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Rotary piston fluid displacement apparatus.

A rotary piston type incompressible fluid displacement apparatus includes a casing in which a cylindrical chamber is defined, a cylindrical piston member operatively connected to a drive shaft and disposed within the cylindrical chamber, and a vane radially slidably disposed within a bore formed at an inner surface of the casing. An axis of the cylindrical piston member is radially offset from an axis of the drive shaft by a predetermined distance. A bias spring disposed within the bore urges the vane into contact with the cylindrical piston member. The casing, the vane and the cylindrical piston member define a first chamber portion and a second chamber portion. The oil in the second chamber portion is continually conducted to the bottom side of the vane so that the vane is radially inwardly urged against the piston member. Accordingly, the piston member is continually in contact with the vane in all operating conditions.

The present invention relates to a rotary piston type incompressible fluid displacement apparatus, and more particularly, to a sealing mechanism for a vane used in the rotary piston type incompressible fluid displacement apparatus.

Rotary piston type incompressible fluid displacement apparatuses are well known in the art. A conventional rotary piston type incompressible fluid displacement apparatus for an oil pump is illustrated in Figure 1.

Referring to Figure 1, the rotary piston incompressible fluid displacement apparatus 500 includes a generally annular cylindrical-shaped housing 510 and a pair of circular plates (not shown) closing the opposite axial opening ends of housing 510. Housing 510 and the pair of circular plates cooperatively define cylindrical chamber 511. A drive shaft (not shown), having longitudinal axis X' which is coaxial to the longitudinal axis of cylindrical chamber 511, rotatably penetrates cylindrical chamber 511. Cylindrical piston member 520 is disposed within cylindrical chamber 511 and is fixedly connected to the drive shaft. The longitudinal axis X of piston member 520 is radially offset from the longitudinal axis X' of the drive shaft. The opposite axial end surfaces of piston member 520 are in fluid tight contact with the inner surface of the pair of circular plates, respectively.

When the drive shaft rotates, piston member 520 rotates around the longitudinal axis X' as indicated by arrow "A" in Figure 1. Housing 510 includes a cylindrical projection 512 projecting radially outwardly from an outer surface of one peripheral portion thereof. Outlet and inlet ports 514 and 513 are formed on the outer peripheral surface of housing 510 at positions which are in front of and to the rear of the cylindrical projection 512 with respect to the rotational "A" of the drive shaft, respectively. A cavity 512a having a first portion 512b and a second portion 512c is axially formed through cylindrical projection 512. First portion 512b of cavity 512a is a circular configuration in transverse cross section and is located at an axial outer end region of cylindrical projection 512. The second portion 512c of cavity 512a is a rectangular configuration in transverse cross section and is linked to an axial inner end of the first portion 512b of cavity 512a.

A valve member or vane 515 having a rectangular-shaped transverse cross section is slidably disposed within second portion 512c of cavity 512a. Snap ring 516 is fixedly disposed at an inner peripheral surface of an axial inner end region of first portion 512b of cavity 512a. Rectangular plate 517 is disposed within second portion 512c of cavity 512a between valve member 515 and snap ring 516. An inner peripheral surface of second portion 512c of cavity 512a, valve member 515 and rectangular plate 517 cooperatively define chamber 512d. A cylindrical depression 515a is formed at an axial outer end surface

of valve member 515. Bias spring 518, which is disposed within second portion 512c of cavity 512a between rectangular plate 517 and cylindrical depression 515a, radially inwardly urges valve member 515 into contact with piston member 520. A circular hole 517a is centrally formed in rectangular plate 517. Atmospheric pressure is continuously conducted into chamber 512d via circular hole 517a. Therefore, valve member 515 is radially inwardly urged by virtue of a first force generated by receiving the substantially constant atmospheric pressure at its axial outer end surface and the force due to restoring force of bias spring 518.

During operation of the rotary piston type incompressible fluid displacement apparatus 500, piston member 520 faces an inner surface of one peripheral portion of housing 510 with a small air gap 521. In addition, piston member 520 contacts valve member 515 as seen at 522. Air gap 521 is substantially sealed by an oil film and shifts along the inner peripheral surface of housing 510 in the rotational direction "A" of the drive shaft. On the other hand, the axial line contact 522 between piston member 520 and valve member 515 reciprocatingly shifts along the axial inner end surface of valve member 515 in the radial direction.

Sealed air gap 521 and the axial line contact 522 divide cylindrical chamber 511 into (n)th sealed-off fluid pocket 511a and (n+1)th sealed-off fluid pocket 511b. The (n)th and (n+1)th sealed-off fluid pockets 511a and 511b are located in front of and to the rear of the axial line contact 522 with respect to the rotational direction "A" of the drive shaft, respectively. Consequently, the portion of the axial inner end surface of valve member 515 located in front of the axial line contact 522 with respect to the rotational direction of the drive shaft receives pressures in the (n)th sealed-off fluid pocket 511a while the other portion of the axial inner end surface of valve member 515 located to the rear of the axial line contact 522 receives pressure in the (n+1)th sealed-off fluid pocket 511b. Accordingly, valve member 515 is radially outwardly urged by virtue of the force generated from the pressure in the (n)th and (n+1)th sealed-off fluid pockets 511a and 511b.

When the drive shaft rotates in the direction of arrow "A" in Figure 1, piston member 520 rotates around the longitudinal axis X' of the drive shaft in the same rotational direction of the drive shaft. As the angular position of piston member 520 changes from that shown in Figure 1, the pressure in the (n+1)th sealed-off fluid pocket 511b gradually decreases, the volume of the (n+1) sealed-off fluid pocket 511b gradually increases and oil begins flowing into fluid pocket 511b from inlet port 513 as indicated by arrow "B" in Figure 1. Simultaneously, the pressure in the (n)th sealed-off fluid pocket 511a sharply increases, then is substantially maintained at its increased value while the

volume of the (n)th sealed-off fluid pocket 511a decreases, and oil begins flowing out of fluid pocket 511a through outlet port 514 as indicated by arrow "C" in Figure 1. During this process, valve member 515 is urged radially outwardly by virtue of the pressure in the (n)th sealed-off fluid pocket 511a.

A further operational description of the apparatus 500 in several angular positions of piston member 520 is described in detail below. In the angular position where the sealed air gap 521 passes axial line 521a which substantially lies upon the axial line contact 522, intake of all into the (n)th sealed-off fluid pocket 511a from inlet port 513 is terminated. In the angular position where the sealed air gap 521 passes axial line 521b, intake of the oil into the (n+1)th sealed-off fluid pocket 511b from inlet port 513 is substantially initiated. In a further angular position where the sealed air gap 521 passes axial line 521c, the ejection of oil from the (n)th sealed-off fluid pocket 511a to outlet port 514 is substantially initiated. In yet another angular position where the sealed air gap 521 passes axial line 521d, the ejection of oil from the (n)th sealed-off fluid pocket 511a to outlet port 514 is substantially terminated.

According to the apparatus described above, valve member 515 receives oppositely directed second and third forces. The second force is generated by the pressure in the (n)th sealed-off fluid pocket 511a directed against the front portion of the axial inner end surface of valve member 515. The second force urges valve member 515 radially outwardly. The third force is resultant of the first force generated by the substantially constant pressure, e.g., atmospheric pressure, at the axial outer end surface of valve member 515 and the restoring force of bias spring 518. The third force urges valve member 515 radially inwardly.

Since the pressure in the (n)th sealed-off fluid pocket 511a sharply increases and then is substantially maintained at its increased value, the second force which radially outwardly urges valve member 511 also sharply increases and then is substantially maintained at its increased value. When the drive shaft rotates with a low rotational speed and the oil has a high temperature (or low viscosity), the pressure in the (n)th sealed-off fluid pocket 511a does not increase to a boundary value at which the second force equals the third force, whereby valve member 515 would lose contact with piston member 520.

However, when the drive shaft rotates with a high rotational speed and the oil has a low temperature (or high viscosity), the pressure in the (n)th sealed-off fluid pocket 511a exceeds the stated boundary value. Therefore, the second force equals or exceeds the third force, and valve member 515 loses contact with piston member 520. This creates a large gap between the outer surface of piston member 520 and the axial inner end surface of valve member 515. Consequently, oil in the (n)th sealed-off fluid pocket 511a flows

back into the (n+1)th sealed-off fluid pocket 511b through this gap so that the amount of the oil flowing from the (n)th sealed-off fluid pocket 511a to outlet port 514 is decreased. This, in turn, leads to inefficient performance. In addition, since the gap is periodically created in accordance with the rotation of the drive shaft, a periodic collision occurs between the piston member 520 and the valve member 515 and creates an offensive noise during the rotation of the drive shaft.

While a bias spring 518 having a large spring constant could be employed to resolve the above defects, the contact force between the outer surface of piston member 520 and the axial inner end surface of valve member 515 is unacceptably increased, especially when the apparatus 500 operates at a low rotational speed and high oil temperature (or low viscosity). Moreover, the increased biasing results in an excessive loss of power and an abnormal abrasion of the contact surfaces between the piston member 520 and the valve member 515.

Accordingly, it is an object of the preferred embodiments to provide a rotary piston type incompressible fluid displacement which can effectively transfer an incompressible fluid from one portion thereof to another portion thereof.

It is another object of the preferred embodiments to provide a rotary piston type incompressible fluid displacement apparatus which can prevent an offensive noise caused by a periodic collision between a rotary piston member and a valve member or a vane during operation of the apparatus.

It is still another object of the preferred embodiments to provide a rotary piston type incompressible fluid displacement apparatus which can be driven without a defective loss of power.

It is a further object of the preferred embodiments to provide a rotary piston type incompressible fluid displacement apparatus which can prevent abnormal abrasion of the contact surfaces between the piston member and the valve member.

The rotary piston type incompressible fluid displacement apparatus of the preferred embodiments includes a casing enclosing a cylindrical chamber. A rotatable drive shaft axially penetrates through the cylindrical chamber. A cylindrical piston member is disposed within the cylindrical chamber and is operatively connected to the drive shaft. A valve element or a vane is radially slidably disposed within a bore which is formed at an inner surface of one peripheral portion of the casing. A bias spring is resiliently disposed within the bore so as to urge the valve element into contact with an outer surface of the cylindrical piston member. An axis of the cylindrical piston member is radially offset from an axis of the drive shaft by a predetermined distance.

The casing, the cylindrical piston member and the valve element cooperatively define a first cham-

ber portin into which an incompressible fluid, such as an oil, is taken and a second chamber portion through which the oil is pumped. An inlet port is formed through the casing on one side of the vane. An outlet port is formed through the casing on the other side of the vane. A conducting means, such a groove, is axially formed through a central portion of one end surface of the valve element. The conducting means conducts oil on the high pressure side of the piston into a hollow space disposed radially outwardly of the valve element. Consequently, the high pressure oil acting on the rear end of the vane assures its contact with the piston member.

Other objects, advantages and features of this invention will be understood when the detailed description of the invention and drawings are considered.

In the accompanying drawings:-

Figure 1 is a longitudinal sectional view of a rotary piston type incompressible fluid displacement apparatus in accordance with the prior art.

Figure 2 is a longitudinal sectional view of a rotary piston type incompressible fluid displacement apparatus in accordance with a first preferred embodiment.

Figure 3 is a view taken along line 3-3 of Figure 2.

Figure 4 is a view taken along arcuate line 4-4 of Figure 2.

Figure 5 is a view similar to Figure 4 showing a second preferred embodiment.

Figure 6 is a view similar to Figure 4 showing a third preferred embodiment.

Referring to Figures 2 and 3, a rotary piston type incompressible fluid displacement apparatus 10 in accordance with a first preferred embodiment is shown. Apparatus 10 is incorporated in a refrigerant compressor as an oil pumping device which supplies lubricating oil from an oil sump to the frictional surfaces of the internal component parts of the compressor.

The apparatus 10 includes an annular cylindrical member 11 and a pair of circular plates 12 and 13 which are disposed within annular cylindrical member 11. The pair of circular plates 12 and 13 are fixedly connected to annular cylindrical member 11 by means of, for example, screws (not shown). Ring member 14 is also disposed within annular cylindrical member 11 and is fixedly sandwiched by circular plates 12 and 13 by means of, for example, screws (not shown). The pair of circular plates 12 and 13 and ring member 14 cooperatively define cylindrical chamber 110.

The apparatus 10 further includes a drive shaft 20, which is also the drive shaft of the compressor. Drive shaft 20 rotatably penetrates circular plates 12 and 13. Drive shaft 20 includes annular projection 21 projecting radially outwardly from an outer peripheral surface thereof. Annular projection 21 functions as a cylindrical piston member. The longitudinal axis X of annular projection 21 is radially offset from the long-

itudinal axis X' of the drive shaft 20. The longitudinal axis X' of the drive shaft 20 is coaxial to the longitudinal axis of cylindrical chamber 110. The opposite axial end surfaces of annular projection 21 are in fluid tight contact with the inner surface of the pair of the circular plates 12 and 13, respectively. When drive shaft 20 rotates, annular projection 21 rotates around the longitudinal axis X' in the same rotational direction of the drive shaft 20 as indicated by arrow "A" in Figure 2.

A bore 30 having a rectangular-shaped transverse cross-section is radially formed through ring member 14. Outlet and inlet ports 32 and 31 are formed through ring member 14 at positions which are in front of and to the rear of bore 30 with respect to the rotational direction "A" of drive shaft 20, respectively. Inlet and outlet ports 31 and 32 are linked to bores 311 and 321, which are formed through annular cylindrical member 11, respectively. A valve member or vane 40 having a rectangular shaped transverse cross section is slidably disposed within bore 30. An axial inner end portion of valve member 40 is U-shaped in longitudinal cross section. Bias spring 41 is resiliently disposed within bore 30 between the axial outer end surface of valve member 40 and the inner surface of annular cylindrical member 11. Bias spring 41 radially inwardly urges valve member 40 into contact with annular projection 21.

During operation of rotary piston type incompressible fluid displacement apparatus 10, the outer surface of one peripheral portion of annular projection 21 faces an inner surface of one peripheral portion of ring member 14 with a small air gap 211 while the outer surface of another peripheral portion of annular projection 21 is in contact at 212 with the axial inner end surface of valve member 40. At gap 211 is substantially sealed by an oil film and shifts along the inner peripheral surface of ring member 14 in the rotational direction "A" of drive shaft 20. On the other hand, the axial line contact 212 between annular projection 21 and valve member 40 reciprocatingly shifts along the U-shaped axial inner end surface of valve member 40.

Sealed air gap 211 and axial line contact 212 divide cylindrical chamber 110 into (n)th sealed-off fluid pocket 110a and (n+1)th sealed-off fluid pocket 110b. The (n)th and (n+1)th sealed-off fluid pockets 110a and 110b are located in front of and to the rear of the axial line contact 212 with respect to the rotational direction "A" of drive shaft 20, respectively. The portion of the axial inner end surface of valve member 40 located in front of axial line contact 212 with respect to the rotational direction of the drive shaft receives pressure in the (n)th sealed-off fluid pocket 110a while the portion of the axial inner end surface of valve member 40 located to the rear of the axial line contact 212 receives pressure in the (n+1)th sealed-off fluid pocket 110b. Accordingly, valve member 40

is urged radially outwardly by virtue of the pressure in the (n)th and (n+1)th sealed-off fluid pockets 110a and 110b.

Referring to Figure 4 in addition to Figures 2 and 3, an axial groove 400 having a rectangular-shaped transverse cross section is formed at a central portion of the front side surface of valve member 40. Axial groove 400 forms a communication conduit between (n)th sealed-off fluid pocket 110a and a hollow space 30a located radially outwardly of the end face of valve member 40. Therefore, valve member 40 is urged radially inwardly by a first force due to the pressure in the (n)th sealed-off fluid pocket 110a at the axial outer end surface thereof. Furthermore, the depth of axial groove 400 is designed so that a bottom surface 440a (Fig. 4) of groove 400 does not pass the axial line contact 212 between the annular projection 21 and the valve member 40.

As the drive shaft 20 rotates in the direction indicated by arrow "A" in Figure 2, annular projection 21 rotates around the longitudinal axis X' of the drive shaft 20 and sealed air gap 211 shifts along the inner peripheral surface of ring member 14. When annular projection 21 is positioned as illustrated in Figure 2, the volume of the (n+1)th sealed-off fluid pocket 110b is increasing. At that time, oil from the oil sump flows into the (n+1)th sealed-off fluid pocket 110b through a pipe member (not shown), bore 311 and inlet port 31 as indicated by arrows "B" in Figure 2. By contrast, the volume of the (n)th sealed-off fluid pocket 110a is decreasing and the oil in the high pressure (n)th sealed-off fluid pocket is ejected through outlet port 32 and bore 321 as indicated by arrow "C" in Figure 2. As the angular position of annular projection 21 changes, the pressure in the (n+1)th sealed-off fluid pocket 110b gradually decreases while the pressure in the (n)th sealed-off fluid pocket 110a sharply increases. Subsequently, the pressure of the oil in the (n)th sealed-off fluid pocket 110a is substantially maintained at its increased value during the remainder of the oil delivery stroke.

An operational description of the apparatus 10 at several angular positions is described in detail below. In the angular position where the sealed air gap 211 passes axial line 211a, intake of oil into the (n)th sealed-off fluid pocket 110a from inlet port 31 is terminated. In the angular position where the sealed air gap 211 passes axial line 211b, intake of oil into the (n+1)th sealed-off fluid pocket 110b from inlet port 31 is substantially initiated. In the angular position where the sealed air gap 211 passes axial line 211c, ejection of oil from the (n)th sealed-off fluid pocket 110a to outlet port 32 is substantially initiated. In the angular position where the sealed air gap 211 passes axial line 211d, the ejection of oil from the (n)th sealed-off fluid pocket 110a to outlet port 32 is substantially terminated.

Valve member 40 receives oppositely directed

second and third forces. More particularly, the second force is generated by the pressure in the (n)th sealed-off fluid pocket 110a at the front portion of the axial inner end surface of valve member 40. The second force urges valve member 40 radially outwardly. The third force is the resultant of the first force generated by the pressure in the (n)th sealed-off fluid pocket 110a at the axial outer end surface of valve member 40 and the restoring force of bias spring 41. The third force urges valve member 40 radially inwardly. Since the portion of the axial inner end surface of valve member 40 exposed to the high pressure oil is smaller than the axial outer end surface of valve member 40 exposed to the high pressure oil, valve member 40 is continually urged radially inwardly by virtue of the restoring force of bias spring 41 and the differential between the first force and the second force.

Accordingly, even when the drive shaft 20 rotates in a high rotational speed and the oil has a low temperature (high viscosity), the axial line contact 212 between annular projection 21 and valve member 40 is maintained. Further, the periodic creation of an air gap between annular projection 21 and valve member 40 is prevented. Therefore, the return of oil from the (n)th sealed-off fluid pocket 110a to the (n+1)th sealed-off fluid pocket 110b through the above air gap is avoided.

This design leads to more efficient pump performance and eliminates the offensive noises due to periodic collisions between annular projection 21 and valve member 40. The spring constant of bias spring 41 is selected to avoid generating an excessive contact force between annular projection 21 and valve member 40 so that an excessive loss of power and abnormal abrasion of the contact surfaces can be avoided.

Figures 5 and 6 illustrate second and third preferred embodiments, respectively. In Figures 5 and 6, the same numerals are used to denote the corresponding elements shown in Figure 4, and an explanation of those elements is omitted. Furthermore, the effect of the second and third preferred embodiments is similar to that of the first preferred embodiment so that an explanation thereof is also omitted.

Referring to Figure 5 in addition to Figure 3, a pair of axial hollow portions 401 having triangular cross sections are formed at both radial end portions of valve member 40. Axial hollow portions 401 permit fluid communication between the (n)th sealed-off fluid pocket 110a and hollow space 30a disposed at the radial outer end of valve member 40. As with the first preferred embodiment, valve member 40 is urged radially inwardly by the pressure in the (n)th sealed-off fluid pocket 110a at the axial outer end surface of valve member 40. Furthermore, axial hollow portions 401 are positioned completely in front of axial line contact 212.

Referring to Figure 6 in addition to Figure 3, an axial groove 141 having a rectangular-shaped transverse cross section is formed at a central portion of a front side surface of bore 30 with respect to the rotational direction "A" of drive shaft 20. Axial groove 141 establishes a fluid communication path between the (n)th sealed-off fluid pocket 110a and hollow space 30a disposed at the radial outer end of valve member 40. Therefore, valve member 40 is urged radially inwardly by the pressure in the (n)th sealed-off fluid pocket 110a acting upon the axial outer end surface of valve member 40.

Claims

1. A rotary piston type fluid displacement apparatus comprising:
 - a casing defining a cylindrical chamber;
 - a rotatable drive shaft axially penetrating through said cylindrical chamber;
 - a cylindrical piston member disposed within said cylindrical chamber and operatively connected to said drive shaft, said cylindrical piston member having an axis radially offset from an axis of said drive shaft;
 - a valve element radially slidably disposed within a bore formed in said casing;
 - resilient biasing means disposed within said bore for urging said valve element into contact with said cylindrical piston member, said resilient biasing means operatively engaging a first end of said valve member;
 - said casing, said cylindrical piston member and said valve element cooperatively defining a first chamber portion and a second chamber portion;
 - an inlet port formed through said casing and operating into said first chamber portion;
 - an outlet port formed through said casing and opening into said second chamber portion; and
 - conducting means for conducting working fluid from said second chamber portion to said first end of said valve member so that said working fluid in said second chamber portion urges said valve member in the valve direction as resilient biasing means.
2. The rotary piston type fluid displacement apparatus of claim 1 wherein the working fluid is an oil.
3. The rotary piston type fluid displacement apparatus of claim 1 wherein said resilient means is a bias spring.
4. The rotary piston type fluid displacement apparatus of claim 1 wherein said bore has a rectangular

cross section.

5. The rotary piston type fluid displacement apparatus of claim 4 wherein said valve element has a rectangular cross section.
6. The rotary piston type fluid displacement apparatus of claim 5 wherein said conducting means is a groove formed axially along a central portion of one end surface of said valve element.
7. The rotary piston type fluid displacement apparatus of claim 6 wherein said groove is rectangular in transverse cross section.
8. The rotary piston fluid displacement apparatus of claim 5 wherein said conducting means is a pair of cut-out portions formed axially through both corners of one end surface of said valve element.
9. The rotary piston type fluid displacement apparatus of claim 8 wherein said cut-out portions are triangular in transverse cross section.
10. The rotary piston by fluid displacement apparatus of claim 5 wherein said conducting means is a groove formed axially through a central portion of one end surface of said bore.
11. The rotary piston type fluid displacement apparatus of claim 10 wherein said groove is rectangular in transverse cross section.
12. The rotary piston type fluid displacement apparatus of claim 5 wherein an inner end portion of said valve element is U-shaped in longitudinal cross section.

Fig. 1
(Prior Art)

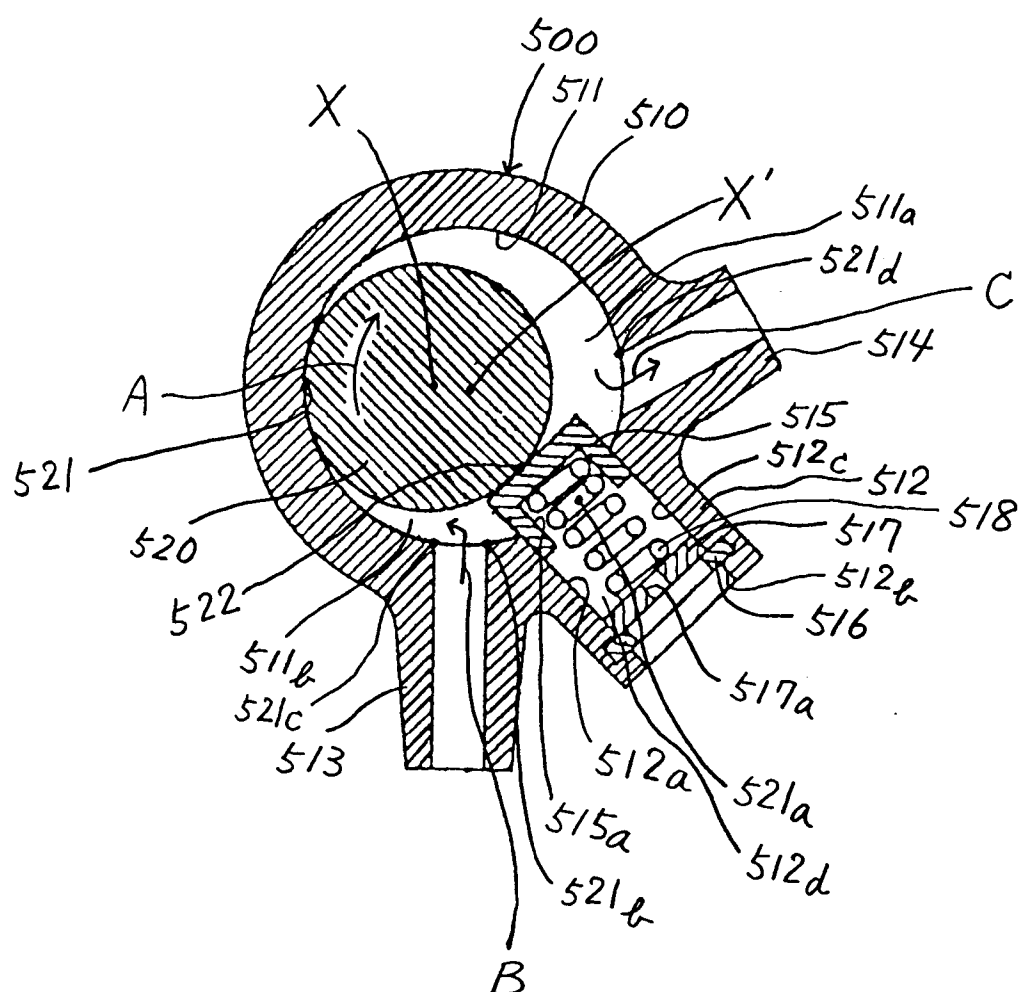


Fig. 2

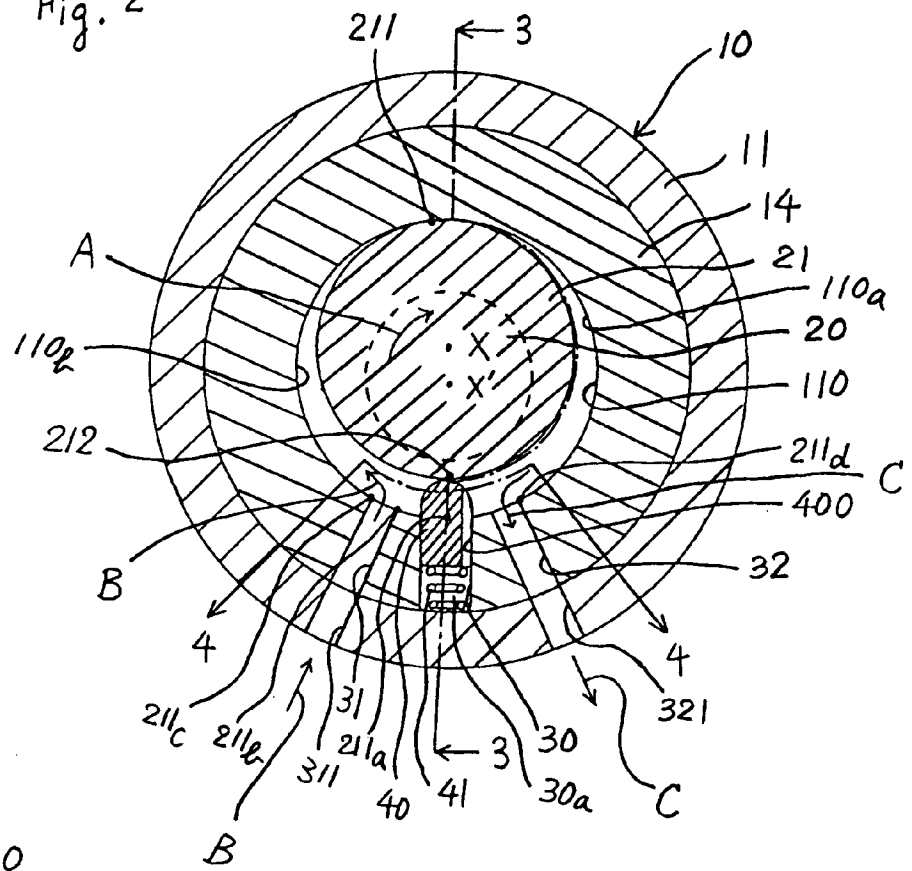


Fig. 3

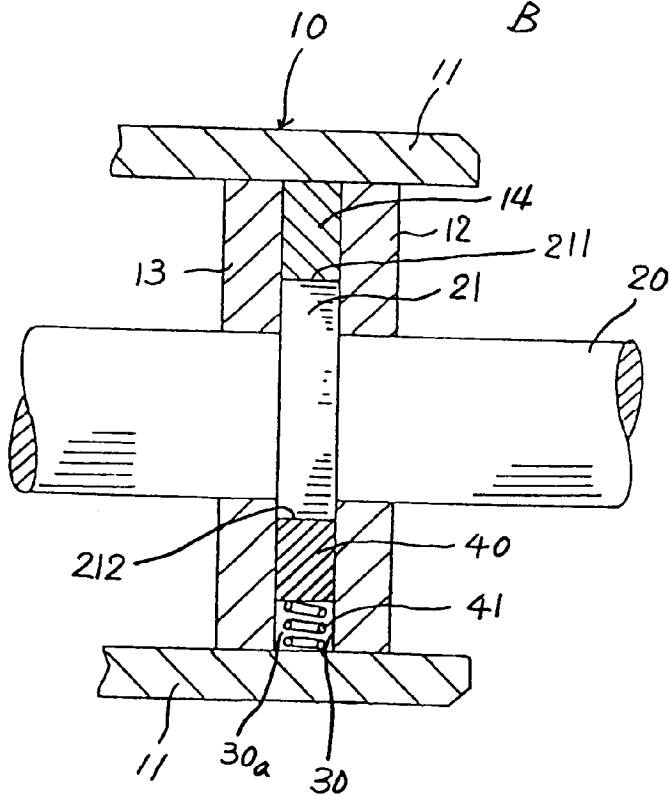


Fig. 4

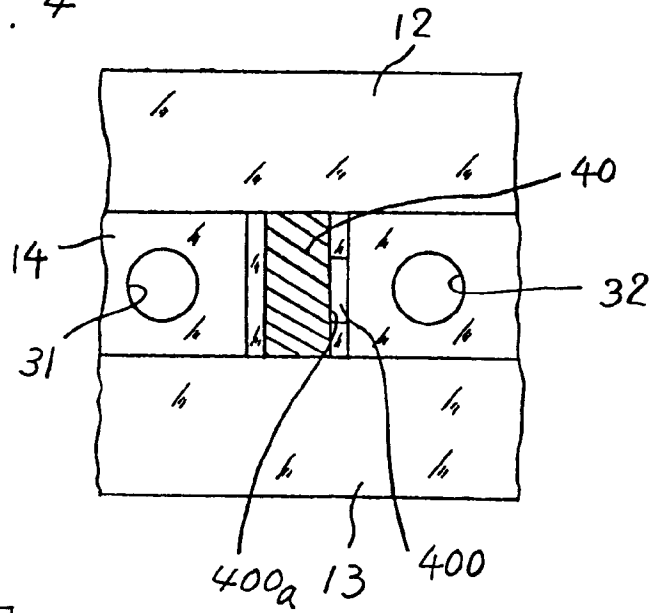


Fig. 5

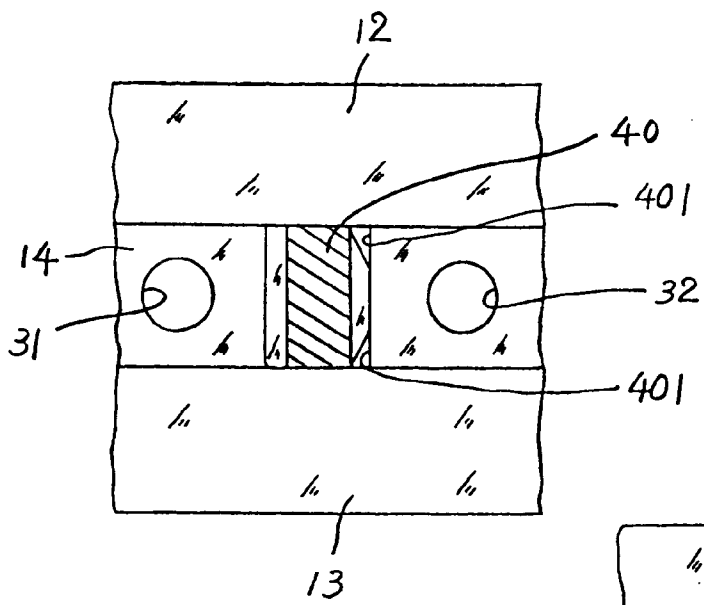
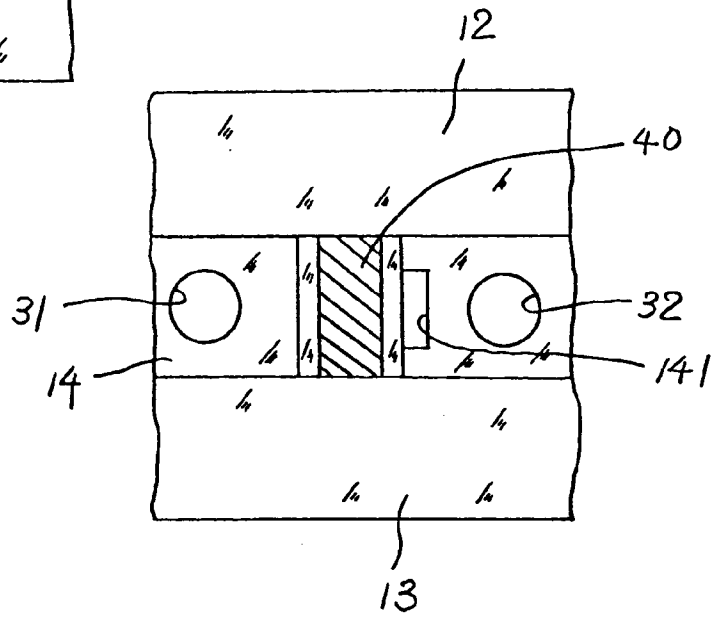


Fig. 6





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 7361

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	US-A-3 221 665 (HARTMANN) * the whole document * ---	1,3,4	F04C2/356 F01C21/08
X	PATENT ABSTRACTS OF JAPAN vol. 13, no. 299 (M-847)(3647) 11 July 1989 & JP-A-01 087 891 (TOSHIBA CORP.) 31 March 1989 * abstract * ---	1,3,12	
X	PATENT ABSTRACTS OF JAPAN vol. 14, no. 23 (M-920)(3966) 17 January 1990 & JP-A-01 262 395 (DAIKIN IND. LTD.) 19 October 1989 * abstract * ---	1,3	
X	GB-A-520 016 (ROBERT BOSCH GMBH) * the whole document * ---	1,3	
A	US-A-3 521 981 (KRZYSZCZUK) * the whole document * ---	1	TECHNICAL FIELDS SEARCHED (Int.Cl.5)
A	GB-A-1 186 345 (FLITCROFT) * the whole document * ---	1	F01C F04C
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 187 (M-236)(1332) 16 September 1983 & JP-A-58 088 486 (ZENERARU K.K.) 26 May 1983 * abstract * -----	1	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13 December 1993	Examiner Dimitroulas, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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