APPLICATION FOR A STANDARD PATENT

We RABUSHIKI KAISHA LITTLE ROCK, YOSHINOBU KOIWA, KELBIN CO., LTD.,
SHUICHI FUJIMORI

hereby apply for the grant of a Standard Patent for an invention entitled
PUMP AND VALVE APPARATUS

which is described in the accompanying specification.

For a Convention application — details of basic application(s) —

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>COUNTRY</th>
<th>DATE OF APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>237,996/87</td>
<td>JAPAN</td>
<td>22nd September 1987</td>
</tr>
</tbody>
</table>

Our address for service is COLLISON & CO., Patent Attorneys, 117 King William Street, Adelaide, South Australia, 5000.

Dated this 22nd day of September 1988

KABUSHIKI KAISHA LITTLE ROCK, YOSHINOBU KOIWA, KELBIN CO., LTD., and SHUICHI FUJIMORI
By their Patent Attorneys, COLLISON & CO.

ALUN W. THOMAS

A000524 22/09/88

To

THE COMMISSIONER OF PATENTS

This form must be accompanied by either a provisional specification (Form 9 and true copy) or by a complete specification (Form 10 and true copy).
DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention application made for a patent for an invention entitled:

"PUMP AND VALVE APPARATUS"

I, YOSHINOBU KOIWA

of 172-14, Kotehashicho, Chiba-shi, Chiba Prefecture, JAPAN

do solemnly and sincerely declare as follows:

1. I am the applicant for the patent

   for (in the case of an application by a body corporate)

   I am authorized by Kabushiki Kaisha Little Rock, one of the applicants for the patent to make this declaration on its behalf.

2. The basic application as defined by section 141 of the Act was made in JAPAN on the 22nd day of September, 1987, by Eiko Sangyo Ltd.

3. Yoshinobu KOIWA

   of 172-14 Kotehashicho, Chiba-Shi, Chiba Prefecture, JAPAN

is the actual inventor of the invention and the facts upon which the applicants are entitled to make the application are as follows: The inventor assigned his right to the invention to the basic applicant and the basic applicant has assigned the right to apply to the applicants by deed of assignment dated 26th August 1988.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

   Except as stated in this paragraph, the basic application referred to in paragraph 2 of this Declaration was not the first application made in a Convention country in respect of the invention the subject of the application.

   An earlier application in respect of the invention the subject of the application was made in

   (Here set out in succeeding paragraphs the facts that show that section 142AA is applicable)

Declared at Chiba, JAPAN this 20th day of December, 1988

TO:

THE COMMISSIONER OF PATENTS.

YOSHINOBU KOIWA

(Signature of Declarant)
In support of the Convention application made for a patent for an invention entitled:

"PUMP AND VALVE APPARATUS"

1. YOSHINOBU KOIWA

of 172-14 Kotehashicho, Chiba-shi, Chiba Prefecture, JAPAN

do solemnly and sincerely declare as follows:

1. I am one of the applicants for the Patent

for the patent to make this declaration on its behalf.

2. The basic application as defined by section 141 of the Act was made in JAPAN on the

22nd day of September, 1987, by Eiko Sangyo Ltd

day of ----------------------------------1987---by

3. I am the actual inventor of the invention referred to in the basic application.

(or, where a person other than the inventor is the applicant)

3. YOSHINOBU KOIWA

of 172-14 Kotehashicho, Chiba-Shi, Chiba Prefecture, JAPAN

is the actual inventor of the invention and the facts upon which the applicants are

entitled to make the application are as follows: The inventor assigned his right to the invention to the basic applicant and the basic applicant has assigned the right to apply to the applicants by deed of assignment dated 26th August 1988.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

(for a request is made under section 142AA of the Patents Act 1952, for an earlier application made in a Convention country to be disregarded)

4. (1) The basic application referred to in paragraph 2 of this Declaration was not the first application made in a Convention country in respect of the invention the subject of the application.

(2) An earlier application in respect of the invention the subject of the application was made in

(3) A request has been made to you under section 142AA of the Patents Act 1952 to disregard that earlier application.

(Here set out in succeeding sub-paragraphs the facts that show that section 142AA is applicable)

Except as stated in this paragraph, the basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

Declared at Chiba, JAPAN this 20th day of December, 1989

TO:

THE COMMISSIONER OF PATENTS.

(Signature of Declarant)

(IMPORTANT — Cross out inapplicable words in above Form.)
In support of the Convention application made for a patent for an invention entitled:

"PUMP AND VALVE APPARATUS"

1. SHUICHI FUJIMORI

of 19-5 Kugenuma - Matsugaoka 2-Chome, Fujisawa-shi, Kanagawa Prefecture, JAPAN

do solemnly and sincerely declare as follows:

1. I am the applicant for the patent. (or, in the case of an application by a body corporate)

   1. I am authorized by KELBIN CO., LTD, one of the applicants for the patent to make this declaration on its behalf.

   2. The basic application as defined by section 141 of the Act was made in JAPAN on the 22nd day of September, 1987, by Eiko Sangyo Ltd

3. I am the actual inventor of the invention referred to in the basic application. (or, where a person other than the inventor is the applicant)

   3. Yoshinobu KOIWA

   of 172-14 Kotehashicho, Chiba-Shi, Chiba Prefecture, JAPAN

   is the actual inventor of the invention and the facts upon which the applicants are entitled to make the application are as follows:

   The inventor assigned his right to the invention to the basic applicant and the basic applicant has assigned the right to apply to the applicants by deed of assignment dated 26th August 1988.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

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   (Here set out in succeeding sub-paragraphs the facts that show that section 142AA is applicable)

   Except as stated in this paragraph, the basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

Declared at Tokyo this 19th day of December, 1988

TO: THE COMMISSIONER OF PATENTS.

(IMPORTANT — Cross out inapplicable words in above Form.)
DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention application made for a patent for an invention entitled:

"PUMP AND VALVE APPARATUS"

1. Shuichi FUJIMORI

of 19-5 Kugenuma-Matsugaoka 2-chome, Fujisawa-shi, Kanagawa Prefecture, JAPAN

do solemnly and sincerely declare as follows:

1. I am the applicant for the patent.

2. I am authorized by

for the patent to make this declaration on its behalf.

2. The basic application as defined by section 141 of the Act was made in JAPAN on the 22nd day of September, 1987, by Eiko Sangyo Ltd.

3. Yoshinobu KOIWA

of 172-14 Kotehashicho, Chiba-Shi, Chiba Prefecture, JAPAN

is the actual inventor of the invention and the facts upon which the applicants are entitled to make the application are as follows: The inventor assigned his right to the invention to the basic applicant and the basic applicant has assigned the right to apply to the applicants by deed of assignment dated 26th August 1988.

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(Here set out in succeeding sub-paragraphs the facts that show that section 142AA is applicable)

Declared at Tokyo this 19th day of December, 1988

TO: THE COMMISSIONER OF PATENTS.

(Signature of Declarant)
DOCUMENTS LODGED WITH THIS APPLICATION ARE UNSUITABLE FOR REPRODUCTION AND MAY BE INSPECTED AT THE PATENT OFFICE A.C.T.
1. A pump apparatus comprised of: a valve box in which a valve chamber inlet and outlet are each provided with a valve; a reciprocating member which moves reciprocally in a cylinder that communicates with the valve chamber of the valve box to open the said valves;

wherein a pressure action chamber is provided between the valve box and the cylinder and a pressure force member divides the pressure action chamber into a valve chamber side and a cylinder side, and contained on the cylinder side of the pressure action chamber divided by the pressure force member is an action medium that transmits to the pressure force member changes in volume of the pressure action chamber produced by the action of the reciprocating member.
6. A valve device comprised of: a valve seat the seating portion of which is formed as a concavity corresponding to a spherical surface; a prescribed number of fluid passages formed therein opening into the said concavity; a valve-piece having a surface corresponding to the valve seat concavity; and a valve spring that resiliently maintains the valve-piece on the concave surface of the valve seat; wherein at least one of the valve seat and valve-piece is formed of a hard resilient material.
COMMONWEALTH OF AUSTRALIA
Patents Act 1952-1969

COMPLETE SPECIFICATION
(ORIGINAL)

FOR OFFICE USE:

Application Number :
Lodged :

Complete Application No. :
Specification Lodged :
Published :

Priority:

Related art:

TO BE COMPLETED BY APPLICANT

Name of Applicant:
KABUSHIKI KAISHA LITTLE ROCK,
YOSHINOBU KOIWA,
KELBIN CO., LTD. and
SHUICHI FUJIMORI

Address of Applicants respectively of:
703, Sankakucho, Chiba-shi, Chiba-pref, Japan,
172-14, Kotehashicho, Chiba-shi, Chiba-pref, Japan,
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19-5, Kugenuma-Matsugaoka 2-Chome, Fujisawa-shi,
Kanagawa pref. Japan

Actual Inventor:

Address for Service: COLLISON & CO., Patent Attorneys, 117 King William Street, Adelaide, South Australia, 5000

Complete Specification for the invention entitled:
PUMP AND VALVE APPARATUS

The following statement is a full description of this invention, including the best method of performing it known to me:

us
BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a pump and valve apparatus that provides a reliable valve opening and closing operation and improved durability.

Description of the Prior Art

Pumps in use include reciprocating pumps in which the reciprocating action of a piston is used to open and close a valve and pressure-feed a fluid such as water, for example. Such reciprocating pumps are divided into three types according to the form of piston used: the bucket type, the plunger type and the piston.

As shown in Figure 12, bucket type pumps have a hole 102 in the piston 101 that slides in a cylinder 100. The hole 102 and the cylinder outlet 103 are provided with respective valves 104 and 105. The piston 101 is caused to move reciprocally via a piston rod 106. The descent of the piston 101 opens the valve 104 and closes valve 105, drawing water through the hole 102 to the upper part of the cylinder 100. This water in the upper part of the cylinder 100 is then sent out under pressure by the rise of the piston 101.

Plunger type pumps, such as shown in Figure 13, are generally used for high-pressure applications. Water, for example, in the cylinder 107 is forced under pressure...
out of the cylinder outlet 106' by the insertion of the plunger 108 into the cylinder 107.

Figure 14 shows a piston type pump in which the movement of a piston 111 driven by a crank mechanism 109 inside a cylinder 110 opens and closes valves 112 and 113 to feed out the water under pressure.

These types of reciprocating pumps use various types of packing, for example rubber, to obtain a watertight seal between the piston and the cylinder. In the bucket pump there is a packing between the cylinder 100 and the piston rod 106, and in the plunger pump the cylinder 107 and plunger 108 are each provided with a packing therebetween. On the piston pumps, piston rings are provided around the circumference of the piston 111.

When these types of conventional reciprocating pumps, especially plunger pumps, are used to pump fluids containing granular material, such as in a cement mill, the motion of the plunger is accompanied by a rubbing of the particles against the packing, which causes the packing to wear rapidly. This has necessitated replacing packings at short intervals, which reduces operating efficiency and shortens the working life of the pump itself. On piston pumps, the piston rings wear and can cause damage to the internal surface of the cylinder.

Various types of valves are used as means of limiting or controlling the fluid flow. Figures 8 and 9 show a valve device used on plunger pumps which are well-
known as pumps for high-pressure applications. These valve devices are comprised of a tubular valve seat 50, a valve-piece 52 provided with a surrounding flange 51, and a valve spring 53 which presses the valve-piece 52 towards the valve seat 50. With plunger pumps used to pump materials such as cement clinker, for example, as the valve-piece 52 of the conventional valve devices opens and closes solid bodies contained in the fluid can be caught between the valve-piece 52 and the valve seat 50.

Because the valve seats 50 used in conventional valve devices are tubular members solid bodies readily pass therethrough, in addition to which as the valve seat 50 and the valve-piece 52 are made of metal, the valve operation is not always reliable if solid bodies are caught therebetween. This can make it impossible to pump constant quantities of fluid at fixed intervals, so use of the pump was accompanied by a lowering of the operating efficiency. Furthermore, solid bodies caught between the valve seat 50 and the valve-piece 52 could cause damage to the seat and valve-piece, resulting in fluid leaking out of the gap between them. Conventionally, therefore, the valve device has had to be replaced at this point, interrupting operations.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a pump and valve apparatus that offers reliable valve operation with improved durability.
To achieve this object, according to the present invention, in a pump apparatus comprised of a valve box in which a valve chamber inlet and outlet are each provided with a valve, and a reciprocating member which moves reciprocally in a cylinder that communicates with the valve chamber of the valve box to open the said valves, a pressure action chamber is provided between the valve box and the cylinder and a pressure force member divides the pressure action chamber into a valve chamber side and a cylinder side, and contained on the cylinder side of the pressure action chamber divided by the pressure force member is an action medium that transmits to the pressure force member changes in volume of the pressure action chamber produced by the action of the reciprocating member.

The invention also comprises a valve device comprising a valve seat the seating portion of which is formed as a concavity corresponding to a spherical surface; a prescribed number of fluid passages formed therein opening into the said concavity; a valve-piece having a surface corresponding to the valve seat concavity; and a valve spring that resiliently maintains the valve-piece on the concave surface of the valve seat; wherein at least one of the valve seat and valve-piece is formed of, or covered with, a hard resilient material, or one is formed of a hard resilient material and the other is covered with a hard resilient material. In addition, the valve seat and valve-piece may be made of wood instead of the hard resilient...
material.

The suction effect of the reciprocating member causes the volume enclosed by the pressure force member to contract by a set amount, which produces a negative pressure in the valve chamber that opens the valve on the inlet side, drawing fluid into the interior of the valve chamber. When the reciprocating member performs an expulsion action, the pressure force member is expanded, via the action medium, by the volume of the expulsion movement of the reciprocating member. As a result, the outlet-side valve opens and an amount of fluid is fed out that is the amount of the change in volume of the pressure action chamber.

The fluid passages formed in the valve seat are small, which makes it hard for solid bodies to pass therethrough. Even if solid bodies should pass through the fluid passages and get caught between the valve seat and the valve-piece, the resilience of the valve seat and/or the valve-piece ensure that such solid bodies do not interfere with the action of the valves.

The above and other features of the invention will become apparent from the description below made with reference to the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view of an embodiment of the valve device according to the present invention applied to a plunger pump:
Figure 2 is a cross-sectional view of the valve device shown in Figure 1;
Figure 3 is a perspective view of the valve device;
Figures 4 to 7 are cross-sectional views of other embodiments of the invention;
Figure 8 is a cross-sectional view of a conventional valve device;
Figure 9 is a perspective view of a conventional valve device;
Figure 10 is an explanatory drawing to explain the operation of the pump apparatus of Figure 1;
Figure 11 is a cross-sectional view of a portion of another embodiment; and
Figures 12 to 14 are cross-sectional views of conventional pump apparatuses.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 is a sectional view of an embodiment of a plunger type pump according to the present invention.
This pump apparatus is comprised of a valve box 2 provided with a valve chamber 1, a plunger box 4 provided with a plunger 3, and a pressure action chamber 5 disposed between the valve box 2 and the plunger box 4. The valve box 2 is provided with a valve device 11 comprised of valve chamber 1 inlet 6 and outlet 7, a valve seat 8, a valve-piece 9 and valve spring 10, which are described later. The plunger 3 is disposed, via a plurality of V-shaped packings 13,
within a cylinder 12 in the plunger box 4 and is slidably operated by a drive means (not illustrated). In the suction process the plunger 3 is contained in the cylinder 12, and in the expulsion process part of the plunger 3 is caused to project from the opening 14 of the cylinder 12 into the pressure action chamber 5.

The pressure action chamber 5 is provided between an opening 15 provided in the wall of the valve chamber 1 of the valve box 2 and the cylinder opening 14 of the plunger box 4. In the pressure action chamber 5 is provided a resilient membrane 16 made of sheet rubber, for example, to form a pressure force member that divides the pressure action chamber 5 into a valve box 2 side and a plunger box 4 side. The enclosed cylinder-side action chamber A formed by the partitioning resilient membrane 16 is filled with an action medium 17 such as oil, for example.

The valve seat 8, valve-piece 9 and valve spring 10 that form the valve device 11 will now be described with reference to Figures 2 and 3. The valve seat 8 has a valve seating portion 18 with a concave surface 19 that corresponds to part of a spherical surface, and is also provided with a number of fluid passages 20 that extend axially to open into the said concave surface 19. The number and diameter of the fluid passages 20 are determined beforehand to values that ensure the achievement of the required flow application. The transverse section of the
fluid passages 20 may be reticular or slit-shaped, as required.

The valve-piece 9 is spherical in shape and is formed from a hard resilient material such as hard rubber or synthetic resin. The diameter of the valve-piece 9 is such that it fits the concave surface 19 or is slightly larger.

The valve seat 8 as well as the valve-piece 9 may also be formed of a hard resilient material, or the valve seat 8 alone may be formed of a hard resilient material.

The valve spring 10 is provided between the valve cover 21 and a spring retainer 22, for example, or the inner wall of the valve box 2, and urges the valve-piece 9 towards the valve seat 8 with a constant force.

The operation of plunger pump provided with the above valve device 11 will now be described. When in the course of the suction process the plunger 3 is moved to the left, with reference to the drawing, the resilient membrane 16 contracts by the amount of change in volume caused by the suction action of the plunger 3. This produces a negative pressure in chamber 1, forcing open the valve-piece 9 against the resistance of the valve spring 10, and the fluid substance flows into the valve chamber 1 via the fluid passages 20.

During the expulsion process, when the plunger 3 is moved to the right, with reference to the drawing, the resilient membrane 16 expands via the action medium 17 by
the amount of change in volume produced by the expulsion stroke of the plunger 3. As a result, the fluid introduced into the valve chamber 1 pushes open the valve-piece 9 on the outlet side against the resistance of the valve spring. An amount of fluid equivalent to the amount of change in volume caused by the expansion of the resilient membrane 16 is fed under pressure through the fluid passages 20.

Because the fluid passages 20 are small holes, any solid bodies included in the fluid that are above a set size are excluded by the valve seat 8, so that only smaller solid particles are allowed to pass through the valve device 11. Even if solid bodies should be caught between the valve seat 8 and the valve-piece 9, the valve seat 8 or the valve-piece 9 are formed of a hard resilient material which deforms, thereby enabling the seal to be maintained.

Figures 4 to 6 illustrate other embodiments of the present invention. Parts that are the same as those in Figure 2 are denoted by the same reference numerals.

In the embodiment shown in Figure 4, the valve seat 8' is covered with a hard resilient material 24 such as hard rubber or synthetic resin. The valve-piece 9' may be covered in the hard resilient material 24 such as shown in Figure 5, or both the valve seat 8 and valve-piece 9' may be covered by the hard resilient material 24. In Figure 6, the valve-piece 9 formed of hard resilient material may be combined with a valve seat 8' covered with hard resilient material.
Shown in Table 1 are the combinations of valve-piece 9 and valve seat 8.

<table>
<thead>
<tr>
<th>Valve Piece</th>
<th>Made of metal</th>
<th>Formed of hard resilient material</th>
<th>Covered with hard resilient material</th>
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</thead>
<tbody>
<tr>
<td>Valve Seat</td>
<td>Made of metal</td>
<td>Formed of hard resilient material</td>
<td>Covered with hard resilient material</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>Formed of hard resilient material</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>Covered with hard resilient material</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

A valve-piece 9, and a valve seat 8, made of wood may also be used in place of the aforementioned hard resilient material. In this case, the water contained in the wooden valve-piece 9 and the valve seat 8 generates a restorative force, so that even if solid bodies are caught between the valve-piece 9 and the valve seat 8 there is little deformation thereof.

The valve-piece 9 may be hemispherical in shape, as shown in Figure 7, and the curvature may be ellipsoid rather than the curve of a perfect sphere.

The inlet-side valve 9 opens in the direction of the valve chamber 1 is normally kept closed by the force of the valve spring 10 urging it in the direction of the valve.
seat 8. The outlet-side valve 9' that opens away from the valve chamber 1 is normally kept closed by the force of the valve return spring 10', provided between the valve box 2 and the valve cover 25, that urges the valve 9' towards the valve seat 8'. The numeral 15 denotes the opening formed in the wall 2a of the valve chamber 1.

The plunger 3 is disposed, via a V-shaped packing 13, within a cylinder 14 in the plunger box 4 and is slidably operated by a drive means (not illustrated). In the suction process the plunger 3 is contained in the cylinder 14, and in the expulsion process part of the plunger 3 is caused to project from the opening of the cylinder 14 into the pressure action chamber 5.

The pressure action chamber 5 is provided between the opening 15 provided in the wall of the valve chamber 1 of the valve box 2 and the cylinder opening of the plunger box 4. In the pressure action chamber 5 is provided a resilient membrane 16 made of sheet rubber, for example, to form a pressure force member that divides the pressure action chamber 5 into a valve box 2 side and a plunger box 4 side. The partitioning resilient membrane 16 is pressed into and around a concave portion 31 formed in the end face of the opening of the box forming the pressure action chamber 5 and is fixed by means of an end plate 32. On the side of the cylinder 14, the enclosed action chamber A formed by the partitioning resilient membrane 16 is filled with an action medium 17 such as oil, for example.
The operation of the pump of the above construction will now be described. When in the course of the suction process the plunger 3 is moved to the left, with reference to the drawing, as shown by Figure 10 the resilient membrane 16 contracts by the amount of change in volume caused by the suction action of the plunger 3. This produces a negative pressure in chamber 1, forcing open the valve-piece 9 against the resistance of the valve spring 10, and the fluid substance flows into the valve chamber 1 via the fluid passages 20.

During the expulsion process, when the plunger 3 is moved to the right, with reference to the drawing, the resilient membrane 16 expands via the action medium 17 by the amount of change in volume produced by the expulsion stroke of the plunger 3. As a result, the fluid introduced into the valve chamber 1 pushes open the valve-piece 9' on the outlet side against the resistance of the valve spring 10, sending through a fixed amount of fluid under pressure.

Figure 11 illustrates another embodiment of the invention. Here, a bellows member 92 is used as the pressure force member. Similarly to the preceding embodiments, the inside of the bellows member 92 is filled with an action medium 17 such as oil. Numeral 93 denotes a return spring for the bellows member 92.

In this embodiment too, in the suction process of the plunger 3 the bellows member 92 is contracted by the spring 93, drawing the fluid substance into the valve
chamber 1. In the expulsion process of the plunger 3, the bellows member 92 is expanded via the action medium 17, and an amount of fluid equivalent to the amount of change in the volume thereof is fed under pressure.

As has been described in the foregoing, as in the valve and pump apparatus according to the present invention the valve seat and/or the valve-piece are resilient, the opening and closing action is not obstructed even if solid bodies are caught between the valve seat and the valve-piece. Also, a multiplicity of fluid passages are formed in the valve seat, and the small sectional area of each of these passages enables large solid bodies to be excluded. In addition to this, it is difficult for the valve seat and valve-piece to be damaged by solid bodies or the like, which increases durability. Use of a wooden valve seat or valve-piece is cheaper and more economical than making them of metal.

With the valve and pump apparatus according to the present invention the fluid can be fed under pressure by changes in the volume of a pressure force member, so that the packing used to maintain the watertightness of the reciprocating member does not come into contact with the fluid. In the case of pressurized pumping of, for example, cement-mill materials and the like, this helps to increase the durability as there is no risk of the seal being damaged. Furthermore, the location of the pressure action chamber between the valve chamber and the cylinder is
highly economical, because it can be used with conventional plunger and other pumps without modification.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A pump apparatus comprised of: a valve box in which a valve chamber inlet and outlet are each provided with a valve; a reciprocating member which moves reciprocally in a cylinder that communicates with the valve chamber of the valve box to open the said valves;

wherein a pressure action chamber is provided between the valve box and the cylinder and a pressure force member divides the pressure action chamber into a valve chamber side and a cylinder side, and contained on the cylinder side of the pressure action chamber divided by the pressure force member is an action medium that transmits to the pressure force member changes in volume of the pressure action chamber produced by the action of the reciprocating member.

2. The pump apparatus according to claim 1 wherein the pressure force member is a resilient, flexible membrane.

3. The pump apparatus according to claim 1 wherein the pressure force member is a bellows-type member capable of expansion and contraction.

4. The pump apparatus according to claims 1 to 3 wherein the reciprocating member is a plunger of a plunger type pump.

5. The pump apparatus according to claims 1 to 3 wherein the reciprocating member is a piston of a piston type pump.
6. A valve device comprised of: a valve seat the seating portion of which is formed as a concavity corresponding to a spherical surface; a prescribed number of fluid passages formed therein opening into the said concavity; a valve-piece having a surface corresponding to the valve seat concavity; and a valve spring that resiliently maintains the valve-piece on the concave surface of the valve seat; wherein at least one of the valve seat and valve-piece is formed of a hard resilient material.

7. The valve device according to claim 6 wherein the flow passages are reticular in shape.

8. The valve device according to claim 6 wherein the flow passages are slit-shaped.

9. The valve device according to any one of claims 6 to 8 wherein the valve-piece is spherical in shape.

10. The valve device according to any one of claims 6 to 9 wherein the hard resilient material is a hard rubber.

11. The valve device according to any one of claims 6 to 9 wherein the hard resilient material is a synthetic resin.

12. A valve device comprised of: a valve seat the seating portion of which is formed as a concavity corresponding to a spherical surface; a prescribed number of fluid passages formed therein opening into the said
concavity; a valve-piece having a surface corresponding to the valve seat concavity; a valve spring that resiliently maintains the valve-piece on the concave surface of the valve seat; wherein at least one of the valve seat and valve-piece is covered with a hard resilient material.

13. The valve device according to claim 12 wherein the flow passages are reticular in shape.

14. The valve device according to claim 12 wherein the flow passages are slit-shaped.

15. The valve device according to claim 12 wherein the valve-piece is spherical in shape.

16. The valve device according to any one of claims 12 to 15 wherein the hard resilient material is a hard rubber.

17. The valve device according to any one of claims 12 to 15 wherein the hard resilient material is a synthetic resin.

18. A valve device comprised of: a valve seat the seating portion of which is formed as a concavity corresponding to a spherical surface; a prescribed number of fluid passages formed therein opening into the said concavity; a valve-piece having a surface corresponding to the valve seat concavity; and a valve spring that resiliently maintains the valve-piece on the concave surface of the valve seat; wherein one of the valve seat and valve-piece is formed of a hard resilient material and the other is covered with a hard resilient material.
19. The valve device according to claim 18 wherein the flow passages are reticular in shape.

20. The valve device according to claim 18 wherein the flow passages are slit-shaped.

21. The valve device according to any one of claims 18 to 20 wherein the valve-piece is spherical in shape.

22. The valve device according to any one of claims 18 to 21 wherein the hard resilient material is a hard rubber.

23. The valve device according to any one of claims 18 to 21 wherein the hard resilient material is a synthetic resin.

24. A valve device comprised of: a valve seat the seating portion of which is formed as a concavity corresponding to a spherical surface; a prescribed number of fluid passages formed therein opening into the said concavity; a valve-piece having a surface corresponding to the valve seat concavity; and a valve spring that resiliently maintains the valve-piece on the concave surface of the valve seat; wherein at least one of the valve seat and valve-piece is made of wood.

25. The valve device according to claim 24 wherein the flow passages are reticular in shape.

26. The valve device according to claim 24 wherein the flow passages are slit-shaped.
27. The valve device according to any one of claims 24 to 26 wherein the valve-piece is spherical in shape.

Dated this 22nd day of September 1988

KABUSHIKI KAISHA LITTLE ROCK,
YOSHINOBU KOIWA,
KELBIN CO., LTD.
SHUICHI FUJIMORI
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DRAWINGS