US 20180149044A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2018/0149044 A1

(43) Pub. Date: May 31, 2018

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(54) VALVE OPENING/CLOSING TIMING CONTROL DEVICE

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(21) Appl. No.: 15/577,467

(22) PCT Filed: Jun. 20, 2016

(86) PCT No.: PCT/JP2016/068263

§ 371 (c)(1),
(2) Date: Nov. 28, 2017

(30) Foreign Application Priority Data

Jun. 29, 2015 (JP) 2015-130150

Publication Classification

(51) Int. Cl.
F01L 1/344 (2006.01)

(52) U.S. Cl.
CPC ***F01L 1/3442*** (2013.01); *F01L 1/047* (2013.01); *F01L 2250/04* (2013.01); *F01L 2101/00* (2013.01)

(57) ABSTRACT

A valve opening/closing timing control device includes a driving rotary body rotatable in synchronism with a crankshaft of an internal combustion engine, a driven rotary body rotatable in unison with a cam shaft of the internal combustion engine and rotatable also relative to the driving rotary body within this driving rotary body, a fluid pressure chamber formed by the driving rotary body and the driven rotary body, and a partitioning portion that partitions the fluid pressure chamber into an advance chamber and a retard chamber. The driving rotary body includes an aluminum housing having a pulley that receives a drive force of the crankshaft via a drive belt and a plate attached to at least one face of the housing. Between the housing and the plate, there is provided a gap allowing outflow of fluid.

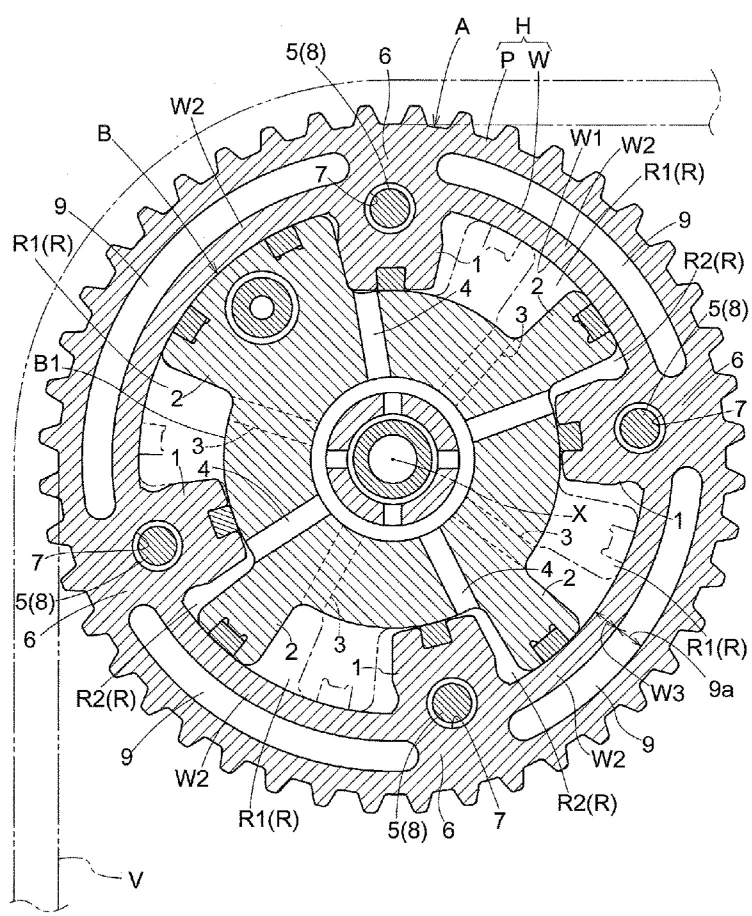


Fig.1

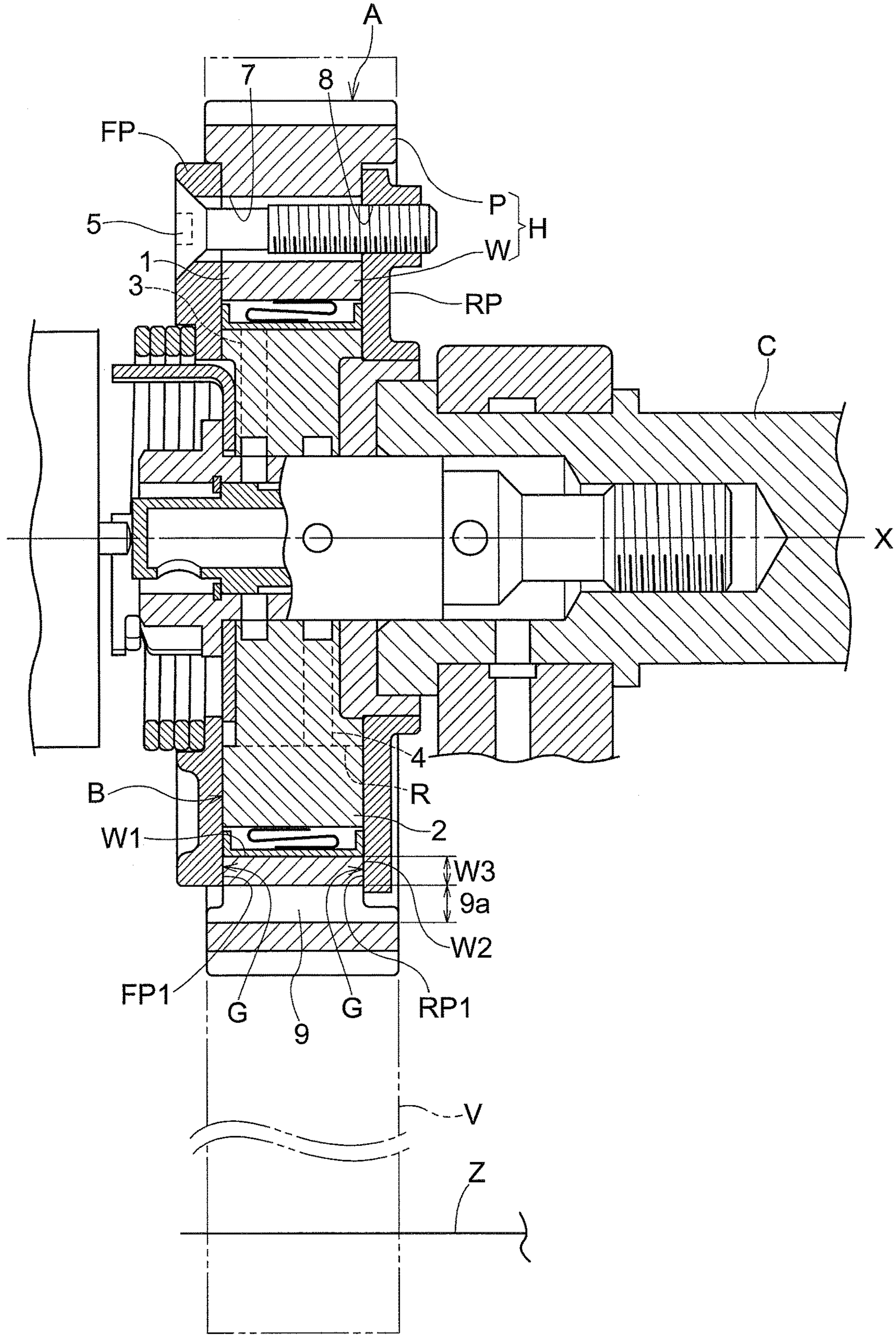
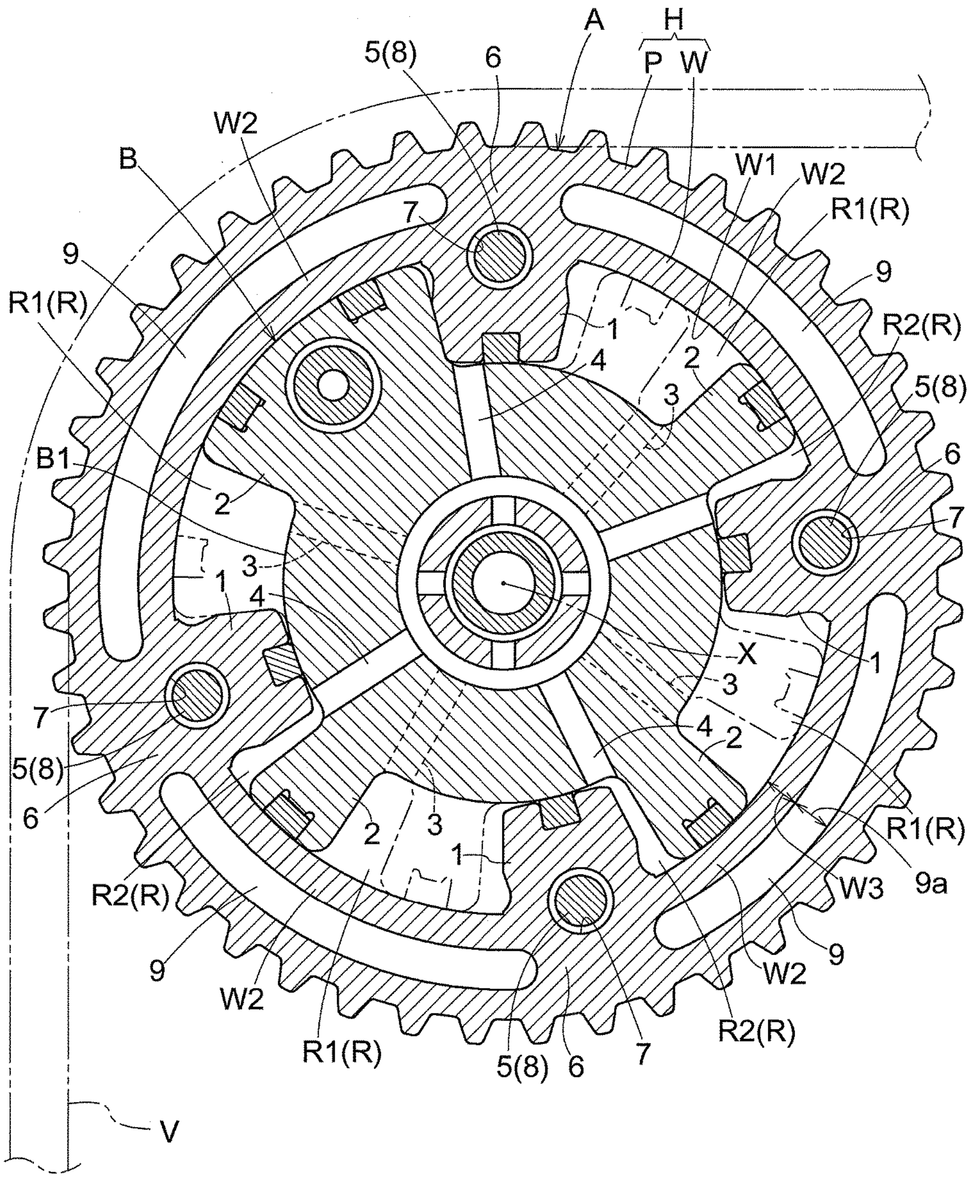


Fig.2



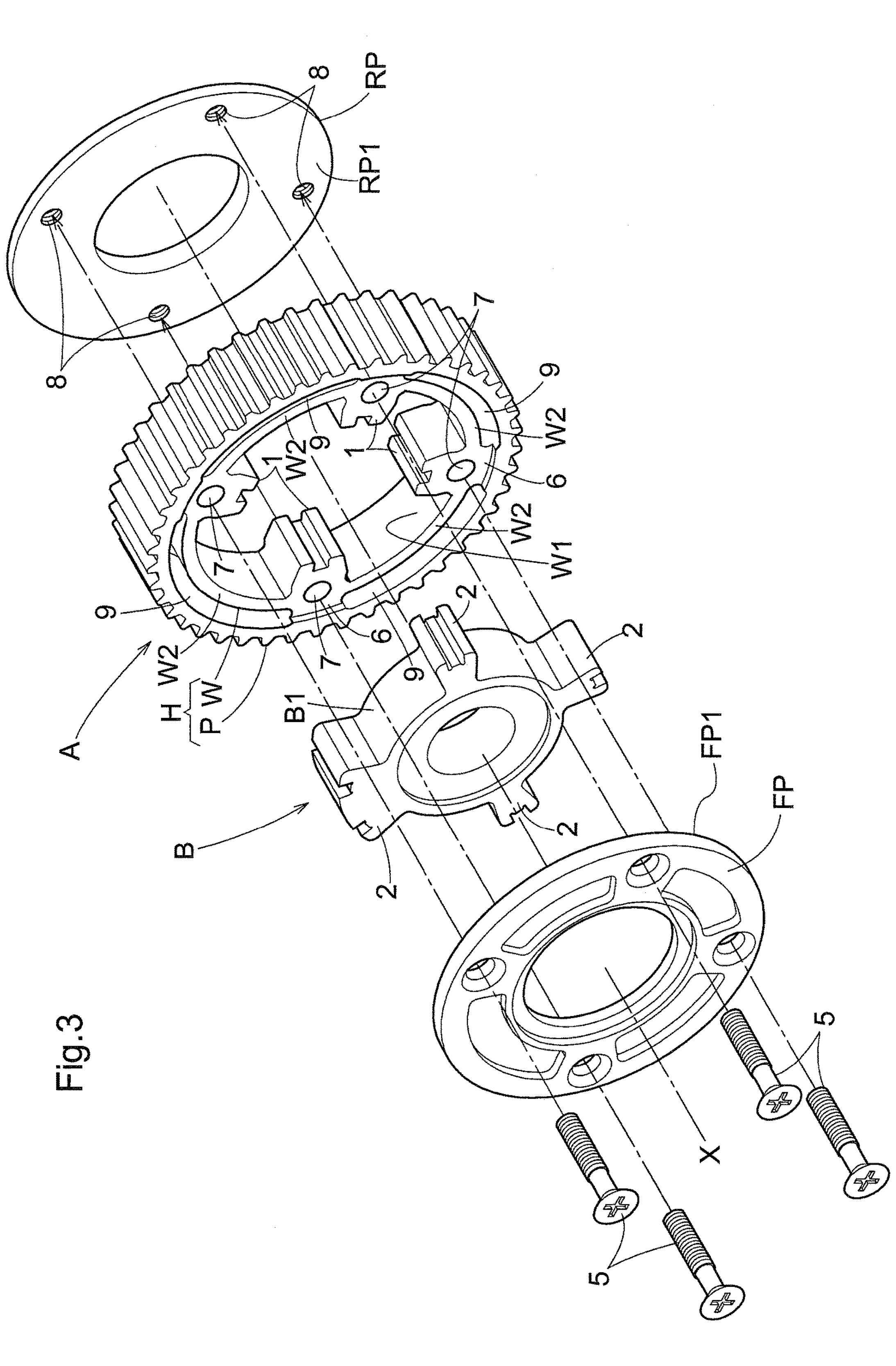


Fig.3

VALVE OPENING/CLOSING TIMING CONTROL DEVICE

TECHNICAL FIELD

[0001] The present invention relates to a valve opening/closing timing control device configured to adjust ignition timing of an internal combustion engine, more particularly to such device in which a driving rotary body having a pulley receiving a drive force from a crankshaft is formed of aluminum material.

RELATED ART

[0002] Such valve opening/closing timing control device having a driving rotary body formed of aluminum material is known from e.g. Patent Document 1. Here, aluminum material is extruded from a mold and then subjected to a first work for shape adjustment and then the outer circumferential face and the inner circumferential face entirely are subjected to an "alumite" (anodized aluminum) treatment for hardening of the respective surface. According to the above document, the use of aluminum material allows weight reduction of the device. Further, as the driving rotary body is produced by extrusion molding, leak of operating oil from the inside of the driving rotary body to the pulley formed outside it can be prevented, thus preventing deterioration of a rubber belt (see paragraphs [0017], [0193]).

PRIOR-ART DOCUMENT

Patent Document

[0003] Patent Document 1: Japanese Unexamined Patent Application Publication No. 2010-203234

SUMMARY

Problem to be Solved by Invention

[0004] In the case of the technique of Patent Document 1 above, while the alumite treatment enhances the surface hardness of the driving rotary body, this treatment also causes deterioration in the surface roughness of e.g. the pulley tooth portion. Then, if the coating layer thickness of the alumite treatment is increased in order to improve the wear resistance of the pulley tooth portion, this will cause further deterioration in the surface roughness. As a result, the belt wound around the pulley can be easily damaged, thus reducing the service life of the belt.

[0005] Further, the pulley is formed to protrude in the radially outward direction from the main body of the driving rotary body along the entire circumference thereof. Thus, deformation caused by the tension of the belt can be transmitted to the main body of the driving rotary body, which may cause deformation of this main body. The inner circumferential face of this main body is exposed to sliding contact with vanes provided in the driven rotary body for forming advance chambers and retard chambers. Therefore, such deformation of the main body leads to deterioration in the contact condition of the vanes, which may lead to inadvertent establishment of communication between an advance chamber and a retard chamber, so that precision control of valve opening/closing timing may become impossible.

[0006] Further, the main body formed integral with the pulley and the front and rear plates are fastened to each other with use of a bolt. Then, the fastening force of the bolt may be applied to the contacting face between the respective plate and the main body, which can cause deformation in the main body. Consequently, the pulley may be deformed to cause deterioration in the tooth portion precision, thus resulting possibly in further reduction of the service life of the drive belt or noise generation by the drive belt.

[0007] In view of the situation described above, there is a need for such valve opening/closing timing control device that uses aluminum material, but allows high precision in the phase control and longer service life of the belt.

Solution

[0008] According to a characterizing feature of the present invention, a valve opening/closing control device comprises:

[0009] a driving rotary body rotatable in synchronism with a crankshaft of an internal combustion engine and rotatable also about a rotational axis;

[0010] a driven rotary body rotatable in unison with a cam shaft of the internal combustion engine about the rotational axis and rotatable to the driving rotary body within this driving rotary body;

[0011] a fluid pressure chamber formed by the driving rotary body and the driven rotary body;

[0012] a partitioning portion provided within the fluid pressure chamber for partitioning the fluid pressure chamber into a retard chamber and an advance chamber allowing introduction and discharge of fluid thereto/therefrom, the partitioning portion selectively displacing relative rotation phase of the driven rotary body relative to the driving rotary body in a retard direction in which capacity inside the retard chamber is increased in association with introduction of the fluid or an advance direction in which capacity inside the advance chamber is increased in association with introduction of the fluid;

[0013] a phase control section that controls either feeding of the fluid to the retard chamber and discharging of the fluid from the advance chamber, or discharging of the fluid from the retard chamber and feeding of the fluid to the advance chamber;

[0014] the driving rotary body including an aluminum housing having a pulley that inputs drive force from the crankshaft via a drive belt and a plate attached to at least one face of the housing extending along the rotational axis; and

[0015] a gap allowing outflow of the fluid therethrough being provided between the housing and the plate.

[0016] In case the pulley and the housing of the driving rotary body are formed of aluminum material, due to relative softness of the material per se, frictional wear tends to occur in the pulley resulting from its contact with the drive belt.

[0017] In view of the above, in the inventive arrangement above, between the housing and the plate, there is provided a gap that allows outflow of fluid therethrough. With this arrangement, the fluid flows out via this gap in association with rotation of the driving rotary body and this fluid will flow to the outer side by the centrifugal force. This fluid will reach the pulley disposed outside the housing and the drive belt wound around this pulley, thus lubricating the contact portion between the pulley and the drive belt. In this way, with the above inventive arrangement, it is possible to obtain a valve opening/closing timing control device that can reduce frictional wear of the pulley and the drive belt, thus being reliable in its operation.

[0018] According to a further arrangement, preferably, the pulley is subjected to an alumite treatment in advance.

[0019] With such alumite treatment of the pulley, the surface strength of the pulley can be increased. However, while the alumite treatment provides enhancement of the surface strength of the pulley, the surface shape of the pulley can be roughened with growth of alumite layer, thus becoming more aggressive to the drive belt wound around this pulley. Notwithstanding, since friction between the drive belt and the pulley is lessened by the fluid fed via the gap, the reliability of the valve opening/closing timing control device will not be impaired.

[0020] According to a further arrangement, preferably, at least one of a contacting face of the housing and a contacting face of the plate is provided as an alumite-treated surface having a predetermined surface roughness; and the contacting face of the housing and the contacting face of the plate are placed in direct contact with each other.

[0021] As described above, fluid is caused to outflow through the gap between the housing and the plate. Therefore, with the inventive arrangement above, at least one of the housing and the plate is formed of aluminum material and at least one of the mutually contacting faces thereof is provided as an alumite-treated face. Namely, the surface roughness of the contacting face is increased by the alumite treatment and the gap is formed by the direct contact between the housing and the plate. Moreover, thanks to the increased strength of the contacting face having the alumite treatment, deformation in the driving rotary member can be prevented. Thus, it becomes possible to obtain a valve opening/closing timing control device having higher reliability.

[0022] With the above-described provision of the alumite treatment to at least one of the housing and the plate, a driving rotary body allowing the outflow of fluid can be formed in an efficient manner. In particular, in the case of providing the alumite treatment to the contacting face of the housing, it is possible to provide the alumite treatment to the pulley and this contacting face simultaneously, whereby the efficiency of the work for forming the gap can be further improved. Further, since the housing and the plate are caused to come into direct contact with each other, there is no need to provide e.g. a sealing member therebetween. So, the configuration of the driving rotary body can be made simple.

[0023] According to a further arrangement, preferably:

[0024] the partitioning portion is provided in the driven rotary body;

[0025] the housing includes a cylindrical wall portion having, in its inner circumferential face, a sliding contacting area where the housing comes into sliding contact with the partitioning portion;

[0026] between the pulley and the cylindrical wall portion, there is formed a groove portion that penetrates in the direction of the rotational axis and extends in a circumferential direction relative to the rotational axis; and

[0027] the groove portion and the sliding contacting area have a mutually overlapped area in a radial direction of the rotational axis.

[0028] An aluminum housing is softer than a steel housing, so some deformation can occur therein when the drive force from the crankshaft is inputted to the pulley via the drive belt. As a result, for instance, some warping may occur in the cylindrical wall portion of the housing, which in turn can lead to formation of a gap between the partitioning portion and the inner circumferential face of the cylindrical wall portion, which face should come into sliding contact with the partitioning portion. Such gap if formed results in inadvertent leakage of the fluid between the advance chamber and the retard chamber, thus leading eventually to imprecision in the phase control of the valve opening/closing timing control device.

[0029] In view of the above, in the inventive arrangement above, between the pulley and the cylindrical wall portion, there is provided a groove portion that penetrates in the direction of the rotational axis and extends in a circumferential direction relative to the rotational axis and the groove portion and the sliding contacting area have a mutually overlapped area in a radial direction of the rotational axis. With this, even when deformation occurs in the pulley, it is still possible to prevent this deformation from being transmitted to the cylindrical wall portion of the housing.

[0030] As a result, it becomes possible to obtain a valve opening/closing timing control device that can effect precise phase control.

[0031] According to a further arrangement, preferably, a width of the groove portion along the radial direction of the rotational axis is set greater than a width of the contacting face of the housing that comes into contact with the plate along the radial direction.

[0032] In the above arrangement, the housing is formed by extrusion molding of an aluminum material for instance. Therefore, with setting of the width of the groove portion to the width defined in the above arrangement, the pulley can be formed with a predetermined outside diameter by locating the position of the pulley on the outer side of the outer face of the cylindrical wall portion and also the extrusion amount of the aluminum material can be reduced by the amount corresponding to the groove portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. **1** is a side view in section of a valve opening/closing timing control device according to an embodiment,

[0034] FIG. **2** is a plane view in section of the valve opening/closing timing control device according to the embodiment, and

[0035] FIG. **3** is an exploded perspective view of a driving rotary body in the embodiment.

EMBODIMENTS

[0036] [General Configuration]

[0037] Next, an embodiment of the present invention will be explained with reference to the accompanying drawings.

[0038] A valve opening/closing timing control device relating to this embodiment is shown in FIGS. **1** through **3**. FIG. **1** is a side view in section of the inventive device. FIG. **2** is a plane view in section of the same and FIG. **3** is an exploded perspective view of a driving rotary body.

[0039] The valve opening/closing timing control device consists mainly of a driving rotary body A (an outer rotor) rotatable in synchronism with a crankshaft Z of an internal combustion engine and rotatable also about a rotational axis X, a driven rotary body B (an inner rotor) mounted within the driving rotary body A and rotatable in unison with a cam shaft C of the internal combustion engine about the rotational axis X, and a phase control section for adjusting a relative rotation phase between the driving rotary body A and the driven rotary body B.

[0040] Between the driving rotary body A and the driven rotary body B, a fluid pressure chamber R is formed. A first protruding portion **1** protruding inwards from the driving rotary body A on the outer side comes into contact with an outer circumferential face B**1** of the driven rotary body B disposed on the inner side; and a second protruding portion **2** protruding from the outer circumferential face B**1** of the driven rotary body B comes into contact with an inner circumferential face W**1** of the driving rotary body A. These first protruding portion **1** and second protruding portion **2** function as "partitioning portions" of the fluid pressure chamber R and partition the fluid pressure chamber R into an advance chamber R**1** and a retard chamber R**2**.

[0041] In operation, when operating fluid is fed to the advance chamber R**1** via an advance oil passage **3** and operating fluid is discharged from the retard chamber R**2** via a retard oil passage **4**, the driven rotary body B is relatively rotated in the clockwise direction in FIG. **2**. As a result, the valve opening/closing timing of the internal combustion engine is advanced. For instance, such an advance operation as above is effected for e.g. increasing the rotational speed of the internal combustion engine. On the other hand, when the operating fluid is fed to the retard chamber R**2** and the operating fluid is discharged from the advance chamber R**1**, the driven rotary body B is relatively rotated in the counterclockwise direction in FIG. **2**. As a result, the valve opening/closing timing of the internal combustion engine is retarded (delayed). This latter operation is effected for e.g. decreasing the rotational speed of the internal combustion engine, and an operation with idling rotation will be effected in a most retarded phase.

[0042] [Housing]

[0043] In this embodiment, a housing H of the driving rotary body A is formed of an aluminum material. This driving rotary body A consists mainly of three components; namely, the housing H integrally forming a pulley P in its outer circumferential portion, a front plate FP and a rear plate RP which sandwich this housing H from the opposed sides thereof. These components are assembled together with using a plurality of fastening bolts **5**. The housing H, as shown in FIG. **3**, has a substantially constant cross sectional shape as seen in a section along the fastening direction and is produced by extrusion molding of the aluminum material. Incidentally, as an alternative arrangement to the above, it is possible to mold the front plate FP or the rear plate RP integrally with the housing H. In such case, the production can be made by e.g. die-casting technique.

[0044] In particular, the housing H includes the pulley P formed on the outer circumferential side and a cylindrical wall portion W formed on its inner circumferential side and accommodating the driven rotary body B. This cylindrical wall portion W includes an inner circumferential face W**1** which comes into sliding contact with the second protruding portion **2** formed in the driven rotary body B. Further, the cylindrical wall portion W includes a plurality of first protruding portions **1** which come into sliding contact with the outer circumferential face B**1** of the driven rotary body B.

[0045] As shown in FIG. **2**, on the outer circumferential side of the cylindrical wall portion W, the pulley P is integrally formed in such a manner that most of it is spaced from the cylindrical wall portion W. The cylindrical wall portion W and the pulley P are connected at connecting portions **6** provided at same positions as the first protruding portions **1** provided at four positions in distribution along the circumferential direction.

[0046] With the above-described arrangement of the cylindrical wall portion W and the pulley P being assembled and formed integrally with each other, in comparison with an arrangement of these two parts being provided separately and connected as such to each other, the above arrangement advantageously eliminates trouble of an alignment operation for them. Further, the arrangement eliminates also the fastening bolts **5** for integrating them together and the fastening operation per se too can be eliminated. Thus, such advantages as weight reduction and cost reduction can be achieved.

[0047] [Bolt Fastening]

[0048] As shown in FIG. **2** and FIG. **3**, a bolt hole **7** formed in the housing H for allowing insertion of the fastening bolt **5** is provided at a center position of the respective first protruding portion **1**. With this arrangement, it is possible to secure a large contact area between the front plate FP or the rear plate RP and the housing H and to avoid application of locally concentrated load to the housing H at the time of fastening of the fastening bolt **5**. Consequently, the arrangement can lessen the possibility of deforming of the front plate FP, the rear plate RP and the housing H. Thus, it becomes possible to prevent unnecessary leakage of the operating fluid held within the fluid pressure chamber R to the outside from e.g. a gap between the front plate FP and the housing H.

[0049] Incidentally, the front plate FP and the rear plate RP too can be formed of aluminum material. In the case of such arrangement, the driving rotary body A can be formed further light-weighted. Incidentally, in case the rear plate RP is formed of aluminum material, a female thread portion **8** to which the fastening bolt **5** engages can be formed slightly longer, so as to prevent damage of this female thread portion **8** by the fastening force.

[0050] Also, the position of the female thread portion **8** is a position between the first protruding portion **1** and the connecting portion **6** along the radial direction. More specifically, this is a position slightly offset toward the first protruding portion **1**. With this position setting, when the second protruding portion **2** of the driven rotary body B reaches the most advanced phase and the most retarded phase to come into contact with the first protruding portion **1**, bending deformation of the first protruding portion **1** can be avoided. Incidentally, in the case of the example shown in FIG. **2**, the arrangement is made such that only the second protruding portion **2** located at the left upper side in FIG. **2** will come into contact with the first protruding portion **1**.

[0051] [Alumite Treatment]

[0052] In case the pulley P and the housing H of the driving rotary body A are formed of aluminum material which is a relatively soft material, frictional wear tends to occur in the pulley P due to its friction with the drive belt V. Then, for this driving rotary body A, in order to enhance the hardness of its surface, an anodizing oxidization treatment, alias, an alumite treatment, is effected. Specifically, this treatment is given to the tooth portion of the pulley P and the lateral face of the cylindrical wall portion W.

[0053] However, the alumite treatment causes deterioration in the surface roughness of the treated surface. For this reason, there will occur aggressiveness such as increased friction coefficient relative to the drive belt V, so that reduction in the service life of the drive belt V may result to the contrary.

[0054] [Gap]

[0055] Then, in this embodiment, as shown in FIG. **1** and FIG. **3**, an arrangement is provided such that operating fluid for the sake of lubrication may be fed to the drive belt V through a gap between the housing H and the front plate FP and the rear plate RP.

[0056] More particularly, between the housing H and the front plate FP and the rear plate RP, gaps G are provided which allow outflow of oil as the operating fluid. Such gaps G are formed e.g. by increasing the surface roughness of a contacting face W**2**, which is a surface of the housing H that comes into contact with the front plate FP or the rear plate RP, by means of the above-described alumite treatment.

[0057] The contacting face W**2** of the housing H is brought into direct contact with a contacting face FP**1** of the front plate FP or a contacting face RP**1** of the rear plate RP each other.

[0058] With the above-described arrangement, in association with rotation of the driving rotary body A, an appropriate amount of oil will outflow through the gap and will flow to the outer side by the centrifugal force. This flowing oil will reach the pulley P disposed on the outer side of the housing H and the drive belt V wound around the pulley P, thus lubricating the pulley P and the drive belt V. Needless to say, the drive belt V used should be made of material suitable for the oil lubrication.

[0059] Further, with the alumite treatment of the contacting face W**2**, the surface hardness of this contacting face W**2** is enhanced. Therefore, at the time of fastening with the front plate FP and the rear plate RP, even if the fastening force of the fastening bolt **5** is too strong, deformation of the cylindrical wall portion W can be prevented.

[0060] Further, with the above-described arrangement, there is no need to provide special sealing material between the cylindrical wall portion W and the front plate FP or the rear plate RP, so the configuration of the driving rotary body A can be simplified.

[0061] In this way, with the driving rotary body A having the above-described arrangement, the configuration of the driving rotary body A can be simplified and at the same time frictional wear of the pulley P and the drive belt V can be reduced. Consequently, it is possible to obtain a valve opening/closing timing control device which is highly reliable.

[0062] Incidentally, for the purpose of forming the gap G, the front plate FP or the rear plate RP may be formed of aluminum material and the contacting face FP**1** of the front plate FP or the contacting face RP**1** of the rear plate RP may be subjected to alumite treatment for enhancing the surface roughness of these faces.

[0063] [Groove Portion]

[0064] In the driving rotary body A used in this embodiment, between the pulley P and the cylindrical wall portion W, there are formed groove portions **9** that penetrate in the direction of the rotational axis X and extend in the circumferential direction relative to the rotational axis X. In the case of the example shown in FIG. **2**, such groove portions **9** are formed over all entire regions other than those of the connecting portions **6** which connect the cylindrical wall portion W and the pulley P.

[0065] Each end portion of the groove portion **9** in the circumferential direction extends to reach a more center side of the first protruding portion **1** than the lateral face of this first protruding portion **1**. Namely, a circumferential length of the respective connecting portion **6** which is the region sandwiched between two adjacent groove portions **9** is set shorter than the circumferential length of the first protruding portion **1** corresponding to the respective connecting portion **6**. The reason for this is as follows. Namely, by securing a large area for the groove portion **9** relative to the region where the second protruding portion **2** of the driven rotary body B comes into sliding contacting with the inner circumferential face W**1** of the cylindrical wall portion W, even if deformation should occur in the pulley P by the drive belt V, the position where such deformation is transmitted to the cylindrical wall portion W can be set away from the sliding contacting region of the second protruding portion **2**.

[0066] Incidentally, the circumferential length of the groove portion **9** need not necessarily be longer than the circumferential length of the sliding contacting region of the second protruding portion **2**. For, such effect of preventing transmission of deformation of the pulley P to the cylindrical wall portion W can be achieved as long as there is present, even of a very small amount, a region where the groove portion **9** and the sliding contacting region are overlapped with each other along the radial direction of the rotational axis X.

[0067] Further, with formation of such groove portions **9** above, when there occurs rise of temperature in the driving rotary body A in the course of operation of the internal combustion engine, such heat will less likely be conducted to the pulley P. Therefore, heat deterioration of the drive belt V can be prevented. First of all, the provision of the groove portions **9** can achieve reduction in the amount of aluminum material used as well as weight reduction of the driving rotary body A.

[0068] On the other hand, as for a width **9***a* of the groove portion **9** in the radial direction, this can vary in size in many ways. Basically, by proving the groove portion **9** to render the cylindrical wall portion W and the pulley P away from each other in the radial direction, this will make deformation in the pulley P to be transmitted less likely to the cylindrical wall portion W. However, advantageously, this width **9***a* of the groove portion **9** will be formed greater than a width W**3** of the contacting face W**2** of the housing H.

[0069] The housing H in this arrangement is formed by extrusion molding of the aluminum material. Therefore, by setting the width **9***a* of the groove portion **9** greater than the width W**3** of the contacting face W**2**, it becomes possible to locate the position of the pulley P on the radially outer side from the outer face of the cylindrical wall portion W, thus forming the pulley P of a predetermined outside diameter and also to reduce the extrusion amount of the aluminum material by the amount corresponding to the groove portion **9**. In this, if the width **9***a* of the groove portion **9** is too short, the portion corresponding to the groove portion **9** at the time of extrusion molding will become too narrow, thus making the molding difficult and causing reduction in the service life of the mold also. Then, by setting the width **9***a* of the groove portion **9** greater than the width W**3** of the contacting face W**2**, the sizes of the mold will become appropriate, so that an extrusion mold that can be readily manufactured and that has good durability can be obtained. With appropriate setting of the width **9***a* of the groove portion **9**, extrusion resistance experienced by the aluminum material in the course of extrusion molding will be reduced and the manufacture efficiency will improve.

[0070] Moreover, with the setting of the width **9***a* of the groove portion **9** greater than the width W**3** of the contacting face W**2**, when e.g. the front plate FP is to be bolt-fastened to the cylindrical wall portion W, transmission of the fastening force applied to the cylindrical wall portion W to the pulley P beyond the connecting portion **6** can be prevented. Therefore, the shape of the pulley P can be maintained as a true circle, so no rotational shake will occur, and damage to the drive belt V can be prevented.

Other Embodiments

[0071] Not only the housing H, but also the front plate FP and the rear plate RP can be formed of aluminum material.

[0072] With the above-described arrangement, there is achieved significant reduction in the weight of the driving rotary body A. In such arrangement, however, the female thread portion **8** of the rear plate RP used for fixing the fastening bolt **5** should have a necessary length along the longitudinal direction of the fastening bolt **5** in order to be able to withstand sufficient fastening torque.

[0073] As the “gap” provided between the cylindrical wall portion W and the front plate FP or between the cylindrical wall portion W and the rear plate RP, a recess extending in the radial direction relative to the cylindrical wall portion W, the front plate FP or the rear plate RP can be provided. Such recess can be formed by cutting, molding or embossing. With the recess formed as such, it is possible to freely set the outflow position and/or outflow amount of the oil, so that more accurate lubricating effect can be achieved.

INDUSTRIAL APPLICABILITY

[0074] The present invention is widely applicable to various kinds of valve opening/closing timing control device configured to effect phase control by feeding/discharging of operating fluid.

DESCRIPTION OF REFERENCE MARKS/NUMERALS

[0075] **1**: first protruding portion (partitioning portion)
[0076] **2**: second protruding portion (partitioning portion)
[0077] **9**: groove portion
[0078] A: driving rotary body
[0079] B: driven rotary body
[0080] C: cam shaft
[0081] FP: front plate
[0082] FP**1**: contacting face of front plate
[0083] RP: rear plate
[0084] RP**1**: contacting face of rear plate
[0085] H: housing
[0086] P: pulley
[0087] R: fluid pressure chamber
[0088] R**1**: advance chamber
[0089] R**2**: retard chamber
[0090] V: drive belt
[0091] W: cylindrical wall portion
[0092] W**1**: inner circumferential face
[0093] W**2**: contacting face of housing
[0094] X: rotational axis
[0095] Z: crank shaft

1. A valve opening/closing control device comprising:
- a driving rotary body rotatable in synchronism with a crankshaft of an internal combustion engine and rotatable also about a rotational axis;
- a driven rotary body rotatable in unison with a cam shaft of the internal combustion engine about the rotational axis and rotatable also relative to the driving rotary body within this driving rotary body;
- a fluid pressure chamber formed by the driving rotary body and the driven rotary body;
- a partitioning portion provided within the fluid pressure chamber for partitioning the fluid pressure chamber into a retard chamber and an advance chamber allowing introduction and discharge of fluid thereto/therefrom, the partitioning portion selectively displacing relative rotation phase of the driven rotary body relative to the driving rotary body in a retard direction in which capacity inside the retard chamber is increased in association with introduction of the fluid or an advance direction in which capacity inside the advance chamber is increased in association with introduction of the fluid;
- the driving rotary body including an aluminum housing having a pulley that inputs drive force from the crankshaft via a drive belt and a plate attached to at least one face of the housing extending along the rotational axis; and
- a gap allowing outflow of the fluid therethrough being provided between the housing and the plate.

2. The valve opening/closing control device of claim **1**, wherein the pulley is subjected to an alumite treatment in advance.

3. The valve opening/closing control device of claim **1**, wherein at least one of a contacting face of the housing and a contacting face of the plate is provided as an alumite-treated surface having a predetermined surface roughness; and the contacting face of the housing and the contacting face of the plate are placed in direct contact with each other.

4. The valve opening/closing control device of claim **1**, wherein:
- the partitioning portion is provided in the driven rotary body;
- the housing includes a cylindrical wall portion having, in its inner circumferential face, a sliding contacting area where the housing comes into sliding contact with the partitioning portion;
- between the pulley and the cylindrical wall portion, there is formed a groove portion that penetrates in the direction of the rotational axis and extends in a circumferential direction relative to the rotational axis; and
- the groove portion and the sliding contacting area have a mutually overlapped area in a radial direction of the rotational axis.

5. The valve opening/closing control device of claim **4**, wherein a width of the groove portion along the radial direction of the rotational axis is set greater than a width of the contacting face of the housing that comes into contact with the plate along the radial direction.

* * * * *