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(71) Applicant: **PUMPTECH N.V.**
Atlantic House
Noorderlaan 147
Bus 5C,
5th Floor
B-2030 Antwerpen(BE)

(72) Inventor: **Buisine, Paul**
Allée du Forez Beccaud
F-42480 La Fouillouse(FR)

(74) Representative: **Richebourg, Michel François**
Schlumberger Dowell
Dowell Patent and Licensing Dept.
26, rue de la Cavée
F-92142 Clamart Cedex (FR)

(54) Pump comprising a partially hollow piston.

(57) The pump according to the present invention consists of a piston (16) of which the end (17) is hollowed out and forms a chamber (19) having an opening (18) and an inlet valve (15).

The alternative displacement of the piston draws and pushs the fluid back through the chamber (19).

The system is totally "in line" and is suitable even for very abrasive fluids such as cement slurry.

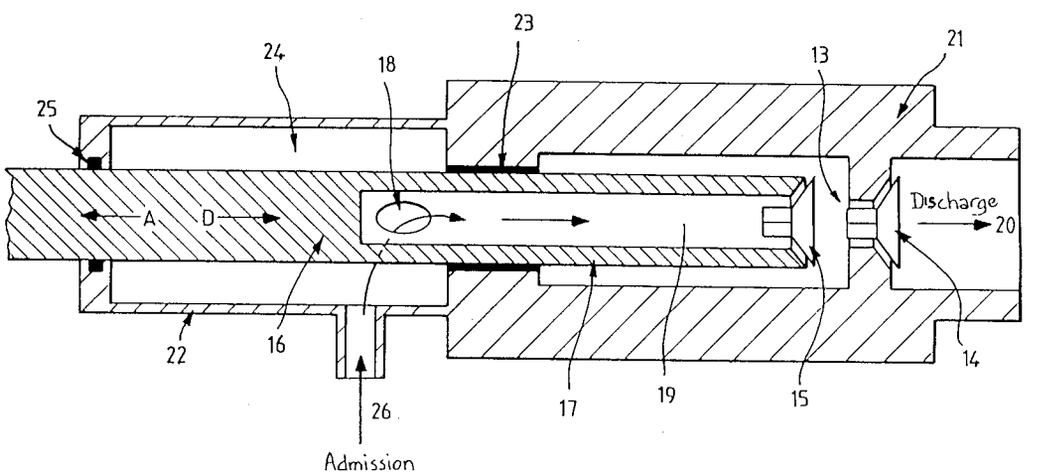

FIG. 2

EP 0 580 196 A1

The present invention relates to the technical domain of pumps and, especially, of high pressure or very high pressure pumps.

Such pumps are met, among other activities, in petroleum and related industries and in industrial cleaning industry and in civil engineering. These pumps are characterized in that their powers are very high, usually about 373 000 to 746 000 or 895 200 Joules/s (say, 500 to 1000 or 1200 CV) and in that they must convey very corrosive fluids (such as highly acid fluids) or very abrasive fluids (such as cement slurries for oil well cementing) or also special fluids such as fracturation gels in the petroleum industry, charged with propping agent (sand), and other particular fluids.

Moreover, petroleum industry requires very strict dimension and weight specifications, which obviously are contradictory to mechanical strength, power, and to wearing and abrasion resistance which are also required for such pumps.

It has been known up to now numerous pumps which must be improved.

A pump of this type schematically consists of a "power end" and a "fluid end". The power end comprises all the elements which are necessary for the piston displacements, and the piston.

The fluid end is a very high pressure end which schematically consists of a body forming the piston chamber, with its inlet valve and outlet valve, and a fluid discharge element.

In conventional pumps, the chamber comprises one (or several) inlet valve and one (or several) outlet valve.

Generally, these valves are placed at the end of the chamber opposite to the free end of the piston.

The structure and the operation of such pumps have been very well known in the art.

It has been also known an agencement called "in line". The present invention is a determining improvement of such a type of "in line" fluid end.

The Fig. 1 shows prior art "in line" fluid ends.

The Fig. 2 shows a preferred embodiment of the invention.

The "in line" pump according to the prior art (Fig. 1) comprises a high pressure body (9), a high pressure chamber (2) and a solid piston (8). The body and the piston have a filler joint (7) which must be submitted to the high pressure of the chamber (2).

In order to simplify, the power end of the pump is not shown.

The fluid end comprises an inlet valve (1) in form of a ring assembled on the return spring (5), at the chamber end which is nearest the piston, and an outlet valve (3) also assembled on a return spring (4). The outlet valve is placed at the other end of the chamber (2) and can tightly close this end.

When the piston displaces in the direction (A) of the inlet, the fluid is drawed by suction in a known manner by the inlet pipes (6). These pipes comprise a tore for symmetrically distributing the fluid. The valve (1) is pushed back and does not oppose the fluid inlet. When the piston arrives on the thrust, the chamber (2) is then filled with the fluid, which is retained by the valve (3) pushed on its seat (10) by the spring (4).

When the piston pushes back in the direction (D), the valve (1) becomes closed, the fluid is compressed into the chamber (2), the valve (3) becomes opered end the fluid is ejected through the discharge pipe (11).

This type of "in line" fluid end has two disadvantages.

On one hand, the joint (7) may not resist, or in badly manner, to the high pressure, which is a serious problem.

On the other hand, the fluid circulation at the inlet in the pipes (6) is as a high abrasion and a risk of mechanical rupture especially at the zone (12) occur.

Finally, the fluid is admitted in the direction (A) and is ejected in the opposite direction (D) which is prejudicial to the pump performances. According to the present invention, the piston is itself modified and co-operates with a "in line" fluid end (Fig. 2).

The equipment according to the invention comprises a high pressure fluid end body (21), a low pressure body (22) delimiting with the piston (16) a low pressure chamber (24), a fluid inlet pipe (26) and a discharge pipe (20).

The high pressure body (21) delimites with the piston (16) a high pressure chamber (13).

The piston (16) is partially hollow at its extension (17) placed in front of the discharge pipe (20) (free end of the piston).

The said extension (17) determines in the body of the piston a high pressure chamber (19) which, to the rear, opens with an opening (or several) in the low pressure chamber (24), and, to the head (i.e. to the discharge pipe) comprises an inlet valve (15).

Finally, the inlet valve (26) opens in the low pressure chamber (24) and the discharge pipe (20) has an outlet valve (14).

A high pressure joint (23) makes the area between the high pressure chamber (13) and the low pressure chamber (24) around the piston tight.

A low pressure joint (25) makes the low pressure chamber (24) tight.

The return springs of the valves (15) and (14) are not shown in order to simplify ; furthermore, their agencement is conventional and obvious when reading the below operating mode.

When the piston displaces in the inlet direction (A), a known phenomenon implies a depression in the high pressure chamber (13). The valve (15) becomes opened, the valve (14) becomes closed, and the fluid circulates from the low pressure chamber (24) to the chamber (19) through the opening or port (18) and, finally, to the chamber (13).

When operating, all of the chambers are obviously permanently filled with fluid.

When the piston pushes back in the direction (D), the valve (15) becomes closed, the fluid is compressed in the chamber (13) by the piston formed by the extension (17) filled with the fluid and closed by the valve (15), the valve (14) becomes opened and the fluid is ejected through the discharge pipe (20).

The present invention provides several advantages, all are very important and even decisive.

It must be appreciated that the dead volume may be lowered up to a very low volume, substantially equal to zero. This obviously has a positive effect on the volumetric efficiency of the high pressure pump.

In the case - which often occurs with the present techniques as it has been above described - the high pressure joint (23) would not correctly make the tightness, this would have only weak consequences because the fluid loss would be easily recuperated in the chamber (24) without any pollution (this factor becomes decisive substantially on all the oil field). As far as the low pressure joint is concerned, the present techniques easily assume a leak absence and then remove any pollution risk, and moreover, the maintenance of such an atmospheric/low pressure joint is easy.

The pipe (26)/chamber (24)/chamber (19)-/chamber (13)/discharge (20) fluid circulation is substantially ideal from the point of view of the fluid hydrodynamic. Especially, the fluid has not to radically change its flow direction. This will obviously decrease the cavitation which especially occurs with viscosified fluids, and with high flow rates, as well as the abrasion process.

The inertial forces produced by the piston will co-operate with the aperture and the closure of the inlet valve exactly at the time which is the more efficiency. This advantage tends to maintain the volumetric efficiency at a high value and also prevents the cavitation.

Finally, the high pressure element symmetry with regard to the axle implies to lower the stress concentration process and then allows a substantial matter decrease and then a weight decrease which is another important parameter in the considered industries.

Obviously, one or several pipes (26) may exist, including pipes with an annulus injection or a multi-point injection, as well as one or several openings (18) having an appropriate form.

The number of pistons is unimportant though tri - piston pumps have been specially used up to now.

The applications relate to especially all the high pressure pumps in all industries.

Claims

1. Pumps of the type comprising a fluid - end called "in line", characterized in that the free end (17) of each piston (16) is hollow and forms a chamber (19) which communicates first with a fluid inlet pipe (26) through one or several openings (18) disposed in the wall (17) of the chamber (19), and secondly with the high pressure chamber (13) of each considered piston, with the help of an inlet valve (15) agenced in order to become opened when the piston goes back into the chamber (13) and thus gets into communication the inlet pipe (26), the chamber (19) with the chamber (13), and becomes closed when the piston goes into the chamber (13), thus obturating the chamber (19) and producing the fluid ejection through a discharge pipe (20) controlled by an outlet valve (14).

2. Pump according to the claim 1, characterized in that the fluid enters into the chamber (19) through one or the openings (18), through a low pressure chamber (24) into which the fluid inlet pipe (26) and one or the openings (18) go.

3. Applications of pumps according the claim 1 or 2, to the high pressure pumps of the petroleum and related industries, of the industrial cleaning industry and of civil engineering.

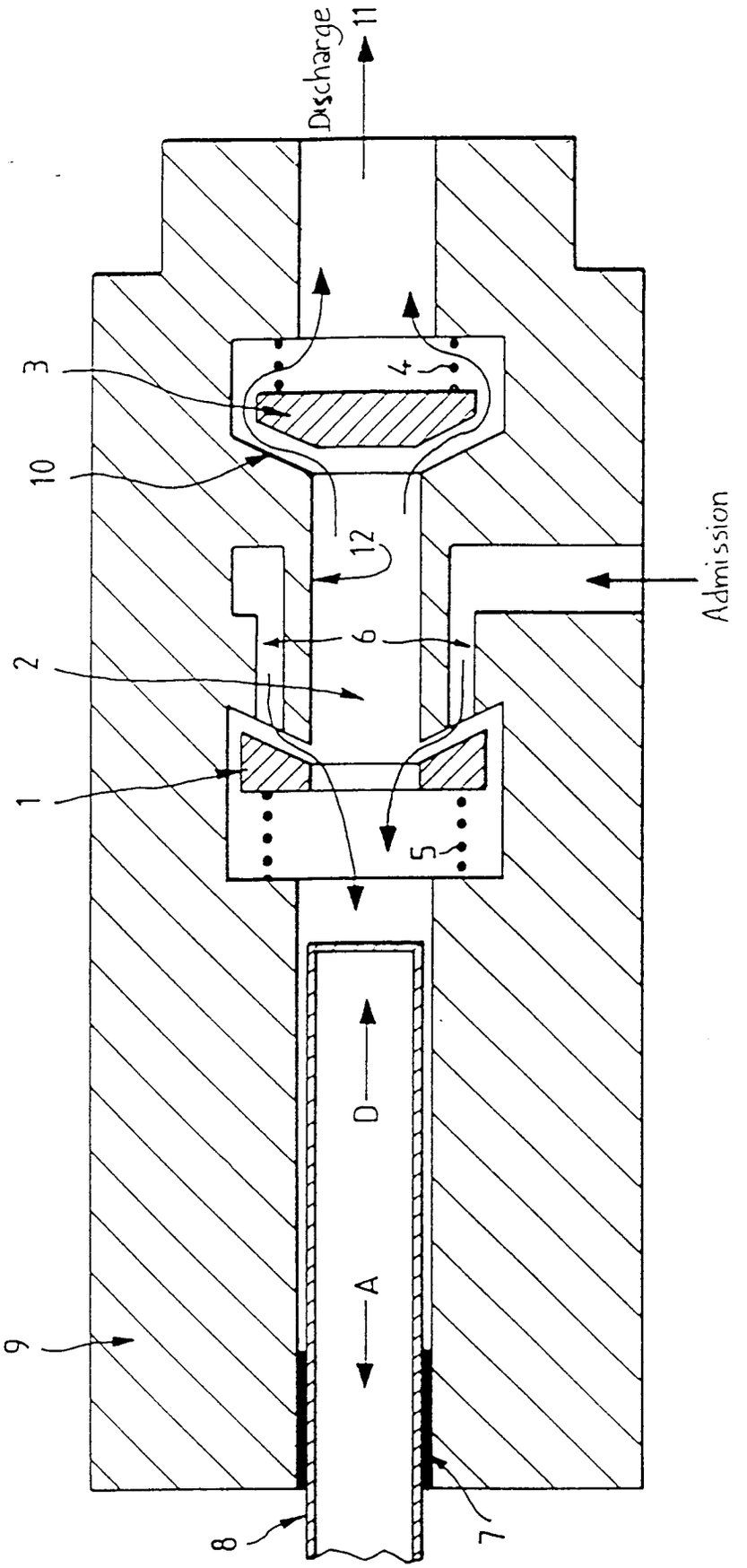

FIG.1

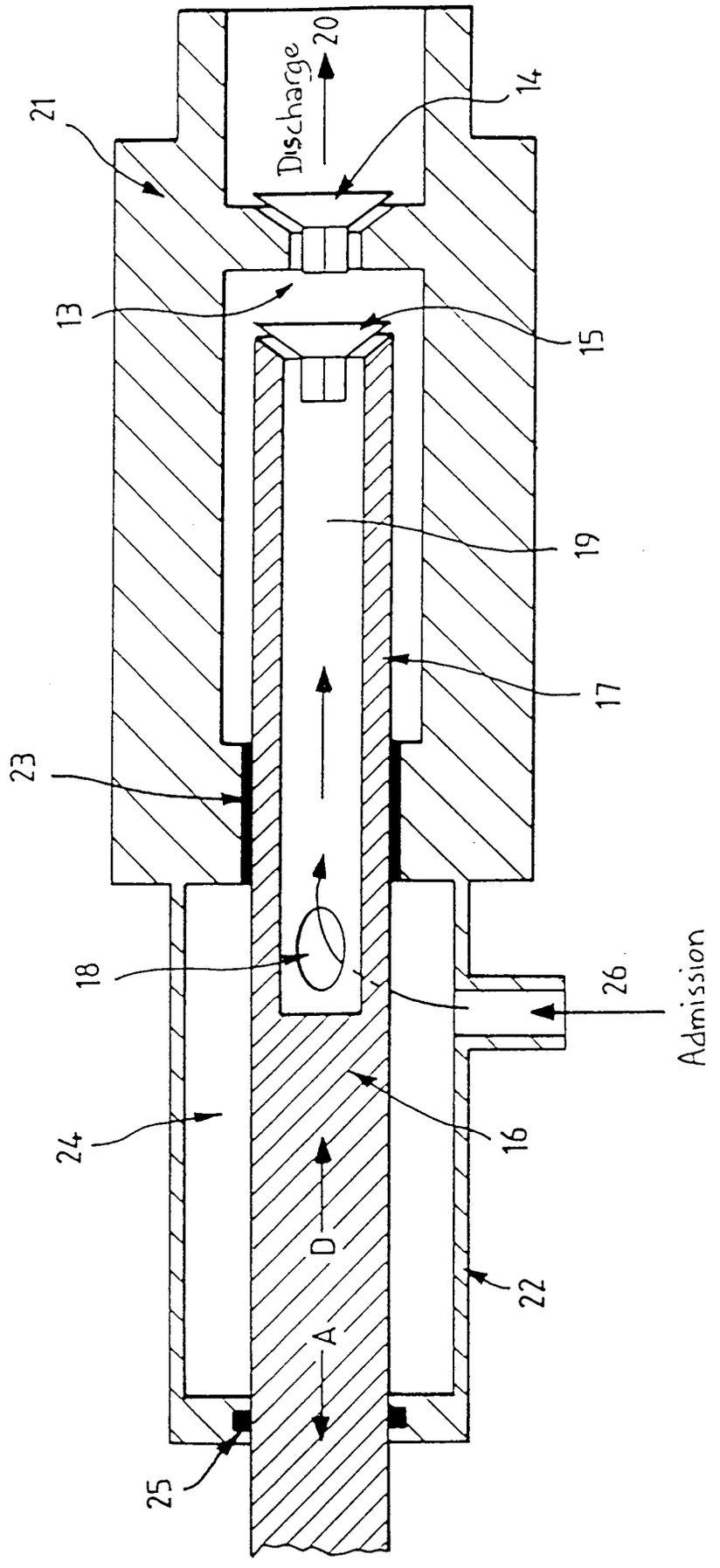

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 20 1766

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	CH-A-257 522 (MESSIER S. A.) * the whole document *	1-3	F04B21/04
X	GB-A-672 173 (S.I.A.M.) * the whole document *	1-3	
X	FR-A-599 965 (A.B.C.I.) * the whole document *	1-3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 SEPTEMBER 1993	VON ARX H.P.

CATEGORY OF CITED DOCUMENTS

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