rotor 20, and the outer rotor 30 is positioned at a predetermined phase (i.e. most retarded angle phase), a head portion 80a of the lock plate (lock member) 80 having a flat plate shape and movably assembled to the outer rotor 30 is inserted into the receiving portion 22 by a predetermined amount so that the relative rotation between the outer rotor 30 and the inner rotor 20 can be locked, i.e. restricted.

[0021] As shown in Fig. 2, the operation fluid (fluid pressure) is supplied to or discharged from the four retarded angle chambers R2, which are defined and divided by the vanes 70, via the retarded angle fluid passage 12 and the second fluid passage 24. In addition, the operation fluid is supplied to or discharged from three advanced angle chambers R1 out of four via the advanced angle fluid passage 11 and the first fluid passage 23. The operation fluid is supplied to the lock plate 80 from the third fluid passage 25 formed on the bottom portion of the receiving portion 22. When the lock plate 80 is moved, the operation fluid is supplied to or discharged from the remaining (i.e. one out of four) advanced angle chamber R1 via the fluid groove 23a connecting the third fluid passage 25 and that advanced angle chamber R1. Accordingly, for one advanced angle chamber R1 out of four, the first fluid passage 23 is not provided and the third fluid passage 25 is shared to be used, which may achieve a simple structure of the fluid passage and a reduced cost of manufacturing.

[0022] Both side portions of the outer rotor 30 in the axial direction thereof are integrally fixed to the annular shaped front plate 40 and the rear plate 50 respectively via four connecting bolts 92. The outer rotor 30 and the inner rotor 20 are rotatable relative thereto within the predetermined range defined by the vane 70 and the lock plate 80 moved within the fluid pressure chamber R0. The timing sprocket 31 is integrally formed on an outer periphery of the outer rotor 30 and on an end side in the axial direction thereof to which the rear plate 50 is connected. In addition, five convex portions 33 are formed on the inner circumference of the outer rotor 30 in the circumferential direction thereof so as to project in the radially inward direction. Each inner circumferential face of each convex portion 33 is slidably in contact with an outer circumferential face of the inner rotor 20. That is, the outer rotor 30 is rotatably supported on the inner rotor 20. A retracting groove portion 34 for accommodating the lock plate 80, and a spring receiving bore 35 connected to the retracting groove portion 34 for ac-

commodating a coil spring 81 that biases the lock plate 80 in the radially inward direction of the outer rotor 30 are formed between the two convex portions 33 out of five. The four fluid pressure chambers R0 mentioned above are formed between five convex portions 33, respectively.

[0023] As shown in Fig. 4, the coil spring 81 is arranged within the spring receiving bore 35 pushing the lock plate 80 in the radially inward direction of the outer rotor 30. The coil spring 81 includes a winding portion 81a and both end portions in the axial direction of the spring 81. The winding portion 81a is formed by spirally winding a wire rod, i.e. a plurality of windings, and having a distance B defined between the windings adjacent to each other in the axial direction as shown in Fig. 4. Both end portions of the winding portion 81a in the axial direction are formed in parallel to a face defined perpendicular to the axial direction of the spring 81. An appropriate clearance is provided between an outer circumference of the winding portion 81a and an inner circumference of the spring receiving bore 35 for forming a guide portion 35a that guides the coil spring 81 so that the winding portion 81a of the coil spring 81 is prohibited to be bent when the coil spring 81 is compressed or extended along with the operation of the lock plate 80. In addition, a concave corner R is formed at a connecting portion between an inner circumferential face of the guide portion 35a and the both end portions of the spring receiving bore 35 in the radial direction thereof to which the both end portions of the coil spring 81 contact respectively, for assuring contact faces for both end portions of the coil spring 81 and also preventing stress occurring when the rotation force is added in the rotating direction in case that the relative rotation between the rotating member 2 and the rotation transmitting member 3 is restricted. Under the above-mentioned structure, a length A of the guide portion 35a in the axial direction of the coil spring 81 is defined larger than the distance B of the coil spring 81 under the condition that the lock plate 80 is engaged with the receiving portion 22. Therefore, when the coil spring 81 is assembled to the spring receiving bore 35 or the head portion 80a of the lock plate 80 is inserted into the receiving portion 22 and thus the coil spring 81 is extended, the winding portion 81a is prevented from climbing over the end portion (concave corner R) of the guide portion 35a and also prevented from being disabled to be compressed.

[0024] The torsion spring 60 is provided by engaging with the front plate 40 at one end and the inner rotor 20 at the other end. The torsion spring 60 biases the inner rotor 20 towards the advanced angle side (clockwise direction in Fig. 2) relative to the outer rotor 30, the front plate 40 and the rear plate 50. Thus, the operation response of the inner rotor 20 to the advanced angle side may be improved.

[0025] The relative rotation between the inner rotor 20 and the outer rotor 30 to the advanced angle side is equal to the movement of the vanes 70 in the advanced

angle direction (clockwise direction) as shown in Fig. 3 from the most retarded angle state as shown in Fig. 2. The most advanced angle phase is restricted at a position where the vane 70 is in contact with one side face of the convex portion 33 in the circumferential direction thereof. The most retarded angle phase is restricted at a position where the head portion 80a of the lock plate 80 is positioned in the receiving portion 22. According to the present embodiment, one of the vanes 70 is in contact with the other side face of the convex portion 33 in the circumferential direction thereof at the most retarded angle phase.

[0026] According to the above-mentioned embodiment, when the internal combustion engine is stopped, the oil pump 205 is stopped and also the switching valve 200 is not energized. Thus, the operation fluid is not supplied to the fluid pressure chambers R0. As shown in Fig. 2, the inner rotor 20 and the outer rotor 30 are positioned at the most retarded angle phase due to a cam friction applied to the retarded angle direction. The head portion 80a of the lock plate 80 is positioned within the receiving portion 22 of the inner rotor 20 and thus the relative rotation between the inner rotor 20 and the outer rotor 30 is restricted at the most retarded angle phase. Even when the internal combustion engine is started and the oil pump 205 is driven, the operation fluid supplied from the oil pump 205 is only virtually provided to the retarded angle chamber R2 via the connecting passage 15, the retarded angle fluid passage 12, and the passage 24 while the duty ratio is small for energizing the switching valve 200 (i.e. the ratio of energizing time relative to the de-energizing time per unit time is small). Therefore, the variable valve timing control device 1 is maintained in a locked state.

[0027] When the retarded angle phase is required for the valve timing depending on the operation condition of the internal combustion engine, the duty ratio for energizing the switching valve 200 is brought to be large and then the position of the spool 204 is switched. The operation fluid supplied from the oil pump 205 is provided to the advanced angle chamber R1 by passing through the connecting passage 16, the advanced angle fluid passage 11, and the first fluid passage 23, or by passing through the fluid groove 23a after supplied to the receiving portion 22 from the third fluid passage 25.

[0028] Meanwhile, the operation fluid stored in the retarded angle chamber R2 is sent to the passage 24, the retarded angle fluid passage 12, and the connecting passage 15 to be discharged from the discharge port 207 of the switching valve 200. Therefore, the lock plate 80 is moved against the biasing force of the spring 81, thereby retracting the head portion 80a from the receiving portion 22. Then, the locked state between the inner rotor 20 and the outer rotor 30 is released. At the same time, the inner rotor 20 integrally rotating with the camshaft 10 and each vane 70 rotate relative to the outer rotor 30, the front plate 40, and the rear plate 50 in the advanced angle direction (clockwise direction in Fig. 2).

Due to the aforementioned relative rotation, the variable valve timing control device 1 is shifted from the state in Fig. 2 to the state in Fig. 3. Then, the timing of the cam is brought in the advanced angle state. The relative rotation phase may be defined arbitrarily by controlling the duty ratio of the switching valve 200. For example, the relative rotation between the inner rotor 20 and the outer rotor 30 may be stopped at the intermediate phase.

It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

Claims

1. A variable valve timing control device (1) comprising a rotating member (2) integrally connected to a camshaft (10) for opening and closing a valve and rotatably assembled to a cylinder head (100) of an internal combustion engine, a rotation transmitting member (3) assembled to the rotating member so as to be rotatable relative thereto within a predetermined range and to which a rotation force from a crankshaft is transmitted, a vane (70) provided on either one of the rotating member and the rotation transmitting member, a fluid pressure chamber (R0) formed between the rotating member and the rotation transmitting member and divided into an advanced angle chamber (R1) and a retarded angle chamber (R2) by the vane, a first fluid passage (23) and a second fluid passage (24) through which an operation fluid is selectively supplied to or discharged from the advanced angle chamber and the retarded angle chamber respectively, a retracting portion (34) formed on either one of the rotation transmitting member and the rotating member and accommodating a lock member (80) biased towards either one of the rotation transmitting member and the rotating member by a spring (81), the spring including a winding portion (81a) formed by a plurality of windings and both end portions in an axial direction of the spring (81), a spring receiving bore (35) connected to the retracting portion for accommodating the spring and including a guide portion (35a) for guiding the spring in the axial direction of the spring, a receiving portion formed on either one of the rotating member and the rotation transmitting member and into which a head portion (80a) of the lock member is inserted when a relative rotation

phase between the rotating member and the rotation transmitting member is positioned at a predetermined phase, and a third fluid passage (25) through which the operation fluid is supplied to or discharged from the receiving portion **characterized in that**

a length (A) of the guide portion in the axial direction is larger than each distance (B) formed between the windings of the spring adjacent to each other in the axial direction.

2. A variable valve timing control device according to claim 1, wherein the spring receiving bore includes a concave comer (R) at a connecting portion between an inner circumferential face of the guide portion and both end portions of the spring receiving bore in the radial direction thereof to which the both end portions of the spring contact respectively.

3. A variable valve timing control device according to claim 1, wherein the guide portion is formed between an outer circumference of the winding portion and an inner circumference of the spring receiving bore.

4. A variable valve timing control device according to claim 2, wherein the guide portion is formed between an outer circumference of the winding portion and an inner circumference of the spring receiving bore.

5. A variable valve timing control device according to claim 1, wherein the both end portions of the spring in the axial direction are formed in parallel to a face defined perpendicular to the axial direction of the spring.

6. A variable valve timing control device (1) comprising a rotating member (2) integrally connected to a camshaft (10) for opening and closing a valve and rotatably assembled to a cylinder head (100) of an internal combustion engine, a rotation transmitting member (3) assembled to the rotating member so as to be rotatable relative thereto within a predetermined range and to which a rotation force from a crankshaft is transmitted, a retracting portion (34) formed on either one of the rotation transmitting member and the rotating member and accommodating a lock member (80) biased towards either one of the rotation transmitting member and the rotating member by a spring (81), the spring including a winding portion (81a) formed by a plurality of windings and both end portions in an axial direction of the spring (81), a spring receiving bore (35) connected to the retracting portion for accommodating the spring and including a guide portion (35a) for guiding the spring in the axial direction of the spring, a receiving portion formed on either one of the ro-

tating member and the rotation transmitting member and into which a head portion (80a) of the lock member is inserted when a relative rotation phase between the rotating member and the rotation transmitting member is positioned at a predetermined phase **characterized in that**

a length (A) of the guide portion in the axial direction is larger than each distance (B) formed between the windings of the spring adjacent to each other in the axial direction.

7. A variable valve timing control device according to claim 6, wherein the spring receiving bore includes a concave comer (R) at a connecting portion between an inner circumferential face of the guide portion and both end portions of the spring receiving bore in the radial direction thereof to which the both end portions of the spring contact respectively.

8. A variable valve timing control device according to claim 6, wherein the guide portion is formed between an outer circumference of the winding portion and an inner circumference of the spring receiving bore.

9. A variable valve timing control device according to claim 7, wherein the guide portion is formed between an outer circumference of the winding portion and an inner circumference of the spring receiving bore.

10. A variable valve timing control device according to claim 6, wherein the both end portions of the spring in the axial direction are formed in parallel to a face defined perpendicular to the axial direction of the spring.

FIG. 1

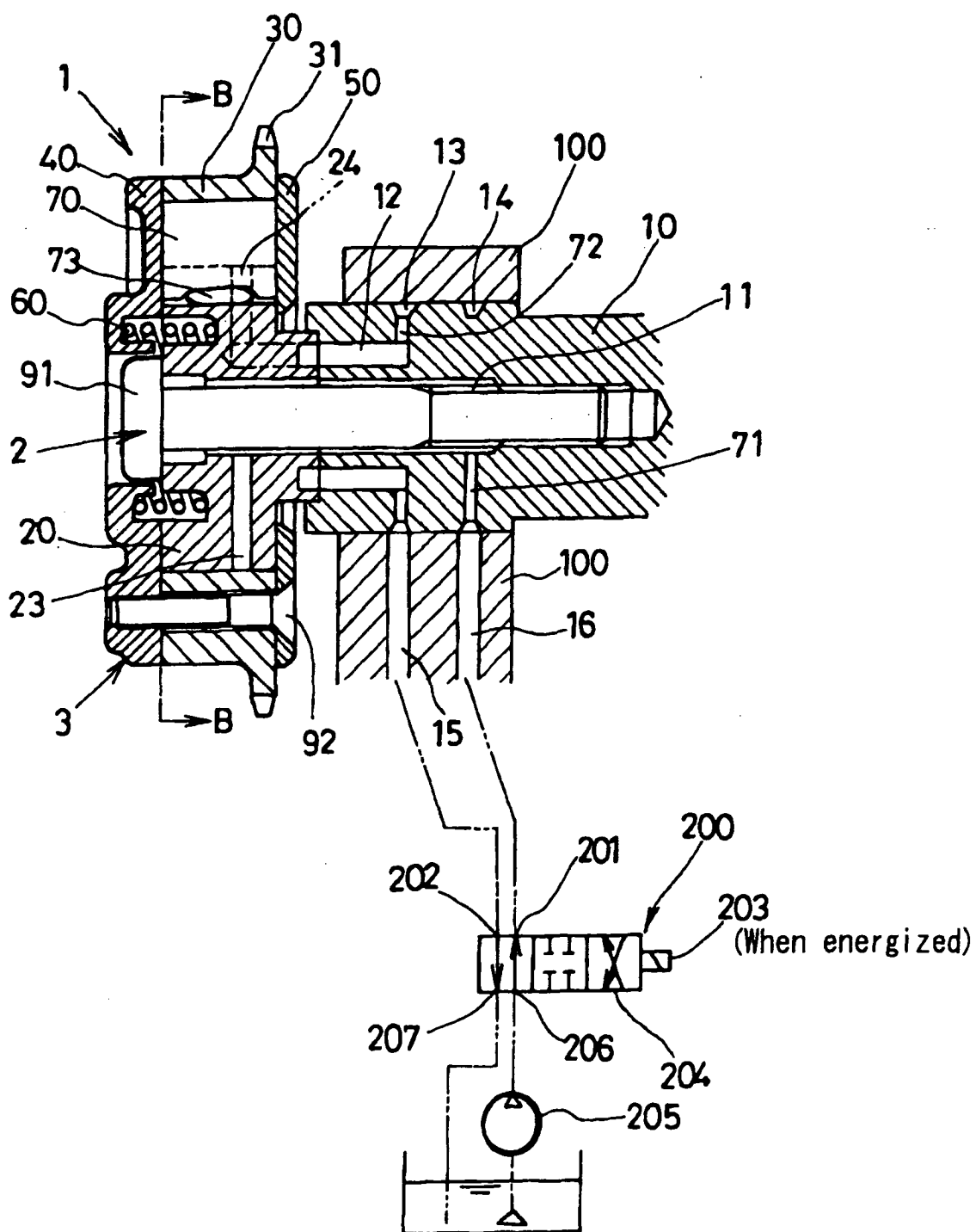


FIG. 2

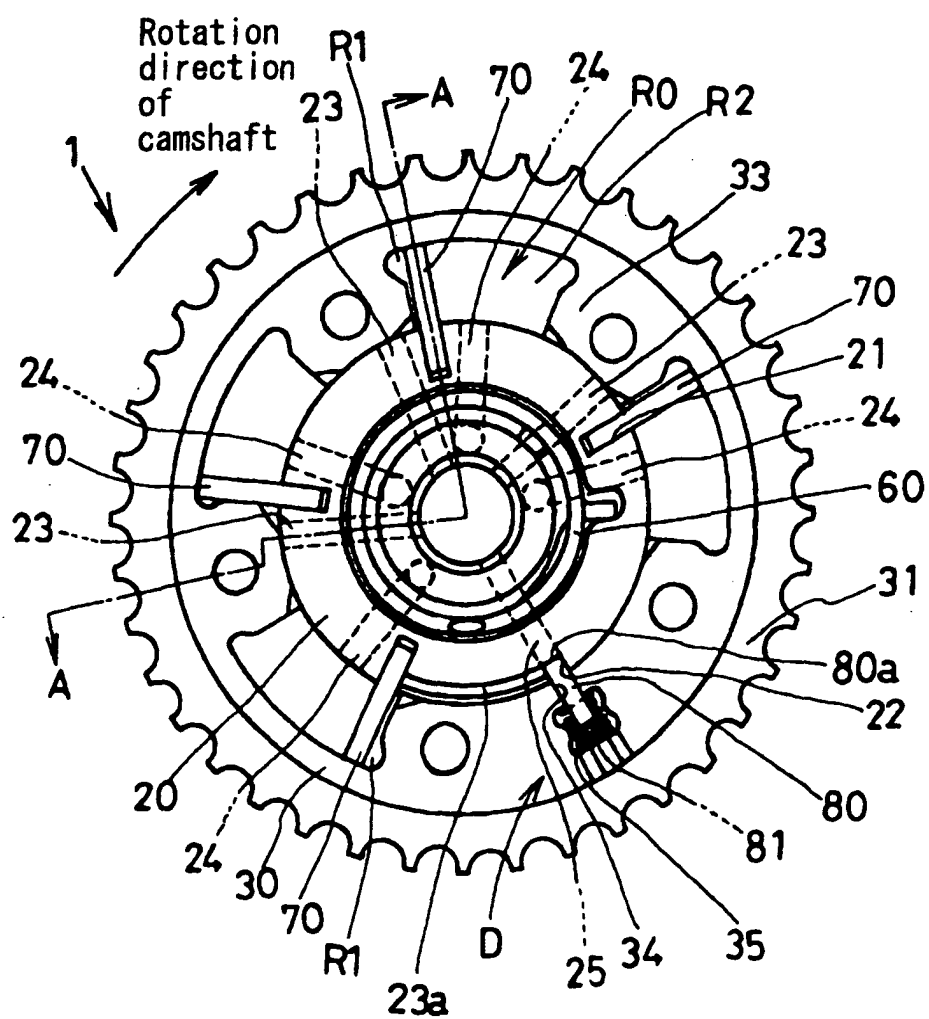


FIG. 3

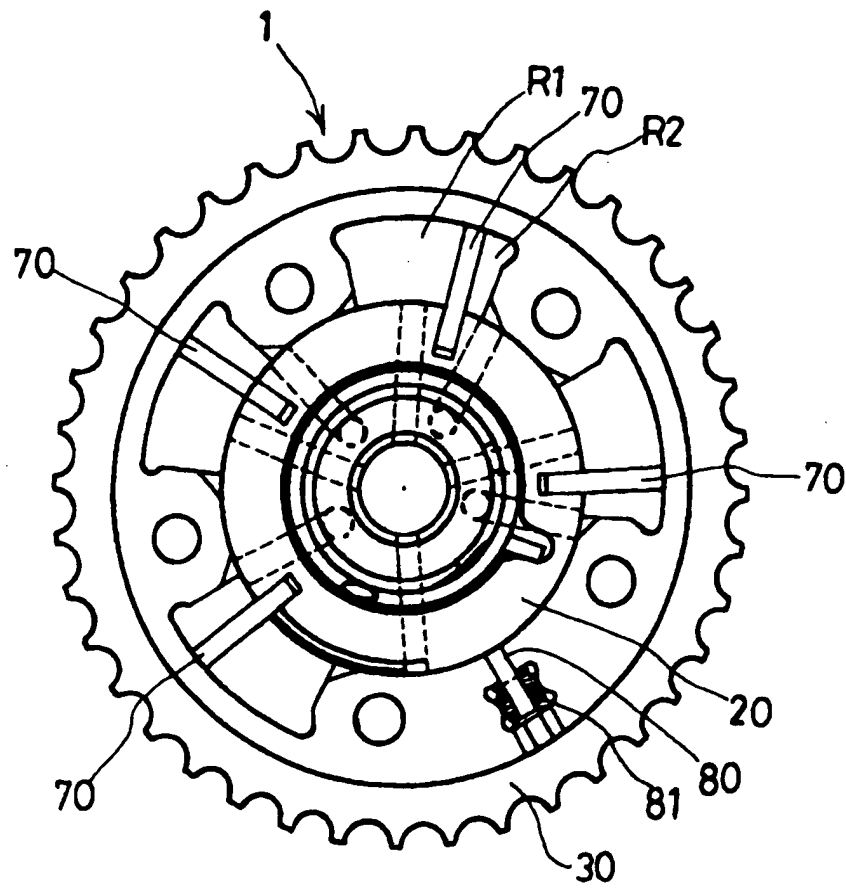
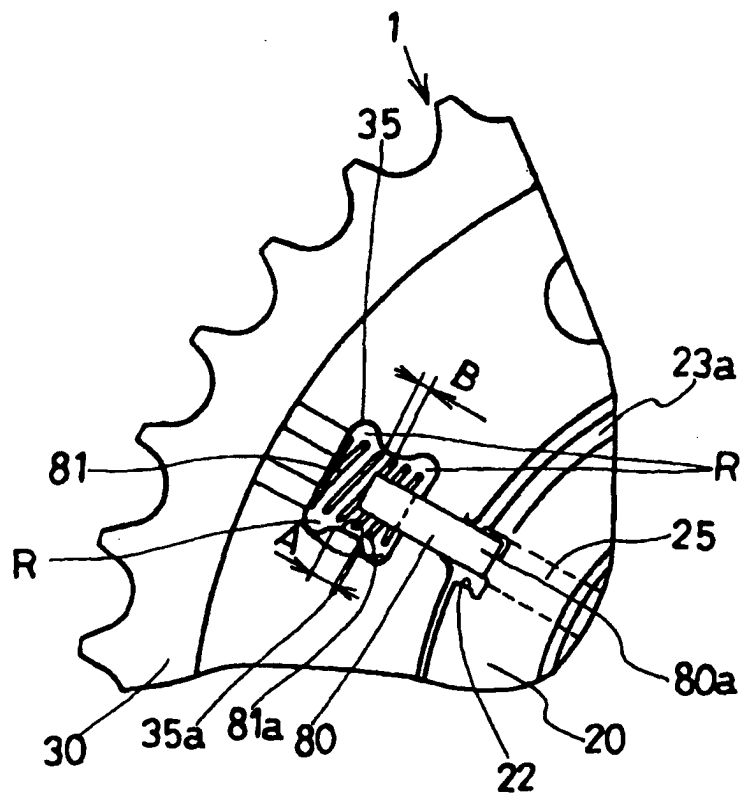


FIG. 4





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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 7 September 2004	Examiner Paulson, B
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04001)



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EUROPEAN SEARCH REPORT

Application Number
EP 04 01 3370

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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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