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(54) **DOUBLE ACTING PISTON PUMP**

DOPPELWIRKENDE KOLBENPUMPE

POMPE À PISTON À DOUBLE ACTION

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to a piston pump which is capable of pumping a fluid at a substantially precise rate and which can handle particulate contaminants in the fluid without unduly affecting the accuracy of the pumping rate.

[0002] A piston-type pump typically includes a cylinder with an internal bore in which a piston rod is reciprocally movable. A seal is provided between opposing surfaces of the cylinder and the piston rod. US2789510, represents the closest prior art with respect to claim 1. The documents WO02/16766 and US4544335 also illustrate a variety of these piston-type pumps.

[0003] A non-return valve incorporated in the piston ensures that fluid is pumped out of the bore. A non-return inlet valve allows fluid into the bore of the cylinder on the corresponding stroke of the piston. Typically these valves are spring-loaded to ensure that they seat properly. Care has to be taken, however, if the fluid which is being pumped is contaminated with solids to ensure, firstly, that the solids are displaced from the valve seats and, secondly, that the volume of fluid displaced by each stroke of the piston remains substantially unaltered.

[0004] Solid material on either valve seat prevents effective sealing and can result in fluid backflow which, in turn, affects the fluid volume which is pumped during any given stroke. If the maximum extent of valve movement is small and the possible contamination particles are large then the likelihood that the particles will become stuck on the valve seats is high.

[0005] It is an object of the invention to provide a piston pump with an activated valve system which allows for flushing of solid particles from the valve seats.

SUMMARY OF INVENTION

[0006] The invention provides a piston pump according to claim 1 which includes a cylinder, a bore in the cylinder, a mouth at a first end of the bore, an entry port at a second, opposing, end of the bore, the cylinder being shaped to define a zone of reducing cross-sectional area towards the entry port, a valve member inside the bore which is sealingly engageable with a seat adjacent the entry port, a component for biasing the valve member towards the seat, a piston rod which extends into the bore through the mouth, a first seal near the mouth between opposing surfaces of the cylinder and the piston rod, a second seal which is movably located inside the bore and which includes an aperture through which the piston rod extends, a formation on the piston rod which is engageable with the second seal, the valve member including a recess into which a leading end of the piston rod, of substantially complementary shape to the recess, is insertable with a close fit, and an exit port from the bore, and wherein, when the piston rod is moved in a first di-

rection relatively to the cylinder, the leading end is inserted into the recess and forces the valve member into sealing engagement with the seat and fluid is displaced from the bore, past the formation on the piston rod, through a fluid path formed between the second seal and the piston rod, and through the exit port, and when the piston rod is moved in a second direction which is opposite to the first direction, the leading end is withdrawn from the recess thereby reducing pressure in the cavity so that the valve member tends to move with the piston rod, against the biasing action of the component, and is displaced from the seat, fluid then entering the bore through the entry port and, upon engagement of the formation with the second seal, fluid is displaced from the bore through the exit port.

[0007] The zone of reducing cross-sectional area, at the second end of the bore, may be of any appropriate shape but preferably is substantially conical with the entry port being located at an apex of the cone.

[0008] The valve member may have a conical end which is substantially complementary in shape to the shape of the zone of reducing cross-sectional area.

[0009] The recess in the valve member may be of any appropriate shape and size and preferably is substantially circular cylindrical.

[0010] The valve member may include an extension piece and the biasing component may act between the cylinder and an extremity of the extension piece.

[0011] The extension piece may extend through the entry port.

[0012] The formation on the piston rod may comprise an annular shoulder.

[0013] The second seal may include an annular formation which is in sealing and sliding contact with a wall of the bore. One or more fluid paths may be defined between opposing surfaces of the annular formation and the piston rod.

[0014] The second seal may include one or more guide formations for positioning the second seal correctly relatively to the piston rod.

[0015] The piston rod may include one or more sections of reduced cross sectional area which, together with an opposing surface or surfaces of the second seal, define fluid flow paths.

[0016] Thus, when the piston rod is moved in the first direction, sealing action between the valve member and its seat is enhanced, due to mechanical action, by engagement of the leading end of the piston rod with the recess while, when the piston rod is moved in the second direction, the valve member is caused to unseat due to a suction-type action as the leading end is withdrawn from the recess.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The invention is further described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic view in cross section of a double-acting piston pump according to the invention, in a first mode;

Figure 2 is a cross sectional view of the piston pump taken on a line 2 - 2 in Figure 1; and

Figure 3 is a view similar to Figure 1 of the piston pump in a second mode.

DESCRIPTION OF PREFERRED EMBODIMENT

[0018] The accompanying drawings illustrate a piston pump 10 according to the invention which includes a body or cylinder 12 in which is formed a bore 14. The body has a mouth 16 at one end and a piston rod 18 extends through the mouth into the bore. A first seal 20 is engaged with the piston rod and provides a fluid-tight seal between an outer surface of the piston rod and an opposing surface of the cylinder.

[0019] The piston rod, at a leading end 22, has a cylindrical projection 24 which extends from a formation 26 in the form of a shoulder which, in turn, is located adjacent a region 28 of the piston rod which has reduced cross sectional dimensions. A second seal 30 is movably located inside the bore adjacent the region 28.

[0020] The second seal 30, as is shown in Figure 2, includes an annular formation 32 which is sliding and sealing contact with a wall of the bore 14 and has a number of inwardly projecting guide ribs 34 which extend towards, and which are generally in contact with, opposing outer surface portions of the piston rod 18. The arrangement is such that a number of fluid paths 36 are formed around the piston rod between opposing surfaces of the piston rod and the annular formation.

[0021] An exit port 40 is provided from the bore adjacent the first seal 20.

[0022] The cylinder 12 at an end which is remote from the mouth 16 has a zone 42 of reducing cross section. In this instance the zone is substantially conical and terminates in an entry port 44 which is centrally positioned i.e. at an apex of the cone.

[0023] A valve member 48 is positioned adjacent the zone 42. The valve member has a first section 50 which has an outer diameter slightly less than the diameter of the bore and in which is formed a recess 52 which is generally circular-cylindrical in shape and which is substantially complementary in shape and size to the cylindrical projection 24. The valve member further includes a second section 60 which has a conical outer surface, complementary in shape to the conical zone 42. A seal 62 is positioned in the conical second section and can engage with sealing contact with a seat formed by a portion of the surface of the conical zone 42. An extension piece 64 projects from the second section through the entry port 44 and terminates in a head 66. A shaped compression spring 68 acts between the head and suitable formations, not shown, on an outer surface of the conical portion of the cylinder.

[0024] A fluid conduit 70 extends from a fluid source,

not shown, and is sealingly engaged with an outer surface of the cylinder around the entry port.

[0025] Figure 1 shows the piston rod 18 moving to the right while Figure 2 shows the piston rod 18 moving to the left relatively to the cylinder.

[0026] In the former case the valve member 48 is normally biased to the right via the action of the spring 68. This action results in a degree of sealing action between the valve member and the conical zone 42. As the cylindrical projection 24 of the piston rod enters the recess 52 it does so with a relatively tight fit. Consequently, initially due to fluid pressure and thereafter due to mechanical action the valve member 48 is strongly urged to the right and the seal 62 is intimately engaged with its seat. The fluid pressure inside the bore in a region between the shoulder formation 26 and the valve member increases for the available volume inside the bore decreases as the projection enters the recess. The fluid is thus pressurised and is expelled from the region referred to past the shoulder formation 26 which has a loose clearance with an inner wall of the cylinder. This fluid flows through the paths 36 and then exits via the exit port 40.

[0027] On the return stroke the piston moves in the direction shown in Figure 3. As the cylindrical projection 24 moves out of the recess 52 a region of reduced pressure is created inside the resulting cavity and the valve member 48 tends to move to the left. The seal 62 is displaced from its seat and fluid can then flow from the conduit 70 through the entry port 44 and around the cylindrical section 50 into the bore. The shoulder formation 26 is eventually advanced into contact with the second seal 30 and this seal is then moved to the left within the bore. As noted the seal is in sealing contact with an inner wall of the cylinder. Consequently fluid inside the bore to the left of the seal 30 is pressurised and is displaced through the exit port 40. Fluid which flows through the entry port 44 into the bore replenishes the pumped fluid. Eventually the projection 24 is completely withdrawn from the recess 52 and when the piston rod reaches the limit of its stroke towards the port 40 the valve member is displaced to the right under the action of the spring 68 into sealing contact with the seat on the conical zone. The cycle can then recommence.

[0028] With each piston stroke, i.e. into the bore and out of the bore, a defined fluid volume is pumped. The valve member is made from an elastomeric material and due to the mechanical force exerted by the piston on the valve member if particles are trapped between the seal 62 and the seat on the conical zone the seal can be deformed to a significant extent to accommodate the effect of the trapped particle.

[0029] When the valve member is moved to an unseated position by the suction effect of the piston rod, the spring 68 is compressed and the clearance between the conical section of the valve member and the valve seat is increased significantly to a dimension which is larger than the size of any particle which could enter via the entry port. The maximum particle size in turn is regulated

by passing the fluid through a suitable filter or strainer, not shown, upstream of the entry port. Thus any particle which is present is dragged through the valve instead of being stuck therein.

[0030] The piston pump employs activated valves. As the piston rod moves into the cylinder the sealing action which initially is dependent on the force of the spring 68 is enhanced by fluid and mechanical pressure generated by the advancing piston rod. On the return stroke the piston rod, as it withdrawn from the recess, creates a region of reduced pressure i.e. a partial vacuum, and the resulting suction force causes the valve member to be displaced by a meaningful distance away from its valve seat.

Claims

1. A piston pump (10) which includes a cylinder (12), a bore (14) in the cylinder, a mouth (16) at a first end of the bore (14), an entry port (44) at a second, opposing end of the bore (14), a valve member (48) inside the bore having a seal (62) which is engageable with a seat adjacent the entry port (44), a component (68) for biasing the valve member (48) towards the seat, a piston rod (18) which extends into the bore (14) through the mouth (16), a first seal (20) near the mouth (16) between opposing surfaces of the cylinder (12) and the piston rod (18), a second seal (30) which is movably located inside the bore (14) and which includes an aperture through which the piston rod (18) extends, a formation (26) on the piston rod (18) which is engageable with the second seal (30), the valve member (48) including a recess (52) into which a leading end of the piston rod (18), of complementary shape to the recess (52), is insertable with a close fit, and an exit port (40) from the bore (14), **characterized in that** the cylinder (12) is shaped to define a zone of reducing cross-sectional area (28) towards the entry port (44), and further **characterised**, when the piston rod (18) is moved in a first direction relatively to the cylinder (12), a leading end (22) is inserted into the recess (52) and forces the valve member (48) into sealing engagement with the seat and fluid is displaced from the bore (14) past the formation (26) on the piston rod (18) through a fluid path (36) formed between the second seal (30) and the piston rod (18) and through the exit port (40), and when the piston rod (18) is moved in a second direction which is opposite to the first direction, the leading end at the piston rod (18) is withdrawn from the recess (52) thereby reducing pressure in a resulting cavity so that the valve member (48) tends to move with the piston rod (18) against the biasing action of the component (68), and is displaced from the seat, fluid then enters the bore (14) through the entry port (44), and upon engagement of the formation (26) with the second seal

(30), fluid is displaced from the bore (14) through the exit port (40).

2. A piston pump according to claim 1 **characterised in that** the zone of reducing cross-sectional area (28), at the second end of the bore (14), is conical (42) with the entry port (44) being located at an apex of the cone.
3. A piston pump according to claim 1 or 2 **characterised in that** the valve member (48) has an end which is complementary in shape to the shape of the zone of reducing cross-sectional area (28).
4. A piston pump according to any one of claims 1 to 3 **characterised in that** the recess (52) in the valve member (48) is cylindrical.
5. A piston pump according to any one of claims 1 to 4 **characterised in that** the valve member (48) includes an extension piece (64) and the biasing component acts between the cylinder (12) and an extremity (66) of the extension piece (64).
6. A piston pump according to claim 5 **characterised in that** the extension piece (64) extends through the entry port (44).
7. A piston pump according to any one of claims 1 to 6 **characterised in that** the formation (26) on the piston rod (18) comprises an annular shoulder.
8. A piston pump according to any one of claims 1 to 7 **characterised in that** the second seal (30) includes an annular formation (32) which is in sealing and sliding contact with a wall of the bore (14) and at least one of the fluid path (36) is formed between opposing surfaces of the annular formation (32) and the piston rod (18).
9. A piston pump according to any one of claims 1 to 8 **characterised in that** the second seal (30) includes at least one guide formation (34) for positioning the second seal (30) correctly relatively to the piston rod (18).
10. A piston pump according to any one of claims 1 to 9 **characterised in that** the piston rod (48) includes at least one section of reduced cross sectional area (28) which, together with an opposing surface of the second seal (30), defines at least one of the fluid flow path (36).

Patentansprüche

1. Kolbenpumpe (10), die einen Zylinder (12), eine Bohrung (14) in dem Zylinder, eine Öffnung (16) an

einem ersten Ende der Bohrung (14), einen Einlassanschluss (44) an einem zweiten gegenüberliegenden Ende der Bohrung (14), ein Ventilelement (48) in der Bohrung, das eine Dichtung (62) aufweist, die mit einem Sitz benachbart zu dem Einlassanschluss (44) in Eingriff gelangen kann, eine Komponente (68), um das Ventilelement (48) in Richtung des Sitzes vorzuspannen, eine Kolbenstange (18), die sich durch die Öffnung (16) in die Bohrung (14) erstreckt, eine erste Dichtung (20) in der Nähe der Öffnung (16) zwischen gegenüberliegenden Oberflächen des Zylinders (12) und der Kolbenstange (18), eine zweite Dichtung (30), die in der Bohrung (14) beweglich angeordnet ist und die eine Öffnung aufweist, durch die die Kolbenstange (18) verläuft, eine Ausformung (26) an der Kolbenstange (18), die mit der zweiten Dichtung (30) in Eingriff gelangen kann, wobei das Ventilelement (48) eine Aussparung (52) aufweist, in die ein vorderes Ende der Kolbenstange (18) mit einer zu der Aussparung (52) komplementären Form mit enger Passung einsetzbar ist, und einen Auslassanschluss (40) aus der Bohrung (14) enthält, **dadurch gekennzeichnet, dass** der Zylinder (12) geformt ist, um eine Zone mit in Richtung zum Einlassanschluss (44) abnehmender Querschnittsfläche (28) zu definieren, und ferner **dadurch gekennzeichnet, dass** dann, wenn die Kolbenstange (18) in einer ersten Richtung relativ zu dem Zylinder (12) bewegt wird, ein vorderes Ende (22) in die Aussparung (52) eingesetzt wird und das Ventilelement (48) in dichtendem Eingriff mit dem Sitz drängt und Fluid aus der Bohrung (14) an der Ausformung (26) an der Kolbenstange (18) vorbei durch einen zwischen der zweiten Dichtung (30) und der Kolbenstange (18) gebildeten Fluidweg (36) und durch den Auslassanschluss (40) verdrängt wird, und dass dann, wenn die Kolbenstange (18) in einer zweiten Richtung entgegengesetzt zu der ersten Richtung bewegt wird, das vordere Ende an der Kolbenstange (18) aus der Aussparung (52) herausgezogen wird, wodurch der Druck in einem sich ergebenden Hohlraum verringert wird, so dass das Ventilelement (48) bestrebt ist, sich zusammen mit der Kolbenstange (18) entgegen der Vorspannungswirkung der Komponente (68) zu bewegen und vom Sitz wegbewegt wird, wobei dann durch den Einlassanschluss (44) Fluid in die Bohrung (14) eintritt und bei einem Eingriff der Ausformung (26) mit der zweiten Dichtung (30) Fluid von der Bohrung (14) durch den Auslassanschluss (40) verdrängt wird.

2. Kolbenpumpe nach Anspruch 1, **dadurch gekennzeichnet, dass** die Zone mit verringerter Querschnittsfläche (28) am zweiten Ende der Bohrung (14) konisch (42) ist, wobei sich der Einlassanschluss (44) an einem Scheitel des Konus befindet.
3. Kolbenpumpe nach Anspruch 1 oder 2, **dadurch ge-**

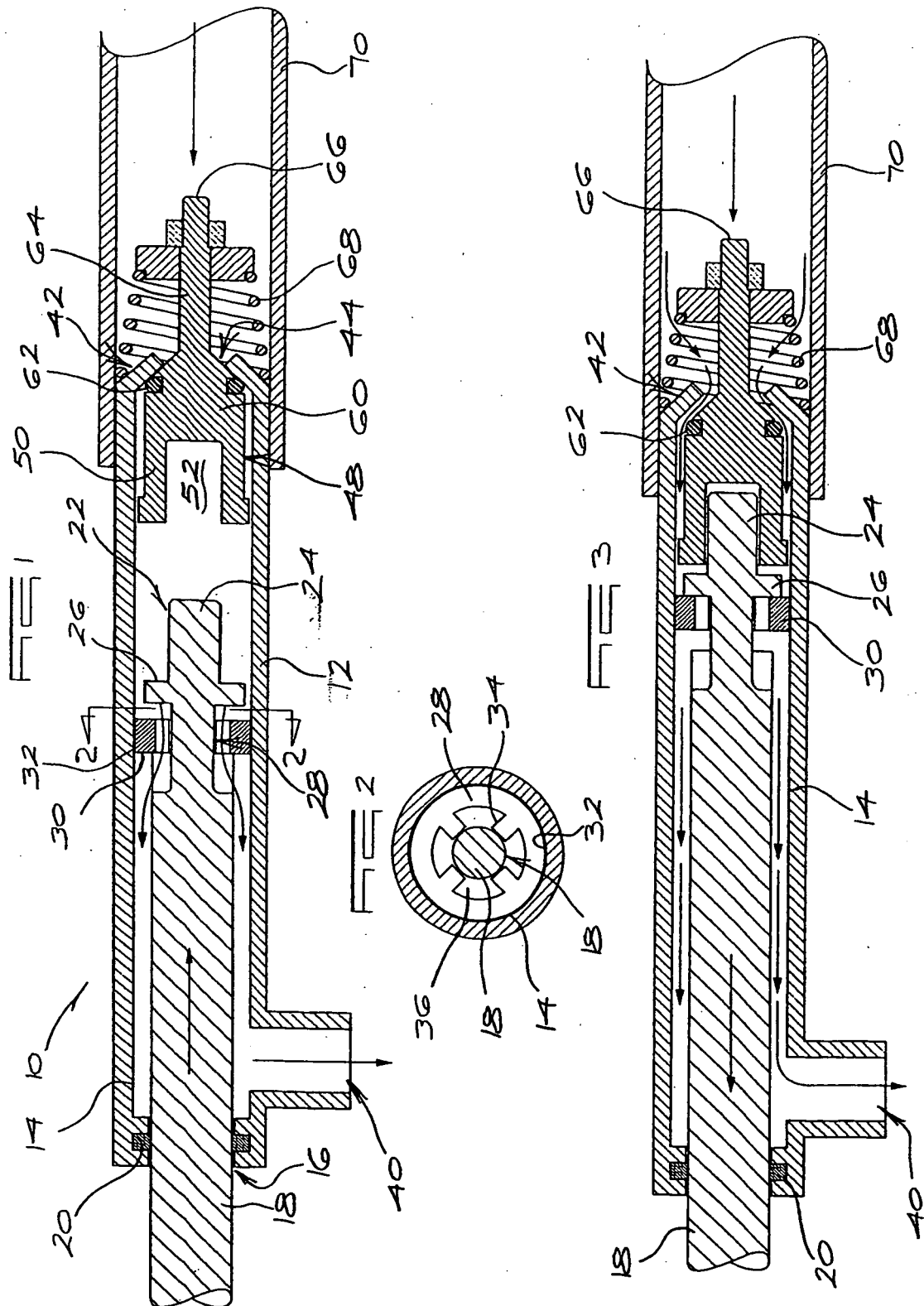
kennzeichnet, dass das Ventilelement (48) ein Ende aufweist, das eine zu der Form der Zone mit abnehmender Querschnittsfläche (28) komplementäre Form besitzt.

4. Kolbenpumpe nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Aussparung (52) im Ventilelement (48) zylindrisch ist.
5. Kolbenpumpe nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** das Ventilelement (48) ein Verlängerungsteil (64) aufweist und die Vorspannungskomponente zwischen dem Zylinder (12) und einem Ende (66) des Verlängerungsteils (64) wirkt.
6. Kolbenpumpe nach Anspruch 5, **dadurch gekennzeichnet, dass** das Verlängerungsteil (64) durch den Einlassanschluss (44) verläuft.
7. Kolbenpumpe nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Ausformung (26) an der Kolbenstange (18) eine ringförmige Schulter enthält.
8. Kolbenpumpe nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** die zweite Dichtung (30) eine ringförmige Ausformung (32) umfasst, die in dichtendem und gleitendem Kontakt mit einer Wand der Bohrung (14) steht und wenigstens einer der Fluidwege (36) zwischen gegenüberliegenden Oberflächen der ringförmigen Ausformung (32) und der Kolbenstange (18) gebildet ist.
9. Kolbenpumpe nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** die zweite Dichtung (30) wenigstens eine Führungsausformung (34) aufweist, um die zweite Dichtung (30) in Bezug auf die Kolbenstange (18) korrekt zu positionieren.
10. Kolbenpumpe nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** die Kolbenstange (18) wenigstens einen Abschnitt mit verringerter Querschnittsfläche (28) umfasst, die zusammen mit einer gegenüberliegenden Oberfläche der zweiten Dichtung (30) wenigstens einen der Fluidströmungswege (36) definiert.

Revendications

1. Pompe (10) à piston, comprenant un cylindre (12), un alésage (14) dans le cylindre, une embouchure (16) à une première extrémité de l'alésage (14), une lumière d'admission (44) à une seconde extrémité, opposée, de l'alésage (14), un élément formant tiroir (48) à l'intérieur de l'alésage ayant un joint d'étanchéité (62) qui peut venir contre un siège adjacent

- à la lumière d'admission (44), une pièce (68) pour pousser l'élément formant tiroir vers le siège, une tige (18) de piston qui s'étend jusque dans l'alésage (14) à travers l'embouchure (16), un premier joint d'étanchéité (20) près de l'embouchure (16) entre des surfaces opposées du cylindre (12) et de la tige (18) de piston, un second joint d'étanchéité (30) disposé d'une manière mobile à l'intérieur de l'alésage (14) et comportant une ouverture à travers laquelle s'étend la tige (18) de piston, une formation (26) sur la tige (18) de piston qui peut venir au contact du second joint d'étanchéité (30), l'élément formant tiroir (48) comportant un évidement (52) dans lequel une extrémité avant de la tige (18) de piston, d'une forme complémentaire de celle de l'évidement (52), peut venir se loger avec un ajustement étroit, et une lumière d'échappement (40) de l'alésage (14), **caractérisée en ce que** la forme du cylindre (12) sert à définir une zone à diminution de section transversale (28) vers la lumière d'admission (44), et **caractérisée en outre en ce que**, quand la tige (18) de piston est actionnée dans un premier sens par rapport au cylindre (12), une extrémité avant (22) s'introduit dans l'évidement (52) et pousse l'élément formant tiroir (48) d'une manière étanche contre le siège et un fluide est déplacé depuis l'alésage (14) et au-delà de la formation (26) sur la tige (18) de piston via un trajet (36) de fluide formé entre le second joint d'étanchéité (30) et la tige (18) de piston et par la lumière d'échappement (40) et, quand la tige (18) de piston est actionnée dans un second sens opposé au premier sens, l'extrémité avant de la tige (18) de piston sort de l'évidement (52) en réduisant de ce fait la pression dans une cavité ainsi créée de telle sorte que l'élément formant tiroir (48) a tendance à accompagner la tige (18) de piston sous l'action de poussée exercée par la pièce (68) et est écarté du siège, du fluide entre alors dans l'alésage (14) par la lumière d'admission (44) et, à l'instant où la formation (26) vient contre le second joint d'étanchéité (30), le fluide est refoulé depuis l'alésage (14) via la lumière d'échappement (40).
2. Pompe à piston selon la revendication 1, **caractérisée en ce que** la zone à diminution de section transversale (28), à la seconde extrémité de l'alésage (14), est conique (42), la lumière d'admission (44) étant située à un sommet du cône.
 3. Pompe à piston selon la revendication 1 ou 2, **caractérisée en ce que** l'élément formant tiroir (48) a une extrémité d'une forme complémentaire de la forme de la zone à diminution de section transversale (28).
 4. Pompe à piston selon l'une quelconque des revendications 1 à 3, **caractérisée en ce que** l'évidement (52) dans l'élément formant tiroir (48) est cylindrique.
 5. Pompe à piston selon l'une quelconque des revendications 1 à 4, **caractérisée en ce que** l'élément formant tiroir (48) comporte une rallonge (64) et la pièce de poussée agit entre le cylindre (12) et une extrémité (66) de la rallonge (64).
 6. Pompe à piston selon la revendication 5, **caractérisée en ce que** la rallonge (64) s'étend à travers la lumière d'admission (44).
 7. Pompe à piston selon l'une quelconque des revendications 1 à 6, **caractérisée en ce que** la formation (26) sur la tige (18) de piston comporte un épaulement annulaire.
 8. Pompe à piston selon l'une quelconque des revendications 1 à 7, **caractérisée en ce que** le second joint d'étanchéité (30) comporte une formation annulaire (32) qui est au contact, d'une manière étanche et glissante, d'une paroi de l'alésage (14) et au moins un trajet (36) de fluide formé entre des surfaces opposées de la formation annulaire (32) et de la tige (18) de piston.
 9. Pompe à piston selon l'une quelconque des revendications 1 à 8, **caractérisée en ce que** le second joint d'étanchéité (30) comporte au moins une formation de guidage (34) pour placer correctement le second joint d'étanchéité (30) par rapport à la tige (18) de piston.
 10. Pompe à piston selon l'une quelconque des revendications 1 à 9, **caractérisée en ce que** la tige (48) de piston comporte au moins une portion à section transversale réduite (28) qui, conjointement avec une surface opposée du second joint d'étanchéité (30), définit au moins un trajet (36) d'écoulement de fluide.



REFERENCES CITED IN THE DESCRIPTION

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