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SPECIFICATION

Title of the Invention: "A CAPACIOUS PISTON MECHANISM
HAVING A ROTARY PISTON STRUCTURE"

Field of the Invention:

This invention relates to a capacious piston mechanism having a rotary piston structure.

Description of Related Art:

At a field relating to a capacious piston machine which has a reversible relation with internal combustion engines, such as a pump, a blower, a compressor and likes, a vane type rotary mechanism having a rotary piston structure has been already utilized. For example, in a case of a rotary blower shown on Drawing 8, blades (5) are biasedly arranged for flexibly moving in radial slots (4) of a rotor (3) provided at a circle-shaped room portion (2) of a squared box (1). Then, the air and/or other fluid are pushed out from a sucking mouth into an exhausting mouth by influence of the blades (5) flexibly moving in the slots (4) of the rotor (3) rotating at high speed and pressure arisen by centrifugal force inside of the circle-shaped room portion (2).

There is originally difficult and contradictive technical problems for a vane rotary type mechanism mentioned above, which is impossible to realize at the same time as a fatal factor coming from a composition which must divide a room being capable of change of its capacity when pushing a vane (blade 5) toward a cam-ring (a circle-shaped room portion 2). Because it must be achieved at the same time by completely improving some serious problems, such as abrasion at an edge of a vane, an additional composition pertinently to push and operate a vane mechanism and obtainment of airtightness and smooth operation on condition of obtainment of seal, which were very difficult to improve in prior art.

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At the present time, it seems that a useful effect by using such a mechanism is restricted because the serious problems mentioned above are solved by only a tactical device, which is not a drastic means for solving the problems in prior art. In viewing the current situation mentioned above, this invention was devised in order to entirely and strategically improve the technical problems.

What this invention aims is to provide a mechanism having a new structure, which does not depend on only edges of a vane for changing capacity. Thus, a new technical mechanism was drastically reached by this invention.

SUMMARY OF THE INVENTION

The inconvenient technical problems in prior art can be easily and completely improved by a capacious piston mechanism having a rotary piston structure shown below.

A new mechanism in this invention comprises:
a small rotor integrated with a main axis and biased against a cylinder-type large rotor for holding a bearing-housing;
slant sliding slots made at facing places in equally divided space between said large rotor and small rotor;
vanes having a certain angle fitted onto said slots as if they were bridges; and
a sucking mouth and an exhausting mouth provided at positions on side-housings.

In this invention, since both of the large rotor and the small rotor rotate at the same time through the bridged bent vanes at a balancing point, capacity-change is carried out by the movement of said vanes in the sliding slots without spoiling smoothness of rotation and sealing effect. Accordingly, this invention can completely improve one of the most difficult points in the traditional mechanism, which strongly forced edges of cantilever projective vanes.

An actual example as to this invention is explained by using the Drawings (1) and (2) as follows.

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A small rotor (7) integrated with a main axis (6) is biasedly arranged against a large rotor (8) to be a ring-shaped cylinder. Said large rotor (8) is surrounded by a bearing-housing (9).

In this case, of course, the small rotor (7) and the large rotor (8) are set at the space between the side-housings (10) and (11') which were fixed by bolts. A pair of slant sliding slots (12, 13, etc.) are provided at facing positions where the small rotor (7) and the large rotor (8) opposite each other, and vanes (14) which were suitably bent are fitly set at the positions between said slots (12) and (13) just like bridges.

Thus, such a unique rotary mechanism in which the large rotor (8) rotates together with the small rotor (7) through the bent vanes (14) constantly seeking a balancing point is realized. In this rotary mechanism, the divided rooms (15, etc.) are formed by said bent vanes (14), and these rooms can change their capacities according to the rotors' rotation. At that time, the vanes (14) only move in the sliding slots (12) and (13).

Consequently, the same result for changing capacity was completely realized by using the above-mentioned method in this invention although it was different from the traditional vane-type rotary mechanism in which change of capacity was reached by pushing and moving edges of cantilever projective vanes on a fixed cam-ring. Drawings (3) to (5) mentioned below show as to how the mechanism in this invention is reached. On Drawing (3) shows that "O" is a central point of a small circle of a radius "r" and "O'" is a central point of a large circle of a radius (1). The two radiuses "OA" and "O'B" roll in keeping parallel.

When the radiuses "OA" and "O'B" are in keeping parallel at an optional turning position, a drawing thereof is made as follows.

When drawing a straight line "AC" forming a constant-angle " α " against a radius "OA" through a point "A" of the radius "OA", said angle " α " becomes an acute angle in right-turn. As the next step, when drawing a straight line "BC" forming an acute angle " β " against a radius "O'B" through a point "B" of the radius "O'B", said angle " β " becomes an acute angle in left-turn. In case that a



crossing point of two straight lines "AC" and "BC" becomes "C", a crossing angle becomes " κ ".

On the above drawing, $\angle CDA = \angle CBE = \beta$ because of $OA // O'B$.

In a case of $\triangle CAD$, $\angle CAD = \alpha$ $\angle CDA = \beta$ $\angle ACD = \kappa$
 $\angle CAD + \angle CDA + \angle ACD = \alpha + \beta + \kappa = 180^\circ$ $\kappa = 180^\circ - (\alpha + \beta)$, therefore, κ also becomes a constant angle because both of α and β are the constant angles.

The below-mentioned is an explanation on the basis of Drawing 4.

In the event that three angles, α , β and κ are prepared in advance under a condition, $0^\circ < \alpha < 90^\circ$ $0^\circ < \beta < 90^\circ$ $\alpha + \beta + \kappa = 180^\circ$, the following drawing based upon this condition is made up.

After pertinently setting a biased quantity "O'O", a small circle of a radius "OA" and a large circle of a radius "O'B" are drawn. At an optional turning point of said radius "OA", when drawing a straight line "AC" forming an angle " α " against said radius "OA" through a point "A", the angle " α " is made as a right-turning angle. After putting a point "F" at a pertinent position on the straight line "AC", when drawing a straight line "FG" forming an angle " κ " against the straight line "AC" through the point "F", the angle " κ " is made as a right-turning angle. Furthermore, after putting a point "G" at a pertinent position on the straight line "FG", when drawing a straight line "GH" forming an angle " β " against the straight line "FG" through the point "G", the angle " β " is made as a right-turning angle. Finally, a radius "O'B" to be in parallel against the straight line "GH" and a straight line "BC" to be in parallel against the straight line "FG" are drawn.

From the above-mentioned explanation, the following expression is clearly derived.

$\angle ACD = \angle HCI = \angle HFG = \kappa$ $\angle CBE = \angle CIH = \angle FGH = \beta$ because of $FG // CI$ $GH // O'B$

Accordingly, $\angle CAD + \angle CBE + \angle ACD = \alpha + \beta + \kappa = 180^\circ$.



In $\triangle CAD$, $\angle CAD + \angle CDA + \angle ACD = 180^\circ$

Therefore, $\angle CDA = \angle CBE$

Finally, the radiuses "OA" and "O'B" become parallel because of being OD//O'B.

On the basis of Drawing 4, it is possible to make the following mechanism.

By connecting straight lines "HC" and "IC", a bent line "HCI" is made. When regarding this bent line "HCI" as a thin bar, it becomes a bent bar "HCI" with a bent angle " κ ". In a case of assuming that a small circle of a radius "OA" is a small circle plate (a), a thin slot corresponding to a line segment "AH" is made in said small circle plate (a).

In a case of assuming that a circle of a radius "O'B" is a large circle plate (b), a large circle of a radius "O'B" is made as a line drawn on said large circle plate (b). A ring-shaped plate (c) having a width of difference between the radiuses "O'B" and "O'B'" is made, and thickness of said ring-shaped plate (c) is equivalent to the thickness of the small circle plate (a). A thin slot corresponding to a line segment "BI" is made on the said ring-shaped plate (c). This ring-shaped plate (c) is fitly put on the large circle plate (b) and is completely fixed thereon (b).

The bent bar, the large circle plate (b) and the small circle plate (a) which have the above-mentioned figures are combined as follows.

Assuming that a biased quantity of the small circle (a) and the large circle (b) from the center of a main axis is "O'O", the small circle plate (a) can be put on the large circle plate (b). In this case, the large circle plate (b) rotates around a point (O'), and the small circle plate (a) rotates around a point "O". The said bent bar "HCI" can smoothly move in the thin slots of the small circle plate (a) and the ring-shaped plate (c) when the said bar was put into the slots.

Rotational power of the small circle plate (a) makes the large circle plate (b) rotate through the bent bar "HCI" as a carrying



medium when the small circle plate (a) is rotated by the power. Then, the radius "O'B" drawn on the large circle plate (b) rotates in keeping parallel against the radius "OA" of the small circle on the small circle plate (a). This means that the both of the circle plates (a) and (b) can rotate at the same angle and speed. Such a movement is achieved even if the biased quantity of "O'O" was changed.

A method for giving a width to the bent line "HCI" is described by using Darwing (5) as follows.

First, a bent line "HCI" is drawn at an optional turning position of the radius "OA" of a small circle plate (a) by using α , β and κ on the following condition; $0^\circ < \alpha < 90^\circ$, $0^\circ < \beta < 90^\circ$, $\alpha + \beta + \kappa = 180^\circ$. This is carried out by the same method for making the drawings of the bent line "HCI" already mentioned. In this figure, a relation of the radius "OA" of the small circle plate (a) and the radius "O'B" of the large circle plate (B) which are corresponding to said bent line "HCI" becomes parallel.

Second, a string "AJ" having a certain length is drawn through a crossing point "A" between the bent line "HCI" and the small circle plate (a). The radius "OJ" through a point "J" is drawn. A central angle " ε " is fixed against the string "AJ". "O'K" is drawn in parallel against the radius "OJ". A string "BK" through a point "K" is drawn. A central angle " ρ " is fixed against the string "BK". Through a point "J", a straight line "JP" is drawn in parallel against a straight line "AH". Further, through a point "K", a straight line "KQ" is drawn in parallel against a straight line "CI".

A crossing piont "L" between the straight lines "JP" and "KQ" is fixed. A bent line "PLQ" which was combined by two straight lines "PL" and "LQ" is drawn. From the above-mentioned figure, the following matter is proved.

In a case of $\angle BO'K$ and $\angle AOJ$, since edges of "OA" and "O'B" and other edges of "OJ" and "O'K" are in parallel at the same direction, it becomes $\angle BO'K = \angle AOJ$ $\rho = \varepsilon$. Therefore, the following mathematical expression can be formed since two isosceles



triangles "BO'K" and "AOJ" are the similar figures.

Mathematical Expression 1:

$$\overline{BK} = \frac{\overline{O'B}}{\overline{OA}} \overline{AJ} = \frac{1}{r} \overline{AJ}$$

Since the length of the string "AJ" is fixed, the length of another string "BK" is also naturally fixed. Therefore, in the bent lines "HCI" and "PLQ", the edges "HC" and "PL" are in parallel at a certain space, and also other edges "IC" and "QL" are in parallel at a certain space.

Further, it is possible to draw the following drawings.

When drawing a vertical segment "AM" against a straight line "CH" through a point "A", a length of the segment "AM" becomes "h".

Also when drawing a vertical segment "BN" against a straight line "CI" through a point "B", a length of the segment "BN" becomes "d".

From the above drawings, the following mathematical expression is proved.

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Mathematical Expression 2:

$$\begin{aligned}\angle JAM &= \angle OAJ - \angle OAM = \angle OAJ - \\ (\angle HAM - \angle HAO) &= \frac{1}{2} (180^\circ - \varepsilon) - \\ (90^\circ - \alpha) &= \alpha - \frac{\varepsilon}{2}\end{aligned}$$

$$\begin{aligned}\angle KBN &= \angle RBN - \angle RBK = \angle RBN - \\ (\angle O' BK - \angle O' BR) &= 90^\circ - \left\{ \frac{1}{2} (180^\circ \right. \\ \left. - \rho) - \beta \right\} &= \beta + \frac{\rho}{2} = \beta + \frac{\varepsilon}{2}\end{aligned}$$

$$\overline{AJ} = 2 \overline{OA} \sin \frac{\varepsilon}{2} = 2r \sin \frac{\varepsilon}{2}$$

$$\overline{BK} = 2 \overline{O'B} \sin \frac{\rho}{2} = 2l \sin \frac{\varepsilon}{2}$$

$$\begin{aligned}h &= \overline{AJ} \cos \angle JAM = 2r \sin \frac{\varepsilon}{2} \cos \\ \left(\alpha - \frac{\varepsilon}{2} \right) &= r 2 \cos \left(\alpha - \frac{\varepsilon}{2} \right) \sin \frac{\varepsilon}{2} \\ &= r \left\{ \sin \left(\alpha - \frac{\varepsilon}{2} + \frac{\varepsilon}{2} \right) - \sin \left(\alpha - \frac{\varepsilon}{2} \right. \right. \\ \left. \left. - \frac{\varepsilon}{2} \right) \right\} &= r \left\{ \sin \alpha - \sin (\alpha - \varepsilon) \right\}\end{aligned}$$

$$\begin{aligned}d &= \overline{BK} \cos \angle KBN = 2l \sin \frac{\varepsilon}{2} \cos \\ \left(\beta + \frac{\varepsilon}{2} \right) &= l 2 \cos \left(\beta + \frac{\varepsilon}{2} \right) \sin \frac{\varepsilon}{2} \\ &= l \left\{ \sin \left(\beta + \frac{\varepsilon}{2} + \frac{\varepsilon}{2} \right) - \sin \left(\beta + \frac{\varepsilon}{2} \right. \right. \\ \left. \left. - \frac{\varepsilon}{2} \right) \right\} &= l \left\{ \sin (\beta + \varepsilon) - \sin \beta \right\}\end{aligned}$$



Therefore, "h" and "d" become a certain length.

When integratedly connecting the bent lines "HCI" and "PLQ" with segments "AM" and "BN", it is possible to regard that this one is a figure added the width of "h" and "d" to the bent line "HCI". So, when being given a certain width and thickness to the bent line "HCI", such a line can become a bent vane.

Thus, the rotary mechanism already mentioned by using Drawings (1) and (2) is objectively proved.

It is possible to realize the mechanism in this invention as a capacious piston mechanism having a rotary piston structure by setting a sucking mouth (16) and an exhausting mouth (17) at the suitable positions of side-housings (10) and (10') for applicable use, which was shown on the Drawings (1) and (2).

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The actual examples in this invention are described as follows.

On the basis of method on Drawings (1) and (2) mentioned above, a sucking mouth (16) and an exhausting mouth (17) are set as an example for a pump.

After dividing the outside-circumference of the small rotor (7) into n pieces (in this case, a value of n is suitably fixed.), the sliding slots (12, etc.) are provided in space "h" at each position equally divided. These slots have slant angle " α " against a radius "r" passing through said equally divided positions.

As the next step, after dividing the inside-circumference of the large rotor (8) into n pieces, the sliding slots (13, etc.) are made in space "d" at each position equally divided. These slots (13, etc.) have slant angle " β " against a radius "l" passing through said equally divided position.

According to the means mentioned above, the bent vane (14) is

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attached into these slots. Each constant angle on the Drawings is the followings.

On condition of $\alpha = 32^\circ$, $\beta = 43^\circ$, $\kappa = 105^\circ$, $\varepsilon = 8^\circ$, since a ring-shaped space between a large rotor (8) and a small rotor (7) is divided by n pieces of the bent vanes (14), n pieces of divided rooms (15, etc.) are made. When the small rotor (7) which was connected with two main axes (6) of this machine rotates left, said small rotor make the large rotor (8) rotate left by the bent vanes (14) as media. At the same time, n pieces of the divided rooms (15, etc.) turn left.

Capacity of each divided room (15) increases and decreases once when said room turns left once. The fluid is sucked from a sucking mouth (16) into the divided room (15) when the capacity in said room increases. On the contrary, the fluid in the divided room (15) is sent out from an exhausting mouth (17) when the capacity in said room decreases. Such a movement is the same as a pump. In this case, exhausting quantity of fluid can be increased and decreased by change of biased quantity of the small rotor (7) and the large rotor (8).

Drawing (6) shows a usage for a bent vane motor.

As shown on Drawing (1) as to a vane pump, it is easily achieved by modifying an exhausting mouth (17) of fluid to an influent mouth (18) and a sucking mouth (16) of fluid to an effluent mouth (19). A new machinery device can be made by combining the above-mentioned modified rotary structure with a device (22) which arises high pressure fluid. The high pressure fluid arisen from said device is continuously supplied from an influent mouth (18) into the divided room (15') of the modified bent vane pump. The fluid which flown into the divided room (15') gives pressure to the bent vane (14'). Said pressure toward the bent vane makes the main axis (6') turn right, and then the divided room (15) turns right. The fluid in the divided room (15) is sent out from the effluent mouth (19) when the divided room (15') is turningly forwarded to said effluent mouth (19).

Therefore, it is proved that this mechanism can work as a

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fluid pressure rotary motor.

Furthermore, the below-mentioned is a practical example for applying a bent vane motor already mentioned.

As shown on Drawing (7), in said bent vane motor, a small influent hole (20) for obtaining heated gas is provided therein instead of an influent mouth (18) of the fluid. The position for setting said influent hole (20) is placed at a position where the capacity begins to increase when said divided room (15') turns left.

An effluent mouth (19) of the fluid of the bent vane motor becomes a gas-exhausting mouth (21) for sending the heated gas out. This improved bent vane motor becomes a heated gas bent vane motor.

When combining a device (23) arising high temperature and pressure gas with said heated gas bent vane motor after a selection of a certain divided room (15') locating at an influent hole (20) of the heated gas out of n pieces of the divided rooms (15, etc.) of a heated gas bent vane motor, a movement therein shows as follows.

First, high temperature and pressure gas which was flown from a gas arising device (23) is continuously flown into the divided room (15') located at a position of an influent hole (20) for the heated gas. The high temperature and pressure gas which was flown into the divided room (15') makes pressure toward a pair of bent vanes (14') forming a divided room (15'). Then, these two bent vanes (14) and (14') receive pressure which pushes each other toward the reverse-direction. However, a torque difference arises against the main axis (6) because there is a difference of space between these two bent vanes (14) and (14'). Such a torque difference makes the main axis (6) turn right, and then the divided room (15') also turns right.

Since capacity of the divided room (15') increases in proportion to a turning movement of said room, the high temperature and pressure gas flows into said divided room (15'). Thus, both of the main axis (6) and the divided room (15') can continue to turn and move because pressure of this high temperature and pressure gas continue to reach the bent vanes (14'). Next, when the divided room (15') turningly passes through an influent hole (20), the high



temperature and pressure gas stops to flow into the divided room (15'). After that, the high temperature and pressure gas being in the divided room (15') adiabatically expands for a reason of increase of capacity therein when said divided room (15') turns. This is the reason why the main axis (6) continues to turn and also the divided room (15') turns and moves because such pressure by adiabatic expansion continuously gives influence to the bent vane (14').

Furthermore, when the divided room (15') is forwarded toward a position of a gas-exhausting mouth (21) by reason that the divided room (15') turns and moves, the heated gas in the divided room (15') sends out from the gas-exhausting mouth (21). In the event that other divided room (15') comes to a position of an in-flowing mouth for the gas after turning movement thereof, the above-mentioned movement is proved by reason that a rotational power toward the main axis (6) continuously works. Therefore, this machinery device can work as a heating engine.

A mechanism in this invention mentioned above shows the following effects.

Smoothness to work and airtightness are extremely expected to be improved because what required by the bent vanes for forming the divided rooms is an only movement at a basic portion of the bridge at the sliding slots when changing capacity.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 shows a front view drawing for a vane pump, which is explaining as an applicable example using a mechanism in the invention.

Fig. 2 shows a side view drawing for a vane pump, which is explaining as an applicable example using a mechanism in the

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invention.

Fig. 3 shows a geometrical drawing for explaining as to composition in the invention.

Fig. 4 shows a geometrical drawing for explaining as to composition in the invention.

Fig. 5 shows a geometrical drawing for explaining as to composition in the invention.

Fig. 6 shows a front view drawing for explaining an application of a mechanism in the invention for a vane pump.

Fig. 7 shows a front view drawing for explaining an application of a mechanism in the invention for a heating engine.

Fig. 8 shows a front view drawing for a rotary blower as a mechanism in prior art.

Reference numerals respectively denote:

1. a box,
2. a circle-shaped room portion,
3. a rotor,
4. a slot,
5. a blade,
6. a main axis,
7. a small rotor,
8. a large rotor,
9. a bearing-housing,
10. a side-housing,
11. a bolt,
12. a sliding slot,
13. a sliding slot,
14. a bent vane,
- 15 & 15'. divided rooms,
16. a sucking mouth,



17. an exhausting mouth,
18. an influent mouth,
19. an effluent mouth,
20. an influent hole,
21. a gas-exhausting mouth,
22. a device for arising high pressure fluid, and
23. a device for arising high temperature and pressure gas.

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Title of the Invention: "A CAPACIOUS PISTON MECHANISM
HAVING A ROTARY PISTON STRUCTURE"

WHAT IS CLAIMED

Claim 1:

A capacious piston mechanism having a rotary piston structure comprises:

a small rotor integrated with a main axis and biased against a cylinder-type large rotor for holding a bearing-housing;

slant sliding slots made at facing places in equally divided space between said large rotor and small rotor;

vanes having a certain angle fitted onto said slots as if they were bridges; and

a sucking mouth and an exhausting mouth provided at positions on side-housings.

Claim 2:

A vane pump comprising a capacious piston mechanism having a rotary piston structure claimed in Claim 1.

Claim 3:

A vane motor comprising a capacious piston mechanism having a rotary piston structure claimed in Claim 1.

Claim 4:

A heat engine comprising a capacious piston mechanism having a rotary piston structure claimed in Claim 1.

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