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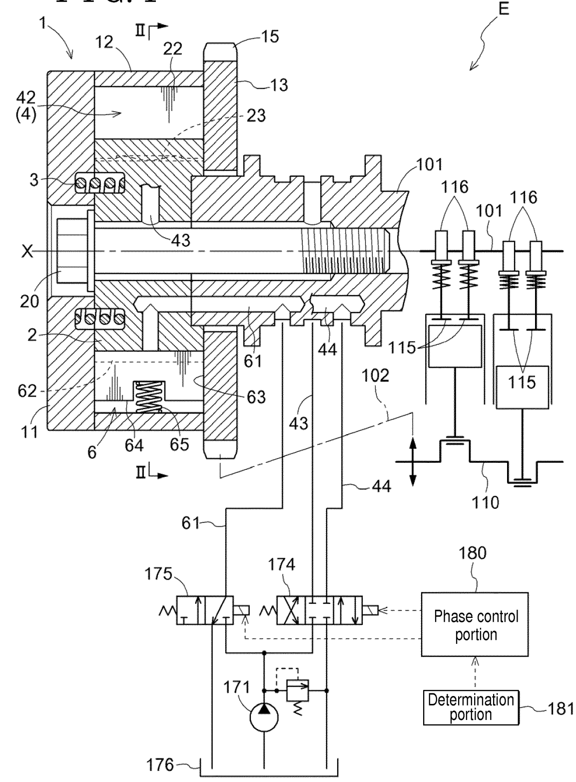
(54) VALVE OPENING/CLOSING TIMING CONTROL DEVICE

(57) A valve opening and closing timing control device being promptly movable to an intermediate lock phase includes a vane selectively moving a relative rotational phase of a driven-side rotary member to a driving-side rotary member between a retarded direction and an advance direction, the retarded direction where a volume within a retard chamber increases by an inflow of a fluid, the advance direction where a volume within an advance chamber increases by the inflow of the fluid, an intermediate lock mechanism being switchable between a lock state and an unlock state, the lock state where the relative rotational phase is locked at an intermediate locked phase by a fitting of a lock member that is provided at the driving-side rotary member into a recess that is provided at the driven-side rotary member, the unlocked state where the relative rotational phase is unlocked by a retraction of the lock member from the recess, and a phase control portion performing a control of a supply of the fluid to the retard chamber and a discharge of the fluid from the advance chamber, or a control of a discharge of the fluid from the retard chamber and a supply of the fluid to the advance chamber, in order for the lock member to reach the intermediate locked phase by reducing a travelling speed of the relative rotational phase from a reference phase to the intermediate locked phase to be slower than the travelling speed of the relative rotational phase to the reference phase when the intermediate lock mechanism is switched from the unlock state to the lock state.

F I G. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a valve opening and closing timing control device that controls a relative rotational phase of a driven-side rotary member rotating integrally with a camshaft of an internal combustion engine relative to a driving-side rotary member rotating synchronously with a crankshaft of the internal combustion engine.

BACKGROUND ART

[0002] Conventionally, a valve opening and closing timing control device controlling the opening and closing timing of one of or both of an intake valve and an exhaust valve has been used in order to enhance a fuel consumption of an internal combustion engine (hereinafter referred to as an engine). This kind of valve opening and closing timing control device controls the opening and closing timing by changing a relative rotational phase between a driving-side rotary member rotating synchronously with a crankshaft and a driven-side rotary member rotating integrally with a camshaft.

[0003] Generally, an optimum opening and closing timing of each of the intake valve and the exhaust valve differs in accordance with an operation condition of the engine, for example, when the engine starts and when a vehicle runs. When the engine starts, the optimum opening and closing timing of each of the intake valve and the exhaust valve for starting the engine is realized by locking the relative rotational phase of the driven-side rotary member relative to the rotation of the driving-side rotary member (hereinafter referred to as a relative rotational phase) at a predetermined phase that is provided between a most retard phase and a most advance phase. However, when the vehicle idles after starting the engine, because an amount of emission of carbon hydride (HC) is increased in a case where the relative rotational phase is maintained at a phase being positioned when the engine starts, it is favorable that the relative rotational phase is changed to a phase where the amount of emission of HC can be inhibited from being generated when the vehicle idles after starting the engine. In addition, it is favorable that the relative rotational phase is changed so as to easily restart the engine that is in a high-temperature state when the vehicle performs an idling stop in which the engine is temporarily stopped in a case where the vehicle stops by an operation of a brake pedal during a normal operation. Such a technology is described in Patent document 1 of which a source is shown below.

[0004] In Patent document 1, a variable valve timing control device of an internal combustion engine including a feature that locks a rotational phase of a camshaft relative to a crankshaft of the internal combustion engine at an intermediate locked phase being positioned at a substantially middle of an adjustable range of the rotational phase is disclosed. The variable timing control device of the internal combustion engine includes a lock control portion that controls an oil-pressure control device in order to lock the rotational phase of the camshaft at the intermediate locked phase by a lock pin when a lock request is generated. The lock control portion controls the oil-pressure control device so that the rotational phase of the camshaft passes through the intermediate locked phase while biasing the lock pin in a lock direction when the lock request is generated. When the rotational phase of the camshaft does not move at the vicinity of the intermediate locked phase during the phase variable control, a control amount of the oil-pressure control device is changed further by a predetermined amount in a moving direction of the rotational phase of the camshaft. In this case, it is determined that the locking is completed in a case where the rotational phase of the camshaft does not move.

DOCUMENT OF PRIOR ART

PATENT DOCUMENT

[0005] Patent document 1: JP2010-138699A

OVERVIEW OF INVENTION

PROBLEM TO BE SOLVED BY INVENTION

[0006] The technology described in Patent document 1 controls the rotational phase of the camshaft to pass through the intermediate locked phase when the lock request is generated. In addition, after the control, the control amount of the oil-pressure control device is further changed to the predetermined amount in the moving direction of the rotational phase of the camshaft when the rotational phase of the camshaft does not move at vicinity of the intermediate locked phase. In a case where the rotational phase of the camshaft does not move further, it is determined that the locking is completed. Thus, the rotational phase of the camshaft may pass through the intermediate locked phase, and in such a case, it takes some time to complete the locking.

[0007] The object of the present invention is, in a view of an aforementioned problem, to provide a valve opening and closing timing control device that can promptly move a relative rotational phase of a driven-side rotary member relative to a driving-side rotary member to an intermediate locked phase.

MEANS FOR SOLVING PROBLEM

[0008] A valve opening and closing timing control device of this invention for achieving the above-mentioned purpose includes a driving-side rotary member rotating synchronously with a crankshaft of an internal combustion engine, a driven-side rotary member rotating integrally with a camshaft of the internal combustion engine, the driven-side rotary member being relatively rotatable with the driving-side rotary member, a fluid pressure chamber being formed with the driving-side rotary member and the driven-side rotary member, a vane being positioned within the fluid pressure chamber, the vane dividing the fluid pressure chamber into a retard chamber and an advance chamber that each allows an inflow and an outflow of a fluid, the vane selectively moving a relative rotational phase of the driven-side rotary member relative to the driving-side rotary member between a retarded direction and an advance direction, the retarded direction where a volume within the retard chamber increases by the inflow of the fluid, the advance direction where a volume within the advance chamber increases by the inflow of the fluid, an intermediate lock mechanism being provided at one of the driving-side rotary member and the driven-side rotary member, the intermediate lock mechanism including a lock member being movable relative to the other of the driving-side rotary member and the driven-side rotary member, the intermediate lock mechanism including a recess extending along a circumferential direction, the recess being provided at the other of the driving-side rotary member and the driven-side rotary member, the intermediate lock mechanism being switchable between a lock state and an unlock state, the lock state where the relative rotational phase is locked at an intermediate locked phase being positioned between a most advance phase and a most retard phase by a fitting of the lock member into the recess, the unlocked state where the relative rotational phase is unlocked by a retraction of the lock member from the recess, and a phase control portion performing a control of a supply of the fluid to the retard chamber and a discharge of the fluid from the advance chamber, or a control of a discharge of the fluid from the retard chamber and a supply of the fluid to the advance chamber, in order for the lock member to reach the intermediate locked phase by reducing a travelling speed of the relative rotational phase from a reference phase that is provided between a present phase and the intermediate locked phase to the intermediate locked phase to be slower than the travelling speed of the relative rotational phase to the reference phase when the intermediate lock mechanism is switched from the unlock state to the lock state.

[0009] As in the present construction, the relative rotational phase of the driven-side rotary member relative to the driving-side rotary member can be in a lock state securely while promptly moving to the reference phase without jumping over the intermediate locked phase. Thus, the relative rotational phase can promptly move to the intermediate locked phase.

[0010] Furthermore, it is favorable that the phase control portion performs one of the control of the supply of the fluid to the retard chamber and the discharge of the fluid from the advance chamber, and the control of the discharge of the fluid from the retard chamber and the supply of the fluid to the advance chamber, in order for the travelling speed of the relative rotational phase from the present phase to the intermediate locked phase to be reduced by a predetermined amount of change.

[0011] As in the present construction, because the travelling time from the current phase to the intermediate locked phase can be easily predicted, a next operation can be efficiently followed.

[0012] Furthermore, it is favorable that the phase control portion performs one of the control of the supply of the fluid to the retard chamber and the discharge of the fluid from the advance chamber, and the control of the discharge of the fluid from the retard chamber and the supply of the fluid to the advance chamber, based on a map defined by a relationship between the travelling speed of the relative rotational phase from the present phase to the intermediate locked phase and a quantity of state showing a state of the fluid flowed to the retard chamber and to the advance chamber.

[0013] The easiness of the flow of the fluid in a case where the fluid passes through the flow passage changes in accordance with, for example, the pressure level and the temperature level of the fluid. Thus, a map defining the quantity of state and the travelling speed is memorized while the pressure level and the temperature level of the fluid serves as the amount of the state showing the state of the fluid. Thus, because the phase control portion controls the supply and discharge based on the map, the phase control position can easily move the relative rotational phase to the intermediate locked phase promptly.

[0014] In addition, it is favorable that the valve opening and closing timing control device further includes a determination portion determining whether the lock member reaches a determination phase, the determination phase being provided between the intermediate locked phase and the reference phase, and the determination portion determines whether the lock member reaches the determination phase when the phase control portion controls the lock member to move to the determination phase after performing one of the control of the supply of the fluid to the retard chamber and the discharge of the fluid from the advance chamber, and the control of the discharge of the fluid from the retard chamber and the supply of the fluid to the advance chamber.

[0015] According to the construction, because the position between the intermediate locked phase and the determination phase can be shallow, the determination portion securely determines whether the lock member reaches the intermediate locked phase.

[0016] In addition, it is favorable that the relative rotational phase moves from the present phase to the reference phase based on a first travelling speed, and the relative rotational phase moves from the reference phase to the intermediate locked phase based on a second travelling speed that is slower than the first travelling speed.

[0017] According to the construction, because the travelling speed of the relative rotational phase is reduced in a case where the relative rotational phase moves from the reference phase to the intermediate locked phase after moving from the present phase to the reference phase, the relative rotational phase can be prevented from passing through the intermediate locked phase. Accordingly, the relative rotational phase can move promptly and securely from the present phase to the intermediate locked phase without passing through the intermediate locked phase.

BRIEF DESCRIPTION OF DRAWINGS

[0018]

[Fig. 1] is a cross sectional view of a valve opening and closing timing control device.

[Fig. 2] is a cross sectional view illustrating a lock state taken along line II-II in Fig. 1.

[Fig. 3] is a cross sectional view illustrating an unlock state taken along line II-II in Fig. 1.

[Fig. 4] is a cross sectional view illustrating a most retard phase state taken along line II-II in Fig. 1.

[Fig. 5] is a view schematically illustrating a reference phase in a case where a relative rotational phase moves from a present position to an intermediate locked phase along an advance direction.

[Fig. 6] is a view schematically illustrating a reference phase in a case where the relative rotational phase moves from the present position to the intermediate locked phase along a retarded direction.

[Fig. 7] is a view illustrating an example of a travelling speed in a case where an inner rotor relative to an outer rotor relatively rotates from the present phase to the intermediate locked phase.

[Fig. 8] is a view illustrating another example of a travelling speed in a case where the inner rotor relative to an outer rotor relatively rotates from the present phase to the intermediate locked phase.

MODE FOR CARRYING OUT THE INVENTION

[0019] A valve opening and closing timing control device according to the present invention is able to move a lock member promptly to an intermediate locked phase in a case where a relative rotational phase of a driven-side rotary member relative to a driving-side rotary member comes to be the intermediate locked phase. Hereinafter, a valve opening and closing timing control device 1 of a present embodiment will be explained in detail. Fig. 1 is a side cross sectional view illustrating a whole configuration of the valve opening and closing timing control device 1 according to the present embodiment. Figs 2 to 4 are cross sectional views illustrating respective states taken along line II-II in Fig. 1. The valve opening and closing timing control device 1 is mounted on a vehicle including an engine as an internal combustion engine as a drive source and on a hybrid vehicle including a drive source including the engine and an electric motor.

[0020] The valve opening and closing timing control device 1 includes an outer rotor 12 serving as a driving-side rotary member and an inner rotor 2 serving as a driven-side rotary member. The outer rotor 12 rotates synchronously relative to a crankshaft 110 of an internal combustion engine E. The inner rotor 12 is relatively rotatable and is coaxially positioned relative to the outer rotor 12 while rotating integrally with a camshaft 101 of the internal combustion engine E. According to the present embodiment, the valve opening and closing timing control device 1 controls an opening and closing timing of an intake valve 115 by setting a relative rotational phase (a relative rotational angle) of the outer rotor 12 and the inner rotor 2 about an axis X.

[0021] The inner rotor 2 is mounted integrally on a distal end portion of the camshaft 101. Specifically, the inner rotor 2 is fitted in and fixed to the distal end portion of the camshaft 10 with a fastening bolt 20.

[0022] The valve opening and closing timing control device 1 includes a front plate 11, the outer rotor 12 and a rear plate 13. The front plate 11 is provided opposite to a side where the camshaft 101 is connected. The rear plate 13 is integrally formed with a timing sprocket 15 and is provided at the side where the camshaft 101 is connected. The inner rotor 2 is covered by the outer rotor 2. The outer rotor 12 is sandwiched by the front plate 11 and the rear plate 13 from opposing ends in an axial direction. In this state, the front plate 11, the outer rotor 12 and the rear plate 13 are fitted in and fixed to one another with the aforementioned fastening bolt 20.

[0023] When the crankshaft 110 is rotationally driven, a rotational driving force is transmitted to the timing sprocket 15 via a power transmission member 102. The outer rotor 12 is rotationally driven in a rotational direction S shown in Fig. 2. The inner rotor 2 is rotationally driven in the rotational direction S in accordance with the rotational drive of the outer rotor 12 to rotate the camshaft 101. A cam 116 being provided at the camshaft 101 opens a valve by pressing down the intake valve 115 of the internal combustion engine E.

[0024] As shown in Fig. 2, the outer rotor 12 is formed with plural protrusions 14 protruding inwardly in a radial direction so as to be separated from one another along the rotational direction S. A fluid pressure chamber 4 is formed by the outer rotor 12 and the inner rotor 2. The protrusion 4 serves as a shoe relative to an outer peripheral surface 2a of the inner rotor 2. According to the present embodiment, an example in which four of the fluid pressure chambers 4 are formed is explained, however, is not intended to limit the scope of the invention.

[0025] A portion of the outer peripheral surface 2a, the portion facing the fluid pressure chamber 4, is formed with a vane groove 21 of which a depth direction corresponds to the radial direction of the inner rotor 2. A portion of a vane 22 is inserted into the vane groove 21 and is standingly positioned outwardly in the radial direction. Thus, the vane 22 is positioned within the fluid pressure chamber 4.

[0026] The fluid pressure chamber 4 is divided into an advance chamber 41 and a retard chamber 42 with the vane 22. The advance chamber 41 and the retard chamber 42 allow an inflow and an outflow of an oil along the rotational direction S. In a case where the oil is supplied to the retard chamber 42, the relative rotational phase of the inner rotor 2 relative to the outer rotor 12 moves (is displaced) in the retarded direction of the relative rotational direction. The retarded direction corresponds to a direction in which a volume of the retard chamber 42 increases by the inflow of the oil, the direction that is shown with a reference numeral S2 in Fig. 2. In a case where the oil is supplied to the advance chamber 41, the relative rotational phase moves (is displaced) in the advance direction of the relative rotational direction. The advance direction corresponds to a direction in which the vane 22 relatively rotationally moves relative to the outer rotor 12 and corresponds to a direction in which a volume of the advance chamber 41 increases by the inflow of the oil, the direction shown with a reference numeral S1 in Fig. 2. A spring 23 is positioned between the vane groove 21 and the vane 22, and biases the vane 22 outwardly in the radial direction. Accordingly, the oil is prevented from leaking at a position between the advance chamber 41 and the retard chamber 42. The vane 22 selectively moves the relative rotational phase between the retarded direction and the advance direction.

[0027] As shown in Figs. 1 and 2, an advance passage 43 is formed at the inner rotor 2 and at the camshaft 101 so as to be communicated with each of the advance chambers 41. A retard passage 44 is formed at the inner rotor 2 and at the camshaft 101 so as to be communicated with each of the retard chambers 42. The advance passage 43 and the retard passage 44 are connected to respective predetermined ports of a first control valve 174.

[0028] Because the first control valve 174 is controlled, the oil is maintained to be supplied, to be discharged, or to be supplied and discharged relative to the advance chamber 41 and the retard chamber 42, and the fluid pressure of the oil is applied to the vane 22. As such, the relative rotational phase is displaced either in the advance direction S1 or in the retarded direction S2. Alternatively, the relative rotational phase is maintained at a desired phase.

[0029] In addition, as shown in Fig. 1, a torsion spring 3 is provided to be extended from the inner rotor 2 to the front plate 11. The torsion spring 3 biases the inner rotor 2 to a retard side in order to resist an averaged displacing force in the retarded direction S2 based on a torque variation of the camshaft 101. Thus, the relative rotational phase can be displaced in the advance direction S1 smoothly and promptly.

[0030] In such a configuration, the inner rotor 2 is smoothly and relatively rotationally movable relative to the outer rotor 12 about the axis X within a predetermined range. The predetermined range in which the outer rotor 12 and the inner rotor 2 are relatively rotationally movable, that is, a phase difference between a most advance phase and a most retard phase, corresponds to a displaceable range of the vane 22 within the fluid pressure chamber 4. The most retard phase corresponds to a phase where the volume of the retard chamber 42 comes to be at a maximum. The most advance phase corresponds to a phase where the volume of the advance chamber 41 comes to be at a maximum.

[0031] In a state where the fluid pressure level of the oil is not stable immediately after the start-up of the internal combustion engine E, an intermediate lock mechanism 6 holds the outer rotor 12 and the inner rotor 2 at respective predetermined relative positions. Accordingly, the relative rotational phase of the outer rotor 12 and the inner rotor 2 is locked at the intermediate locked phase that is positioned between the most retard phase and the most advance phase. As such, because the relative rotational phase is held at the intermediate locked phase, the rotational phase of the camshaft 101 relative to the rotational phase of the crankshaft 110 is appropriately maintained. Thus, the stable rotation of the internal combustion engine E is realized. According to the present embodiment, the intermediate locked phase corresponds to a phase in which the respective opening timings of the intake valve 115 and of the exhaust valve are partially duplicated (overlapped) with each other, or corresponds to a phase in which the closing timing of the exhaust valve and the opening timing of the intake valve 115 are substantially the same (zero lap). As a result, if the phase is such that the respective opening timings of the intake valve 115 and of the exhaust valve are partially duplicated with each other, the carbon hydride (HC) is reduced at the start-up of the internal combustion engine E. Accordingly, the low-emission internal combustion engine E is available. In addition, if the phase is such that the closing timing of the exhaust valve and the opening timing of the intake valve 115 are substantially the same, the combustion engine E that has a great start-up performance at a cold area and that has a great idling stability is available.

[0032] According to the present embodiment, as shown in Figs. 1 and 2, the intermediate lock mechanism 6 includes an intermediate lock passage 61, two of intermediate lock grooves 62, a housing portion 63, two plate-shaped intermediate lock members 64, and a spring 65. The intermediate lock groove 62 corresponds to a recess of the present invention, and the intermediate lock member 64 corresponds to a lock member of the present invention.

[0033] The intermediate lock passage 61 is formed at the inner rotor 2 and at the camshaft 101, and connects the intermediate lock groove 62 to a second control valve 175. Because the second control valve 175 is controlled, the supply/discharge of the oil to/from the intermediate lock groove 62 can be switched independently. The intermediate lock groove 62 is formed to be extended on the outer peripheral surface 2a of the inner rotor 2 in a circumferential direction and has a predetermined width in the relative rotational direction. The housing portion 63 is formed at two positions of the outer rotor 12. Two of the intermediate lock members 64 are positioned at the respective housing portions 63, and are able to be in and out of the housing portions 63 in the radial direction. Thus, according to the present embodiment, the intermediate lock member 64 is formed at the outer rotor 12 and is movable relative to the inner rotor 2. The spring 65 is positioned at the housing portion 63 and biases each of the intermediate lock members 64 inwardly in the radial direction, that is, biases each of the intermediate lock members 64 to a side where the intermediate lock groove 62 is provided.

[0034] In a case where the oil is discharged from the intermediate lock groove 62, each of the two of the intermediate lock members 64 protrudes to be fitted into each of the intermediate lock grooves 62. Accordingly, each of the intermediate lock members 64 is retained simultaneously at a predetermined position of each of the intermediate lock grooves 62. As a result, as shown in Fig. 2, the relative rotational phase of the inner rotor 2 relative to the outer rotor 12 is locked at the aforementioned intermediate locked phase. In a case where the second control valve 175 is controlled to supply the oil to the intermediate lock groove 62, as shown in Fig. 3, both of the intermediate lock members 64 are retracted from the respective intermediate lock grooves 62 to the respective housing portions 63. Thus, because the relative rotational phase is unlocked, the inner rotor 2 comes to be relatively rotationally movable. Hereinafter, a state where the intermediate lock mechanism 6 locks the relative rotational phase at the intermediate phase is referred to as a lock state. In addition, a state where the lock state is released is referred to as an unlock state. The intermediate lock mechanism 6 is switchable between the lock state and the unlock state.

[0035] Meanwhile, for example, a pin shape can be appropriately adapted as the shape of the intermediate lock member 64 other than the plate shape that is shown in the present embodiment.

[0036] According to the present embodiment, each of the two of the intermediate lock grooves 62 has a ratchet structure so that the groove depth comes to be gradually deeper along the retarded direction S2 of the inner rotor 2. Accordingly, the intermediate lock member 64 is gradually restricted and comes to be easily entered into the intermediate lock groove 62. Meanwhile, the intermediate lock passage 61 is divided into two on the way of the inner rotor 2 and is connected to each of the intermediate lock grooves 62.

[0037] The present valve opening and closing timing control device 1 is provided with a most retarded angle lock mechanism 7 in addition to the aforementioned intermediate lock mechanism 6. The most retarded angle lock mechanism 7 locks the relative rotational phase to the most retard phase by holding the outer rotor 12 and the inner rotor 2 at the predetermined relative positions at the time of low-speed rotation, for example, at the time of an idling operation. That is, irrespective of the displacing force in the retarded direction S2 and in the advance direction S1 based on the torque variation of the camshaft 101, because the inner rotor 2 does not relatively rotationally move, the stable idling operation state can be realized. In addition, according to the present embodiment, the most retard phase corresponds to a phase where the valve is opened at a later timing than the closing timing of the exhaust valve, the phase in which the start-up performance of the internal combustion engine E is secured while preventing a pre-ignition at a warm area of the internal combustion engine E.

[0038] As shown in Fig. 2, the most retarded angle lock mechanism 7 is provided with a most retarded angle lock passage 71, a most retarded angle lock groove 72, a housing portion 73, a plate-shaped most retarded angle lock member 74, and a spring 75. According to the present embodiment, the most retarded angle lock passage 71 is used in parallel with one of the plural advance passages 43. The most retarded angle lock member 74 serves as a same member as the intermediate lock member 64 being provided at one of the two of the intermediate lock members 64, the one being positioned in the advance direction S1. Similarly, the housing portion 73 serves as a same member as the housing portion 63 being provided at one of the two of the housing portions 63, the one being positioned in the advance direction S1. The spring 75 serves as a same member as the spring 65 being positioned at the housing portion 63.

[0039] In such a configuration, in a state where the oil is discharged from the most retarded angle lock groove 72, the most retarded angle lock member 74 protrudes to the most retarded angle lock groove 72. As shown in Fig. 4, in a case where the most retarded angle lock member 74 is retained at the most retarded angle lock groove 72, the relative rotational movement of the inner rotor 2 relative to the outer rotor 12 is locked and the relative rotational phase is held at the most retard phase. In a case where the first control valve 174 is controlled to try to displace the relative rotational phase to the advance side, the oil is supplied to the most retarded angle lock groove 72. Accordingly, the most retarded angle lock member 74 is retracted from the most retarded angle lock groove 72 to the housing portion 73. That is, the relative rotational phase is unlocked.

[0040] In a case where the relative rotational phase corresponds to a phase other than the most retard phase, because the most retarded angle lock member 74 is dislocated from the most retarded angle lock groove 72, the most retarded angle rock member 74 is slidingly in contact with the outer peripheral surface 2a of the inner rotor 2. Meanwhile, regarding to the shape of the most retarded angle lock member 74, the pin shape can be appropriately adapted other than the plate shape shown in the present embodiment.

[0041] In such a configuration, in a case where the electric power supply to the second control valve 175 is stopped at the intermediate lock state shown in Fig. 2, the unlock state is established as shown in Fig. 3. After that, because the oil is continuously supplied to the intermediate lock groove 62 as long as the electric power supply to the second control valve 175 is continuously stopped, the intermediate lock member 64 does not enter into the intermediate lock groove 62.

[0042] As shown in Fig. 4, in a case where the relative rotational phase is displaced to the most retard phase, and in a case where the most retarded angle lock member 74 faces the most retarded angle lock groove 72, the most retarded angle lock member 74 (64) is entered into the most retarded angle lock groove 72 to be established in the most retarded angle lock state.

[0043] As such, according to the configuration of the present embodiment, the number of components can be reduced while the configuration is simplified. Thus, a manufacturing cost can be reduced. In addition, because the intermediate lock member 64 and the most retarded angle lock member 74 are commonly used with each other, the outer rotor 12 has an additional space in the circumferential direction, and as shown in Fig. 2, four of the fluid pressure chambers 4 can be provided. As a result, because the force for displacing the relative rotational phase is increased, the prompt phase displacement can be realized. In addition, the displaceable range of the relative rotational phase can be increased by increasing the width of the fluid pressure chamber 4 in the circumferential direction.

[0044] Next, the structure of an oil-pressure passage according to the present embodiment will be explained. As shown in Fig. 1, the oil-pressure passage is provided with a pump 171, a first control valve 174 and a second control valve 175. The pump 171 is driven by the internal combustion engine E and supplies the oil. The first control valve 174 controls the supply of the oil to the fluid pressure chamber 4. The second control valve 175 controls the supply of the oil to the intermediate lock mechanism 6.

[0045] A phase control portion 180 controls respective operations of the first control valve 174 and of the second control valve 175 in order to control the aforementioned relative rotational phase. For example, in a case where the intermediate lock mechanism 6 shifts from the unlock state to the lock state, the phase control portion 180 controls the supply of the fluid to the retard chamber 42 and the discharge of the fluid from the advance chamber 41, or the discharge of the fluid from the retard chamber 42 and the supply of the fluid to the advance angle chamber 41 in order for the intermediate lock member 64 to reach the intermediate locked phase. An arithmetic processing unit is used for the phase control portion 180. The phase control portion 180 is configured by a single control device or by plural control devices.

[0046] According to the present embodiment, the pump 171 serves as a mechanical oil-pressure pump that is driven by a rotational force transmitted from the crankshaft 110 of the intermediate combustion engine E. The pump 171 pumps the stored oil stored in an oil pan 176 from an inlet port and discharges the oil from an outlet port to a downstream. The outlet port of the pump 171 is communicated with respective predetermined ports of the first control valve 174 and of the second control valve 175.

[0047] A variable electromagnetic spool valve can be used for the first control valve 174. The variable electromagnetic spool valve displaces a spool being positioned within a sleeve so as to be slidable against a spring by the energization from the phase control portion 180 to a solenoid. The first control valve 174 includes an advance port, a retard port, a supply port, and a drain port. The advance port is communicated with the advance passage 43. The retard port is communicated with the retard passage 44. The supply port is communicated with a flow passage of the downstream of the pump 171. The drain port is communicated with the oil pan 176.

[0048] The first control valve 174 is configured by a three-position control valve that is able to perform three-state controls that are, an advanced angle control, a retarded angle control, and a hold control. The advanced angle control communicates the advance port to the supply port and communicates the retard port to the drain port. The retarded angle control communicates the retard port to the supply port and communicates the advance port to the drain port. The hold control closes the advance port and the retard port. Because the advanced angle control is performed, the vane 22 relatively rotationally moves in the advance direction S1 relative to the outer rotor 12. The relative rotational phase is displaced to the advance side. Because the retarded angle control is performed, the vane 22 relatively rotationally moves in the retarded direction S2 relative to the outer rotor 12. The relative rotational phase is displaced to the retarded angle. Because the hold control is performed, the vane 22 does not relatively rotationally move. The relative rotational phase can be held at a desired phase.

[0049] In a case where the advanced angle control is performed, the oil is supplied to the advance passage 43 and to the most retarded angle lock passage 71. In the most retarded angle lock state, the most retarded angle lock passage 71 is closed by the most retarded angle lock member 74. In the most retarded angle unlock state in which the most retarded angle lock member 74 is retracted from the most retarded angle lock groove 72 by the advanced angle control, the oil is supplied to the advance chamber 41 via the advance passage 43. The inner rotor 2 relatively rotationally moves to the advanced angle.

[0050] The phase control portion 180 controls the first control valve 174 to control the supply or the discharge of the oil relative to the advance chamber 41 and the most retarded angle lock passage 71, or the retard chamber 42. Accordingly, the first control valve 174 performs a switching control of the intermediate lock mechanism 6 between the lock state and the unlock state, and performs the control of the relative rotational phase of the inner rotor 2 relative to the outer rotor 12. According to the present embodiment, when the first control valve 174 is energized, the retarded angle control comes to be available. When the energization of the first control valve

174 is stopped, the advanced angle control comes to be available. In addition, the first control valve 174 sets the opening by the adjustment of the duty ratio of the electric power being supplied to an electromagnetic solenoid. Accordingly, the fine adjustment of the supply/discharge amount of the oil is available.

[0051] Similarly to the first control valve 174, a variable electromagnetic spool valve is used for the second control valve 175. The second control valve 175 includes a restriction port, a supply port and a drain port. The restriction port is communicated with the intermediate lock passage 61. The supply port is communicated with the flow passage of the downstream of the pump 171. The drain port is communicated with the oil pan 176. The second control valve 175 is configured as a two-position control valve being able to control two-state controls that are a release control and a restriction control. The release control communicates the restriction port to the supply port. The restriction control communicates the restriction port to the drain port. The phase control portion 180 controls the second control valve 175 to control the supply/discharge of the oil to/from the intermediate lock groove 62 of the intermediate lock mechanism 6. As such, the second control valve 175 performs the switching control of the intermediate lock mechanism 6 between a restricted state or a released state.

[0052] The second control valve 175 can switch between the supply of the oil to the intermediate lock groove 62 and the discharge of the oil from the intermediate lock groove 62. According to the present embodiment, the second control valve 175 is configured such that when the second control valve 175 is energized, the oil can be discharged from the intermediate lock groove 62, and the energization of the second control valve 175 is stopped, the oil can be supplied to the intermediate lock groove 62.

[0053] Here, a crank angle sensor detecting a rotational angle of the crankshaft 11 is provided in the vicinity of the crankshaft 110 of the internal combustion engine E. A camshaft angle sensor detecting a rotational angle of the camshaft 101 is provided in the vicinity of the camshaft 101. The phase control portion 180 detects the relative rotational phase from detection results of the crank angle sensor and of the camshaft angle sensor and determines which phase the relative rotational phase is positioned. In addition, for example, the on/off information of an ignition key is transmitted to the phase control portion 180. The control information of an optimum relative rotational phase in accordance with an operation state of the internal combustion engine E is memorized within a memory of the phase control portion 180. The phase control portion 180 controls the relative rotational phase in accordance with the operation state of the internal combustion engine E.

[0054] The phase control portion 180 according to the present embodiment performs one of a control of the supply of the fluid to the retard chamber 42 and the discharge of the fluid from the advance chamber 41, and a control of the discharge of the fluid from the retard chamber 42 and the supply of the fluid to the advance chamber 41 by reducing the travelling speed of the relative rotational phase from a reference phase to the intermediate locked phase to be slower than the travelling speed of the relative rotational phase to the reference phase that is provided between a present phase and the intermediate locked phase. According to the present embodiment, regarding the present phase, as mentioned above, the phase control portion 180 detects the relative rotational phase from the detection results of the crank angle sensor and of the camshaft angle sensor, and determines which phase the relative rotational phase is positioned. The reference phase is provided between the present phase and the intermediate locked phase. The reference phase can be provided to be changeable to an intermediate position each time between the present phase and the intermediate locked phase. Alternatively, the reference phase can be pre-provided in the vicinity of the intermediate locked phase.

[0055] Figs. 5 and 6 schematically illustrate the reference phase and the intermediate locked phase. Fig. 5 shows an example of a case where two of the intermediate lock members 64 move to the intermediate locked phase from a state where the intermediate lock members 64 are not positioned within the intermediate lock grooves 62, respectively, by the rotation of the inner rotor 2 in the advance direction S1. Fig. 6 shows an example of a case where two of the intermediate lock members 64 move to the intermediate locked phase from a state where the intermediate lock members 64 are not positioned within the intermediate lock grooves 62, respectively, by the rotation of the inner rotor 2 in the retarded direction S2. In Figs. 5 and 6, in a case where a position having a reference numeral A corresponds to the intermediate locked phase and in a case where a position having a reference numeral O corresponds to the present phase, a reference phase P is provided therebetween. Meanwhile, the reference phase P is provided within the intermediate lock groove 62 in Fig. 5. Alternatively, the reference phase P can be provided at an out of the intermediate lock groove 62. Furthermore, the reference phase P is provided at the out of the intermediate lock groove 62 in Fig. 6. Alternatively, the reference phase P can be provided within the intermediate lock groove 62.

[0056] In such a case, the phase control portion 180 performs one of the control of the supply of the fluid to the retard chamber 42 and the discharge of the fluid from the advance chamber 41, and the control of the discharge of the fluid from the retard chamber 42 and the supply of the fluid to the advance chamber 41 so as to reduce the traveling speed of the relative rotational phase by a predetermined amount of change from a position O of the present phase to a position A of the intermediate locked phase via a position P of the reference phase. The reduction of the speed by the predetermined amount of change indicates that the travelling speed is reduced by a predetermined negative acceleration and indicates that the travelling speed is reduced gradually as shown in Fig. 7. Accordingly, the relative rotational phase can be promptly and securely moved from the present phase to the intermediate locked phase.

[0057] Meanwhile, a change of the travelling speed shown in Fig. 7 corresponds to an example. For example, as shown in Fig. 8, the relative rotational phase moves from the position O of the present phase to the position P of the reference phase based on a predetermined first travelling speed. The relative rotational phase can move from the position P of the reference phase to the position A of the intermediate locked phase based on a second travelling speed that is slower than the first travelling speed. While the relative rotational phase travels from the position O of the present phase to the position A of the intermediate locked phase, the travelling speed of the relative rotational phase can be naturally changed by equal to or more than three steps.

[0058] According to the present embodiment, a determination portion 181 determines whether the intermediate lock member 64 reaches the reference phase when the phase control portion 180 controls the intermediate lock member 64 to travel to a side where the reference phase is positioned after controlling the supply and discharge. The control of the supply and discharge by the phase control portion 180 serves as a control performing one of the control of the supply of the fluid to the retard chamber 42 and the discharge of the fluid from the advance chamber 41, and the control of the discharge of the fluid from the retard chamber 42 and the supply of the fluid to the advance chamber 41 so that the intermediate lock member 64 comes to be positioned at the intermediate locked phase.

[0059] Controlling the intermediate lock member 64 to travel to a side where the reference phase is positioned (a side of a position of the present phase in a case where the intermediate lock member 64 travels to the intermediate locked phase) will hereunder be explained as a determination control. After the determination control, in a case where the determination portion 181 determines that the intermediate lock member 64 reaches the position P of the reference phase, the result is transmitted to the phase control portion 180. In such a case, the phase control portion 180 recognizes that the relative rotational phase of the inner rotor 2 relative to the outer rotor 12 does not correspond to the intermediate locked phase. The phase control portion 180 controls the first control valve 174 to travel to the intermediate locked phase.

[0060] Meanwhile, after the determination control, in a case where the determination portion 181 determines that the intermediate lock member 64 does not reach the position P of the reference phase, the result is transmitted to the phase control portion 180. In such a case, the phase control portion 180 recognizes that the relative rotational phase of the inner rotor 2 relative to the outer rotor 12 corresponds to the intermediate locked phase. The phase control portion 180 stops the control of the first control valve 174.

[0061] According to the present embodiment, in a case where the determination portion 181 determines that the intermediate lock member 64 is not provided at the position P of the reference phase after the control of the supply and discharge by the first control valve 174, the phase control portion 180 alternately supplies the fluid to the retard chamber 42 and to the advance chamber 41. The case where the determination portion 181 determines that the intermediate lock member 64 is not provided at the position P of the reference phase after the control of the supply and discharge by the first control valve 174 corresponds to a case where the intermediate lock member 64 is positioned at the intermediate locked phase. In such a case, because the relative rotation of the inner rotor 2 and the outer rotor 12 is restricted, the vane 22 swings in the advance direction S1 and in the retarded direction S2 in a state where the relative rotation is restricted by the supply of the fluid alternately to the retard chamber 42 and to the advance chamber 41 by the phase control portion 180. As such, because the intermediate lock member 64 does not reach the reference phase, it can be determined that the intermediate lock member 64 is securely fitted in the intermediate lock groove 62. Accordingly, according to this configuration, the fitted-in state of the intermediate lock member 64 can be confirmed. Because the respective oil pressure levels of the retard chamber 42 and of the advance chamber 41 increase and decrease, the respective oil pressure levels of passages being connected to the retard chamber 42 and to the advance chamber 41 increase and decrease in accordance with the oil pressure levels of the retard chamber 42 and of the advance chamber 41. Accordingly, extraneous materials within the passages can be circulated and removed (cleaned).

[Another embodiment]

[0062] According to the aforementioned embodiment, each of two of the intermediate lock grooves 62 has the ratchet structure so that the groove depth comes to be gradually deeper along the retarded direction S2 of the inner rotor 2. However, the applicability of this invention is not limited to this. The intermediate lock groove 62 can be naturally configured to have a constant groove depth.

[0063] In the aforementioned embodiment, two of the intermediate lock grooves 62 and two of the intermediate lock members 64 are provided. However, the applicability of this invention is not limited to this. For example, the single intermediate lock groove 62 and the single intermediate lock member 64 are provided and the intermediate lock groove 62 has the ratchet structure so that the groove depth comes to be gradually deeper along the retarded direction S2 of the inner rotor 2. In such a case, it is favorable that the length of the intermediate lock groove 62 in the circumferential direction, the length of a position having a deeper groove, is set at a degree where the outer rotor 12 and the inner rotor 2 do not relatively rotate with each other in a case where the intermediate lock member 64 is fitted into the deeper groove.

[0064] Alternatively, the intermediate lock groove 62 can be configured to have a constant groove depth. In such a case, it is favorable that the length of the intermediate lock groove 62 in the circumferential direction is set at a degree where the outer rotor 12 and the inner rotor 2 allow relative rotation with each other in a case where the intermediate lock member 64 is fitted into the intermediate lock groove 62.

[0065] In the aforementioned embodiment, the intermediate lock member 64 is explained to be provided at the outer rotor 12 and the intermediate lock groove 62 is explained to be provided at the inner rotor 2. However, the applicability of this invention is not limited to this. The intermediate lock member 64 can be naturally provided at the inner rotor 2 and the intermediate lock groove 62 can be configured to be naturally provided at the outer rotor 12.

[0066] In the aforementioned embodiment, in a case where the determination portion 181 determines that the intermediate lock member 64 is not provided at the position P of the reference phase after the control of the supply and discharge by the first control valve 174, the phase control portion 180 is explained to alternately supply the fluid to the retard chamber 42 and to the advance chamber 41. However, the applicability of this invention is not limited to this. In a case where the determination portion 181 determines that the intermediate lock member 64 is not provided at the position P of the reference phase after the control of the supply and discharge by the first control valve 174, the phase control portion 180 can be naturally configured so as not to 1 alternately supply the fluid to the retard chamber 42 and to the advance chamber 4. Furthermore, the phase control portion 180 can be configured so as to supply the fluid to the retard chamber 42 and to the advance chamber 41 alternately in a case where the determination portion 181 performs the determination.

[0067] According to the aforementioned embodiment, an example where the valve opening and closing timing control device 1 controls the opening and closing timing of the intake valve 115 is explained. However, the applicability of this invention is not limited to this. The valve opening/control timing control device 1 can be configured to naturally control the opening and closing timing of the exhaust valve.

[0068] According to the aforementioned embodiment, the determination portion 181 is explained to determine whether the intermediate lock member 64 reaches the reference phase when the intermediate lock member 64 is controlled to move to the reference phase after the control of the supply and discharge by the phase control portion 180. However, the applicability of this invention is not limited to this. A position of a determination phase is provided between the position A of the intermediate locked phase and the position P of the reference phase. The phase control portion 180 performs one of the control of the supply of the fluid to the retard chamber 42 and the discharge of the fluid from the advance chamber 41, and the control of the discharge of the fluid from the retard chamber 42 and the supply of the fluid to the advance chamber 41. After that, the determination portion 181 determines whether the intermediate lock member 64 reaches the position of the determination phase when the phase control portion 180 controls the intermediate lock member 64 to move to the determination phase side. In such a case, because a position between the intermediate locked phase and the position for determination (the position of the determination phase) can be shallow, the determination portion 181 can determine whether the intermediate lock member 64 reaches the intermediate locked phase more securely.

[0069] According to the aforementioned embodiment, the phase control portion 180 is explained to perform one of the control of the supply of the fluid to the retard chamber 42 and the discharge of the fluid from the advance chamber 41, and the control of the discharge of the fluid from the retard chamber 42 and the supply of the fluid to the advance chamber 41 so that the travelling speed of the relative rotational phase from the present phase to the intermediate locked phase is reduced by the predetermined amount of change. However, the applicability of this invention is not limited to this. For example, the phase control portion 180 performs one of the control of the supply of the fluid to the retard chamber 42 and the discharge of the fluid from the advance chamber 41, and the control of the discharge of the fluid from the retard chamber 42 and the supply of the fluid to the advance chamber 41 based on a map that is defined by a relationship between the travelling speed of the relative rotational phase from the present phase to the intermediate locked phase and the quantity of state showing a state of the fluid that is flowed to the retard chamber 42 and to the advance chamber 41. The quantity of state showing the state of the fluid corresponds to a temperature level and a pressure level of the fluid, for example. The map that defines the traveling speed with the relationship of the temperature level and the pressure level of the fluid is pre-memorized, and the phase control portion 180 can be configured to control the oil pressure levels of the retard chamber 42 and of the advance chamber 41 based on the map. In such a case, because the phase control portion 180 controls the travelling speed from the reference phase to the intermediate locked phase to be slower than the travelling speed from the present phase to the reference phase, the relative rotational phase can be promptly travelled to the intermediate locked phase.

INDUSTRIAL AVAILABILITY

[0070] The present invention is applicable to a valve opening and closing timing control device that controls the relative rotational phase of a driven-side rotary member rotating integrally with a camshaft of an internal combustion engine relative to a driving-side rotary member rotating synchronously with a crankshaft of the internal combustion engine.

EXPLANATION OF REFERENCE NUMERALS

[0071]

1	valve opening and closing timing control device
2	inner rotor (driven-side rotary member)
4	fluid pressure chamber
6	intermediate lock mechanism
12	outer rotor (driving-side rotary member)
22	vane
41	advance chamber
42	retard chamber
62	intermediate lock groove (recess)
64	intermediate lock member (lock member)
101	camshaft
110	crankshaft
180	phase control portion
E	internal combustion engine
S1	advance direction
S2	retarded direction

Claims

1. A valve opening and closing timing control device comprising:

a driving-side rotary member rotating synchronously with a crankshaft of an internal combustion engine;
a driven-side rotary member rotating integrally with a camshaft of the internal combustion engine, the driven-side rotary member being relatively rotatable with the driving-side rotary member;
a fluid pressure chamber being formed with the driving-side rotary member and the driven-side rotary member;
a vane being positioned within the fluid pressure chamber, the vane dividing the fluid pressure chamber into a retard chamber and an advance chamber that each allows an inflow and an outflow of a fluid, the vane selectively moving a relative rotational phase of the driven-side rotary member relative to the driving-side rotary member between a retarded direction and an advance direction, the retarded direction where a volume within the retard chamber increases by the inflow of the fluid, the advance direction where a volume within the advance chamber increases by the inflow of the fluid;
an intermediate lock mechanism being provided at one of the driving-side rotary member and the driven-side rotary member, the intermediate lock mechanism including a lock member being movable relative to the other of the driving-side rotary member and the driven-side rotary member, the intermediate lock mechanism including a recess extending along a circumferential direction, the recess being provided at the other of the driving-side rotary member and the driven-side rotary member, the intermediate lock mechanism being switchable between a lock state and an unlock state, the lock state where the relative rotational phase is locked at an intermediate locked phase being positioned between a most advance phase and a most retard phase by a fitting of the lock member into the recess, the unlocked state where the relative rotational phase is unlocked by a retraction of the lock member from the recess; and
a phase control portion performing a control of a supply of the fluid to the retard chamber and a discharge of the fluid from the advance chamber, or a control of a discharge of the fluid from the retard chamber and a supply of the fluid to the advance chamber, in order for the lock member to reach the intermediate locked phase by reducing a travelling speed of the relative rotational phase from a reference phase that is provided between a present phase and the intermediate locked phase to the intermediate locked phase to be slower than the travelling speed of the relative rotational phase to the reference phase when the intermediate lock mechanism is switched from the unlock state to the lock state.

2. The valve opening and closing timing control device according to claim 1, wherein the phase control portion performs one of the control of the supply of the fluid to the retard chamber and the discharge of the fluid from the advance chamber, and the control of the discharge of the fluid from the retard chamber and the supply of the fluid to the advance chamber, in order for the travelling speed of the relative rotational phase from the present phase to the intermediate locked phase to be reduced by a predetermined amount of change.

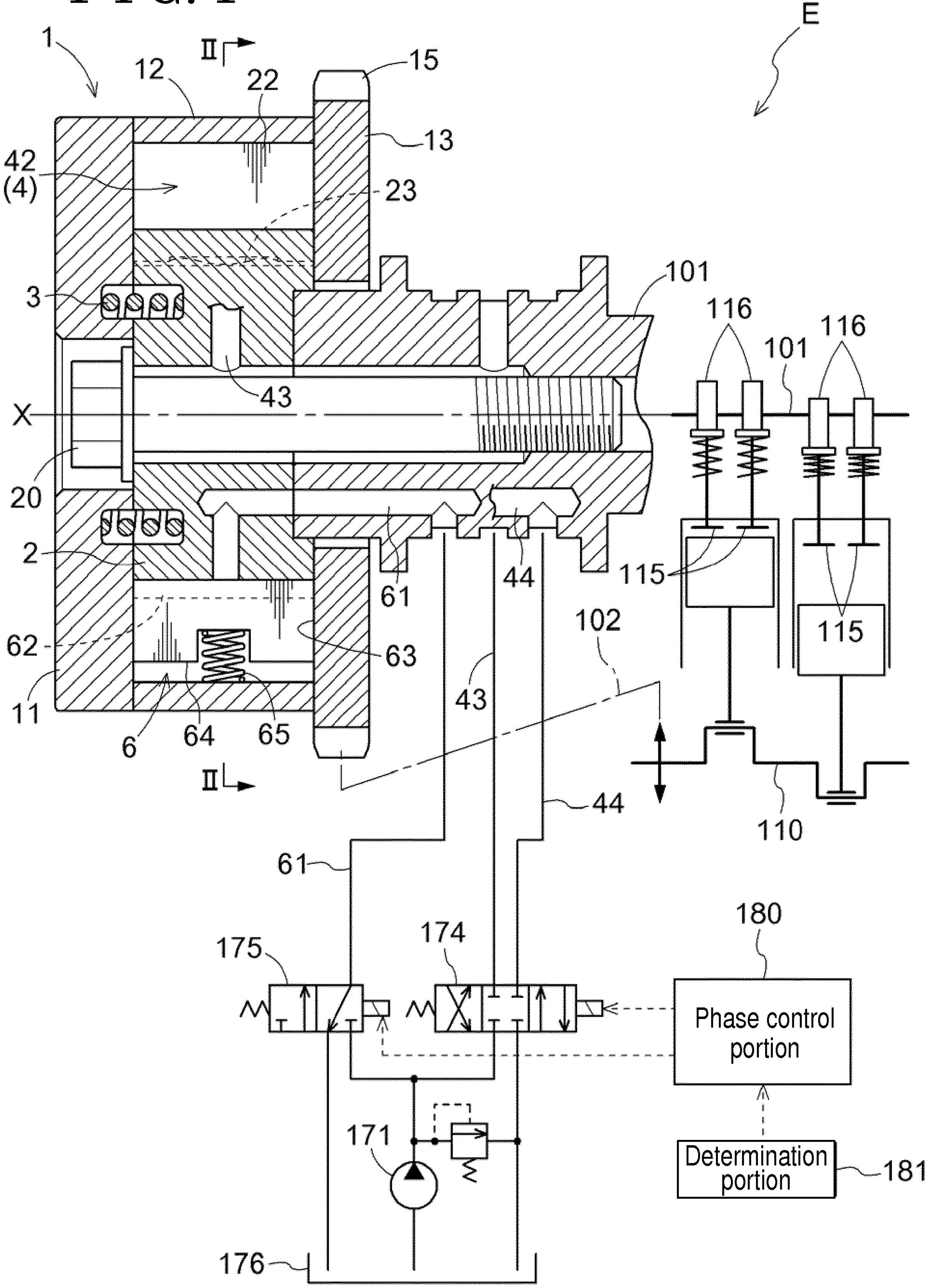
3. The valve opening and closing timing control device according to either claim 1 or 2, wherein the phase control portion performs one of the control of the supply of the fluid to the retard chamber and the discharge of the fluid from the advance chamber, and the control of the discharge of the fluid from the retard chamber and the supply of the fluid to the advance chamber, based on a map defined by a relationship between the travelling speed of the relative rotational phase from the present phase to the intermediate locked phase and a quantity of state showing a state of the fluid flowed to the retard chamber and to the advance chamber.

4. The valve opening and closing timing control device according to any one of claims 1 through 3 further comprising:

a determination portion determining whether the lock member reaches a determination phase, the determination phase being provided between the intermediate locked phase and the reference phase; wherein
the determination portion determines whether the lock member reaches the determination phase when the phase control portion controls the lock member to move to the determination phase after performing one of the control of the supply of the fluid to the retard chamber and the discharge of the fluid from the advance chamber, and the control of the discharge of the fluid from the retard chamber and the supply of the fluid to the advance chamber.

5. The valve opening and closing timing control device according to any one of claims 1 through 4, wherein the relative rotational phase moves from the present phase to the reference phase based on a first travelling speed; and
the relative rotational phase moves from the reference phase to the intermediate locked phase based on a second travelling speed that is slower than the first travelling speed.

FIG. 1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102
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110
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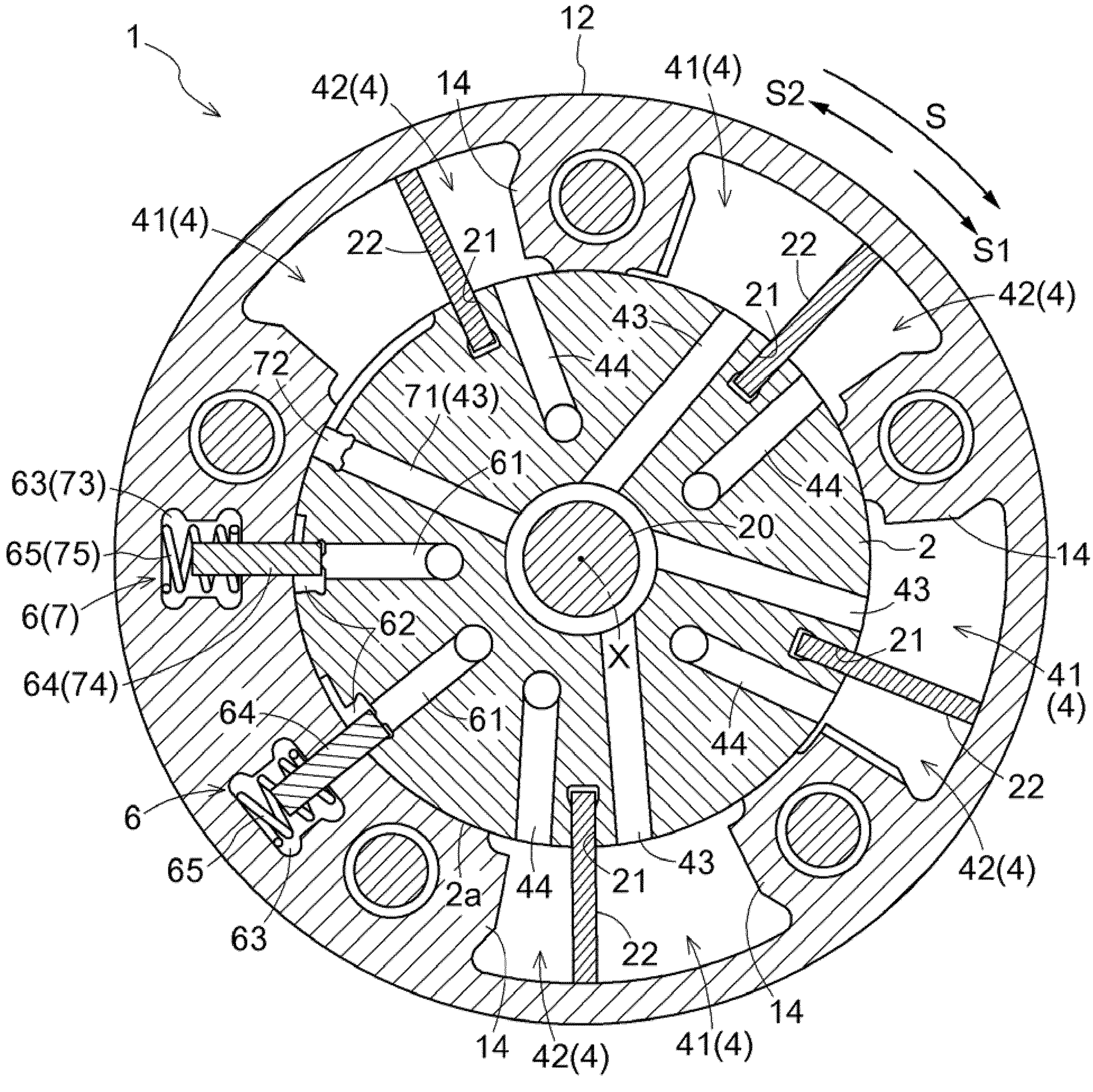
175
174
180
Phase control portion
171
Determination portion
181
176

FIG. 2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F I G. 3

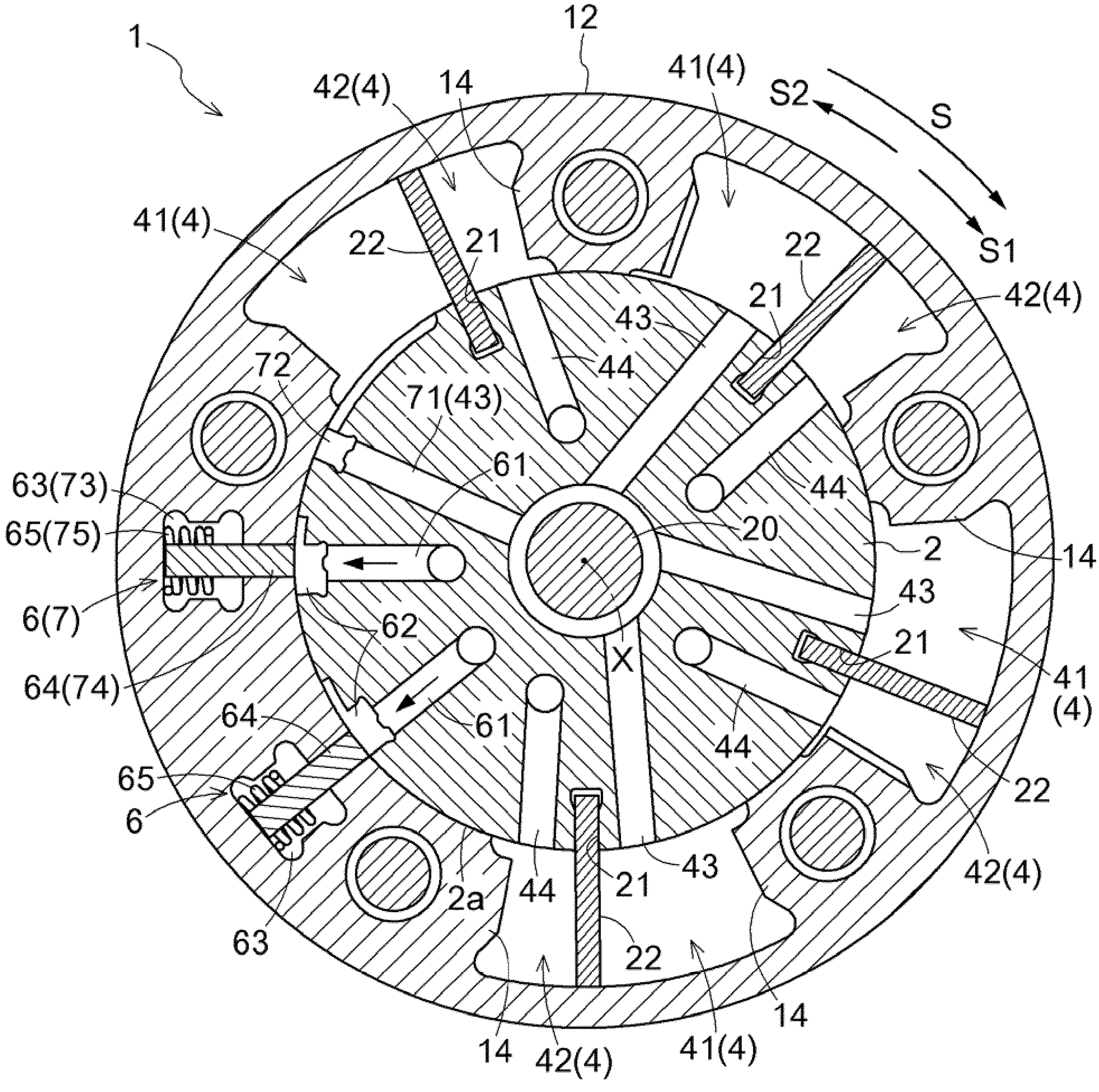
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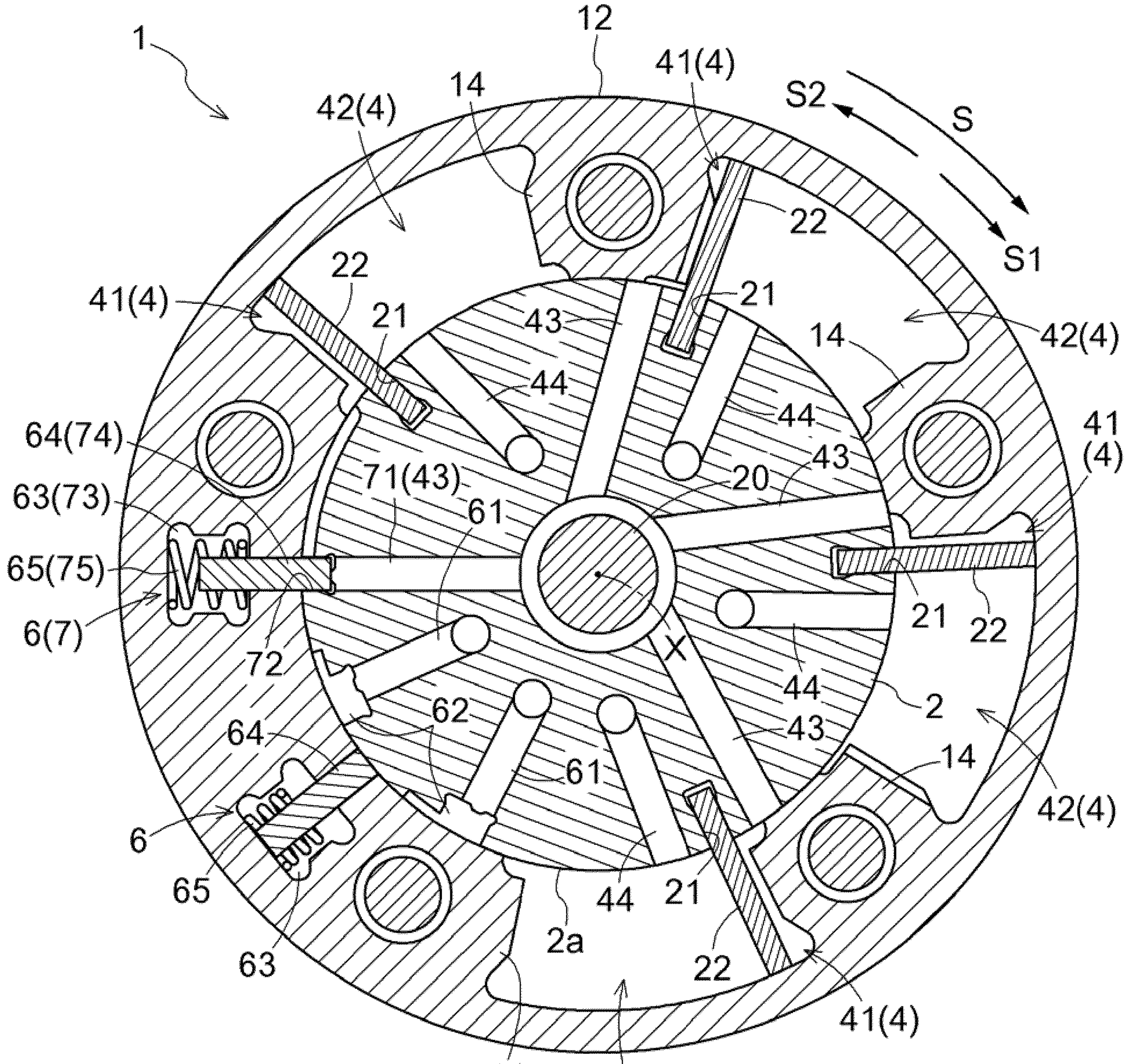
FIG. 4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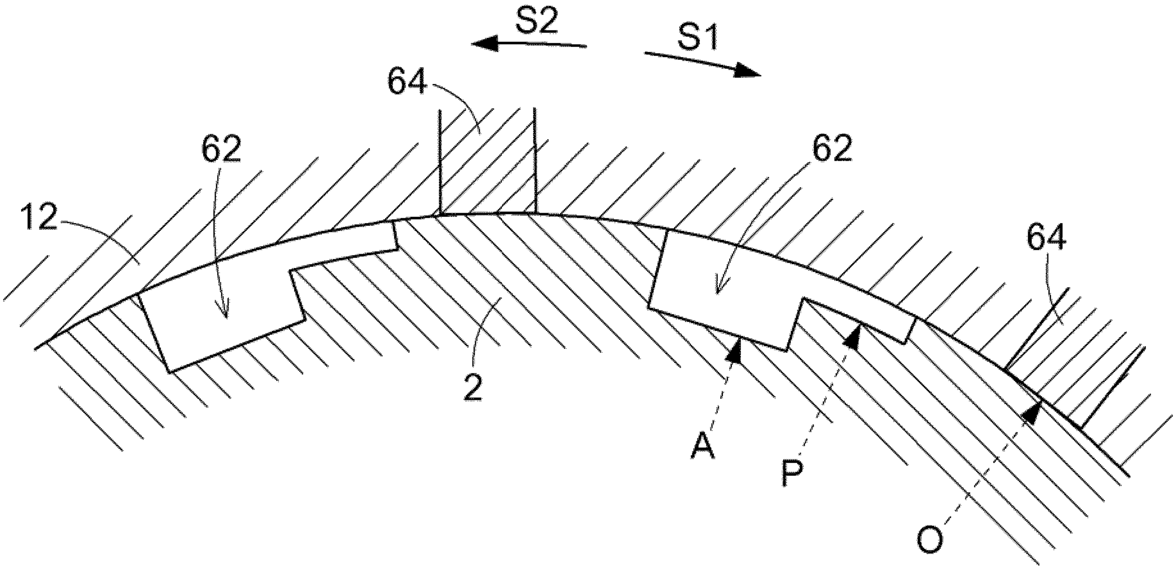
F I G. 5



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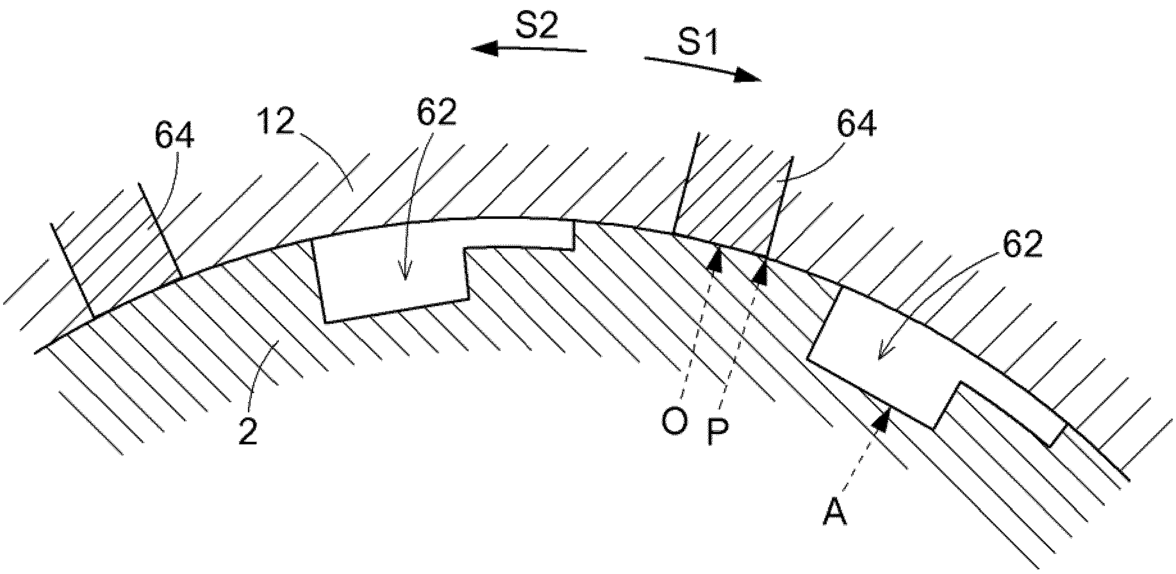


FIG. 7

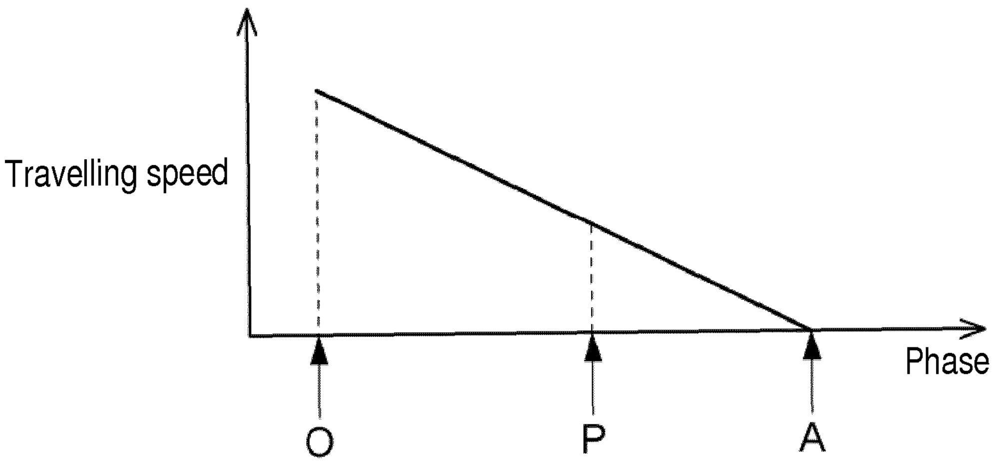
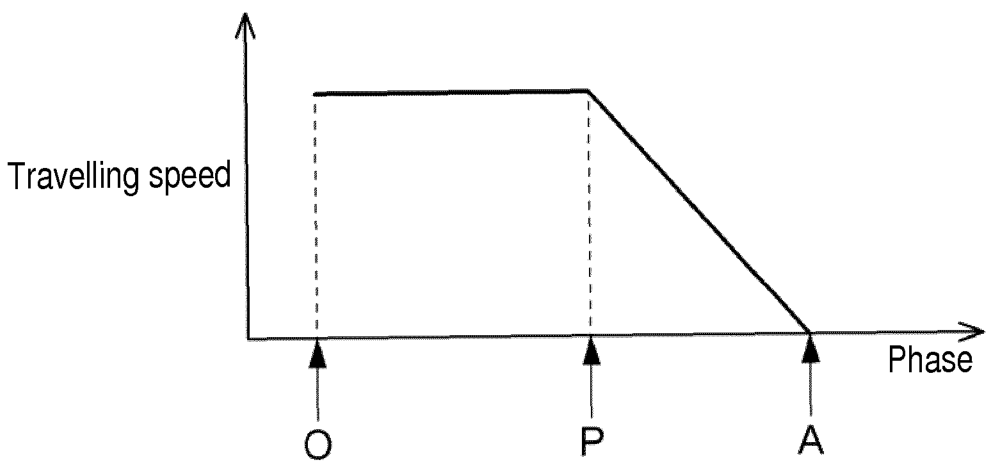


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2014/066855

A. CLASSIFICATION OF SUBJECT MATTER

F01L1/356(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01L1/356

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-173119 A (Toyota Motor Corp.), 29 June 1999 (29.06.1999), paragraphs [0019], [0068] (Family: none)	1-5
A	JP 2004-218587 A (Hitachi Unisia Automotive, Ltd.), 05 August 2004 (05.08.2004), paragraph [0008] & US 2004/0139937 A1 & DE 102004002395 A1 & CN 1517534 A	1-5
A	JP 2013-19352 A (Aisin Seiki Co., Ltd.), 31 January 2013 (31.01.2013), paragraphs [0001] to [0013] & WO 2013/008710 A1	1-5

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August, 2014 (28.08.14)	09 September, 2014 (09.09.14)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/066855

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2008-280933 A (Denso Corp.), 20 November 2008 (20.11.2008), paragraphs [0001] to [0023] (Family: none)	1-5
A	JP 2011-231713 A (Toyota Motor Corp.), 17 November 2011 (17.11.2011), paragraphs [0001] to [0032]; fig. 9 & US 2013/0042829 A1 & WO 2011/135419 A1	1-5

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010138699 A **[0005]**