

Description

The present invention relates to a pneumatic valve designed to control particularly a compressed-air-operated membrane pump and is set forth in detail in the preamble of patent claim 1.

US-A 3 465 686 discloses an air-operated hydraulic pump using a shuttle valve, the shuttle of which is effected in all positions by very strong permanent magnets mounted in the valve housing adjacent the ends of the shuttle. The idea with this valve is to influence the shuttle in any position, i.e. even any intermediate position, so that the shuttle operates fully from end to end. For achieving such a great attractive force and yet render the valve operative, the magnets are spaced from the ends of the shuttle. This is obligatory and extremely critical, as a gap as narrow as 0.5 mm creates only 1/10 of the retaining power of a gap equal to 0 mm, i.e. when physical contact has been established between the shuttle and one of the permanent magnets. If the control air is designed to move the shuttle from one end position to the other at a pressure of ten pounds per square inch, it will certainly not when physical contact has been established between the shuttle and a permanent magnet and a releasing force of one hundred pounds per square inch will be required. It goes without saying that this previously known valve requires very accurate tolerances and will seize to function whenever there is a slight play or, after some time of operation, a certain natural wear and tear.

Furthermore, this valve will create a high level of noise, as the strong magnets will make the shuttle bounce from one seat on to the other, in which connection O-rings allegedly intended to reduce noise necessarily must render the extremely important accurate size of said gap between shuttle and permanent magnets variable and thus creating a non-desired varying influence on the retaining power due to the material used for the O-rings and not to forget varying conditions of operation and wear and tear.

The object of the invention is to improve and develop valves already known in this field, in order to avoid in particular the aforementioned drawbacks as well as other drawbacks and achieve high reliability, which will be explained in more detail in the following description.

These objects are attained according to the invention by designing a valve of the kind set forth above mainly in the way set forth in the characterizing clause of patent claim 1.

Additional characterizing features and advantages of the present invention are set forth in the following description, reference being made to the accompanying drawings, in which:

Fig. 1 shows a conventional pneumatic valve, mainly in a diametrical longitudinal section, in one of two functional positions;

Fig. 2 shows a corresponding view of the same valve, its plunger being placed in an ineffective or locking intermediate position;

Fig. 3 is a view which corresponds to Fig. 1 and shows valve according to the present invention;

Fig. 4 is a view which corresponds to Fig. 1 and shows another embodiment of a valve according to the invention;

Fig. 5 is a perspective view of a preferred embodiment of a plunger, designed to form a part of the valves according to Fig. 3 and 4; and

Fig. 6 shows a partly schematic partial section of a membrane pump, provided with a valve according to the invention.

The present invention relates primarily to a main valve, i.e. a 3-way/5-gate-valve, which is pneumatically controlled and designed e.g. for compressed-air-operated membrane pumps.

Said valve mainly comprises a valve body 1, body ends 2, a plunger 5 and five connection gates 8, 9, 10, 11 and 12, which are disposed in said valve body, as well as a control air gate 13 and 14 respectively in each one of said two ends 2 respectively. Said ends are attached to the valve body by means of screws 3.

Fig. 1 shows a conventional valve with a presently used design, plunger 5 being disposed in a valve cap 4 having requisite O-ring seals 6 and 7 respectively. Plunger 5 is actuated through gate 13 or 14 by a compressed-air-impulse, which subsequently to the work done is exhausted. Fig. 1 shows plunger 5 in its left position. Thus, it has been actuated by compressed air, which has been fed through gate 13. When the plunger reaches its end position, its movement is damped, e.g. by means of a stop element, namely a shock absorber rubber 15. In this position the main air quantity is fed into the valve through input gate 8, out through output gate 9 and to the pump membrane in order to perform the pumping.

Exhaust gate 10, which is connected to e.g. a second air chamber of a compressed-air-operated membrane pump, communicates with the exterior air and the air is exhausted through a recess 21 in plunger 5 and a ventilating gate 11.

When the compressed air has performed its work, the control air is exhausted through gate 13, in case it has not been exhausted earlier, and gate 14 is pressurized, plunger 5 thereby moving in valve cap 4 to its righthand end position. Gate 10, which so far has been vented, is now pressurized by means of air entering through gate 8 and one of two recesses 21, 22 in plunger 5, the connection between gate 8 and gate 9 being simultaneously disrupted and gate 9 being connected to a ventilating gate 12, air chamber no. 1 thereby being exhausted.

In a compressed-air-operated membrane pump the pressurization and the exhaustion through gates 13 and 14 respectively are done by means of a control valve, which is actuated by the end positions of the

membranes. Additional embodiments are possible, in which said control valve is actuated e.g. by the position of the pump shaft and the pump shaft is in that case the shaft which connects the two membranes.

In a compressed-air-operated membrane pump its capacity and its lifting height are controlled by means of the amount of compressed air and its pressure, when it appears at gate 8. For practical reasons a branching from gate 8 is provided, which feeds compressed air to said control valve, i.e. the same pressure is used to operate the pump as to control main valve plunger 5.

Normally this system works faultlessly, but not in those instances when the pump is to be operated using a most reduced air pressure, in order to on some occasions utilize a flow, which approaches 0, from a pump having a substantial capacity, a sufficient air pressure being available in order to operate the pump, but an insufficient air pressure to control main valve plunger 5, and consequently the plunger may in some instances end up in an intermediate position, shown in Fig. 2. This situation occurs often, if the air flow to the pump is cut off and there is a relatively large air volume between the cut-off area and the main valve of the pump and the pump is operated until the air has been expended. This happens often in work shops operating in an intermittent way. Shortly before the air pressure ceases completely, an impulse intended to shift the position of the main valve plunger may issue and due to the air expense into the air chamber of the pump, while a smaller amount of air is expended to control the plunger, the amount of air available may turn out to be insufficient to push the plunger to the opposite end position and the plunger will stop in an intermediate position, which is shown in Fig. 2. It is true that at this very moment no shut-down has occurred, but when compressed air again is fed in order to start the pump, the compressed-air-flow via gate 8 has been completely shut off from the rest of the gates and the pump cannot be started.

In order to avoid this drawback the the main valve has been modified as follows

At the ends of plunger 5 counter stop members in the form of magnets 16 have been inserted and in those instances when ends 2 have not been made of a magnetic material a stop element in the form of a soft iron core has been disposed in the place where previously shock absorber rubber 15 was disposed. Of course, said magnets may be disposed in said ends and if the plunger is not made of a magnetic material, then said counter stop members may be made of a soft iron core. This device is shown in Fig. 3.

Members 15, 16 lock plunger 15 in the respective end positions and a force is needed, which can be adjusted, in order to move plunger 5, i.e. the pressure of the compressed air which is fed into gates 13 and 14 respectively must be sufficiently large to overcome the attractive force of the magnet. In case said pressure

is insufficient, plunger 5 will remain in its end position and the pump will quit, but in case the pressure is sufficient, the pressure and the air volume are also sufficient to push the plunger into its opposite end position, where it is locked by means of the magnetization force.

Regarding the already known embodiments there is a risk that when the pump is hauled plunger 5, due to vibrations and shocks, will end up in an intermediate position, which hinders the start of the pump. This is avoided in an efficient way by means of the present invention.

The embodiment described and shown in Fig. 3 does not involve any damping of plunger 5 against ends 2, since shock absorber rubbers 15 have been replaced by a permanent magnet and a soft iron core. Of course, said two parts can be designed in such a way that no strength problems will arise, but on the other hand the valve will emit a harder sound, which may prove to be troublesome, particularly if large valves are used. However according to the invention permanent magnet 16 is inserted deeper into plunger 5 and in this way a circular cavity 17 is formed in the ends of the plunger. See Fig. 4. The diameter of this cavity is adapted in such a way, on comparison with previous embodiments, that soft iron core 15 is replaced with a somewhat thicker core, which fits into cavity 17. Between core 15 and plunger 5 there is formed a narrow air gap 18, through which the air trapped in cavity 17 is to pass. This gap is adapted to provide an air-cushion-damping here and in this way the above-mentioned drawbacks with an elevated sound level disappears.

According to Fig. 5 a permanent magnet or a soft iron core 16 is fitted into the two plunger ends, and the free end surface of this magnet or core preferably is positioned in the same plane as the respective plunger ends. Member 16 is surrounded by a projections 19, which protrudes from said end surfaces and comprises a cylindrical tube fastened to the plunger end and made of e.g. aluminum. In this way a cavity 20 is formed, which can cooperate with member 15 in the way described above in order to provide a so called air-cushion-damping.

Of course, also the plunger end itself may be so closely fitted into a recess in said ends, that a damping is obtained.

A preferred field of application for a valve according to the present invention is illustrated in fig. 6. The following references numerals are used: 101 a membrane, 102 a membrane shaft, 103 a nut, 104, 113 mounting plates, 114 a control valve, 105 a control valve shaft, 106 a control valve operating shaft, 107 a pump body, 108 a control valve outlet, 109 a control valve connection, 110 a control valve connection, 111, 112 a branching duct. The air flow passages are shown by arrows and the mode of operation of the pump, which is already known, probably is easy to

understand.

Summarizing the present invention, this emanates from the idea of making use of a small yet sufficient holding or retaining power as a threshold for releasing the plunger, which thus will be unaffected by magnetic power as soon as it has been released from the actual magnet. An example will make this quite clear. When physical contact has been established between plunger and magnet, the latter develops a retaining force of e.g. 3,4 N, which is app. 0,75 pounds. As soon as this power or threshold has been overcome and the plunger has left the magnet for as little as 0,5 mm, which is 20/1000", the retaining force will be reduced to app. 0,3 N, which is app. 0,066 pounds. Therefore, one can say that once the plunger has left one of the magnets, the magnetic influence on same cannot be measured in practice any longer. A valve designed in this way will accordingly not prevent a pump from working in very low regions of pressure and capacity, which often is desirable if not crucial.

Often, a retaining force equivalent to a pressure of 10 mbar will be sufficient for a valve according to the invention. Said pressure should be between 5 mbar and 200 mbar, preferably between 10 and 50 mbar. When in such a case the plunger has been released from its retained end position, it can move about freely without the magnets exerting any influence on same. Beyond a very narrow gap of up to 0,5 or 1,0 mm, the power of the magnets is so small, that the friction of the plunger in relation to a surrounding sleeve is bigger. Thus, the invention conceived the idea, that a comparatively low release-threshold is all what matters, and that everything considerably stronger than so will be detrimental to the desired mode of operation of a valve of this kind and even counteract if not all but some objectives. Thanks to the shock absorbing features bringing about an air-cushion-damping and slowing down the speed of the plunger, the valve according to the invention will be utmost silent in operation and gain a long life. Needless to say, that in manufacture and assemblance extreme tolerances won't have to be observed.

The field of application of the valve is of course not limited to compressed-air-operated membrane pumps, but the valve is always expedient to use in e.g. vibrating, shaking machines and various equipments, in which most reduced air pressures are to be used.

Claims

1. A pneumatic valve designed to control particularly a compressed-air-operated membrane pump, comprising a valve body (1) having gates (8-12) for supply of compressed air, for operation and/or for pressurizing said pump or the like respectively, ends (2) which close the valve body and have control-air-

gates (13, 14), which are connected to a control valve, a pneumatic timer or the like (114), a plunger (5) moveable in said valve body between said ends and provided with recesses (21, 22) and/or raised portions in order to guide compressed air between selected gates, the ends of said plunger (5) and the ends (2) of said valve body are adapted to cooperate magnetically, characterized in that the ends of said plunger and the ends of said valve body are designed to come in physical contact with each other and develop a very low mutual retaining force in such a way, that the magnetic retaining force effective in the actual end position is intended to provide a threshold for a certain minimum control pressure from the respective control-air-gate (13 or 14) and guarantee a fast initial movement as well as safe transfer of the plunger to the other end position, that the magnetic retaining force and thus the said control-pressure-threshold for releasing the plunger from the respective valve body end is in the range 5-200, preferably 10-50 mbar, in order to permit only control-pressure related plunger movements without measurable effect of the magnetic power on the plunger movements beyond said retaining force and releasing threshold, and that in order to promote silent valve operation and counteract wear and tear of plunger and valve body ends, in the latter and/or in the ends of the plunger there are provided shock absorbing cavities (20) effective to slow down the speed of the plunger and designed to provide a so called air-cushion-damping and which disappear completely or partially, when said valve body ends and said plunger engage with each other.

2. A valve according to patent claim 1, characterized in that permanent magnets (17 and 18, respectively) are inserted in the ends of said plunger (5) and/or in said valve body ends (2).

3. A valve according to patent claim 1 or 2, characterized in that said plunger (5) and/or said valve body ends (2) comprise permanent magnets and a magnetically treated material, respectively.

4. A valve according to any of patent claims 1-3, characterized in that a soft iron core (16) is inserted in said valve body ends (2) or in said plunger ends.

5. A valve according to any of claims 1-4, characterized in that said cavity is formed by a tube, a ring or the like, which surrounds a magnet and/or a soft iron core or the like.

Patentansprüche

1. Pneumatisches Ventil, insbesondere zur Regelung einer mit Druckluft betätigten Membranpumpe mit einem Ventilgehäuse (1) mit Durchlässen (8-12) zur Förderung von Druckluft, zur Betätigung und/oder zum Unterdrucksetzen genannter Pumpe od.dgl., mit Enden (2), die das Ventilgehäuse verschliessen und Regelluftdurchlässe (13, 14) aufwei-



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gates (13, 14), which are connected to a control valve, a pneumatic timer or the like (114), a plunger (5) moveable in said valve body between said ends and provided with recesses (21, 22) and/or raised portions in order to guide compressed air between selected gates, the ends of said plunger (5) and the ends (2) of said valve body are adapted to cooperate magnetically, characterized in that the ends of said plunger and the ends of said valve body are designed to come in physical contact with each other and develop a very low mutual retaining force in such a way, that the magnetic retaining force effective in the actual end position is intended to provide a threshold for a certain minimum control pressure from the respective control-air-gate (13 or 14) and guarantee a fast initial movement as well as safe transfer of the plunger to the other end position, that the magnetic retaining force and thus the said control-pressure-threshold for releasing the plunger from the respective valve body end is in the range 5-200, preferably 10-50 mbar, in order to permit only control-pressure related plunger movements without measurable effect of the magnetic power on the plunger movements beyond said retaining force and releasing threshold, and that in order to promote silent valve operation and counteract wear and tear of plunger and valve body ends, in the latter and/or in the ends of the plunger there are provided shock absorbing cavities (20) effective to slow down the speed of the plunger and designed to provide a so called air-cushion-damping and which disappear completely or partially, when said valve body ends and said plunger engage with each other.

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sen, die an ein Regulierventil, eine pneumatische Zeituhr od.dgl. (114) angeschlossen sind, mit einem Kolben (5), welcher in genanntem Ventilgehäuse zwischen genannten Enden beweglich und mit Aussparungen (21, 22) und/oder erhabenen Bereichen versehen ist, um Druckluft zwischen ausgewählten Durchlässen zu führen, wobei die Enden genannten Kolbens (5) und die Enden (2) genannten Ventilgehäuses dazu vorgesehen sind, magnetisch zusammenzuwirken, dadurch gekennzeichnet, dass die Enden genannten Kolbens und die Enden genannten Ventilgehäuses dazu vorgesehen sind, in physischen Kontakt miteinander zu kommen und eine sehr geringe gegenseitige Haltekraft zu entwickeln derart, dass die magnetische Haltekraft, die in der betreffenden Endlage wirksam ist, dazu vorgesehen ist, eine Schwelle zu bilden für einen gewissen minimalen Regulierdruck von dem betreffenden Regelluftdurchlass (13 oder 14) und eine schnelle Ausgangsbewegung sowie eine sichere Überführung des Kolbens in die andere Endlage zu garantieren, dass die magnetische Haltekraft und somit die genannte Regulierdruckschwelle zur freigabe des Kolbens von dem betreffenden Ventilgehäuseende im Bereiche von 5-200, vorzugsweise 10-50 mbar liegt, um nur regulierdruckrelatierte Kolbenbewegungen zu gestatten ohne messbare Einwirkung der magnetischen Kraft auf die Kolbenbewegungen über die genannte Haltekraft und die Freigabeschwelle hinaus, und dass zur Förderung eines geräuschlosen Ventilbetriebes und zum Entgegenwirken von Verschleiss des Kolbens und der Ventilgehäuseenden in den letzteren und/oder den Enden des Kolbens schockabsorbierende Hohlräume (20) vorgesehen sind, welche wirksam sind, um die Geschwindigkeit des Kolbens zu dämpfen und dazu vorgesehen sind, eine sogenannte Luftkissendämpfung zu schaffen, und welche ganz oder teilweise verschwinden, wenn die genannten Ventilgehäuseenden und der genannte Kolben miteinander in Eingriff stehen.

2. Ventil nach Anspruch 1, dadurch gekennzeichnet, dass Permanentmagnete (16 bzw. 17) in die Enden genannten Kolbens (5) und/oder in die genannten Ventilgehäuseenden (2) eingesetzt sind.

3. Ventil nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass genannter Kolben (5) und/oder genannte Ventilgehäuseenden (2) Permanentmagneten bzw. ein magnetisch behandeltes Material besitzen.

4. Ventil nach einem der Ansprüche 1-3, dadurch gekennzeichnet, dass ein Weicheisenkern (16) in genannte Ventilgehäuseenden (3) oder in genannte Kolbenenden eingesetzt ist.

5. Ventil nach einem der Ansprüche 1-4, dadurch gekennzeichnet, dass genannter Hohlraum aus einem Rohr, einem Ring od.dgl. gebildet ist, welches bzw. welcher einen Magneten und/oder einen Weicheisenkern od.dgl. umgibt.

Revendications

1. Soupape pneumatique conçue pour commander particulièrement une pompe à membrane à air comprimé, comprenant un corps de soupape (1) ayant des passages (8 à 12) pour délivrer de l'air comprimé, pour commander et/ou pour mettre sous pression ladite pompe ou analogues respectivement, des extrémités (2) qui ferment le corps de soupape et ayant des passages d'air de commande (13, 14), qui sont raccordés à une soupape de commande, un temporisateur pneumatique ou analogues (114), un piston (5) déplaçable dans ledit corps de soupape entre lesdites extrémités et prévu avec des évidements (21, 22) et/ou des parties surélevées afin de guider l'air comprimé entre les passages sélectionnés, les extrémités dudit piston (5) et les extrémités (2) dudit corps de soupape sont adaptées pour agir magnétiquement mutuellement, caractérisée en ce que les extrémités dudit piston et les extrémités dudit corps de soupape sont conçues pour venir en contact physique l'un avec l'autre et développer une forme de maintien mutuel très faible d'une manière telle que la force de maintien magnétique effective dans la position d'extrémité réelle est destinée à procurer un seuil pour une certaine pression minimale de commande à partir du passage d'air de commande respectif (13 ou 14) et garantir un déplacement initial rapide de même qu'un déplacement sûr du piston à l'autre position d'extrémité, en ce que la force de maintien magnétique et ainsi ledit seuil de pression de commande pour libérer le piston de l'extrémité de corps de soupape respective est dans la plage de 5 à 200, de préférence de 10 à 50 mbar, afin de permettre des déplacements du piston se rapportant seulement à la pression de commande sans effet mesurable de la puissance magnétique sur le déplacement du piston au-delà de ladite force de maintien et du seuil de libération et, en ce qu'afin d'encourager le fonctionnement silencieux de la soupape et d'agir contre l'usure et le déchirement des extrémités du piston et des extrémités du corps de soupape, dans ce dernier et/ou dans les extrémités du piston, il est prévu des cavités absorbant les chocs (20) efficaces pour ralentir la vitesse du piston et conçues pour procurer ce que l'on appelle un amortissement à coussin d'air et qui disparaît complètement ou partiellement lorsque les extrémités du corps de soupape et dudit piston viennent en contact les unes avec les autres.

2. Soupape selon la revendication 1, caractérisée en ce que les aimants permanents (17 et 16 respectivement) sont insérés dans les extrémités dudit piston (5) et/ou dans lesdites extrémités du corps de soupape (2).

3. Soupape selon la revendication 1 ou 2, caractérisée en ce que ledit piston (5) et/ou lesdites extrémités du corps de soupape (2) comprennent des aimants permanents et un matériau magnétiquement



traité, respectivement.

4. Soupape selon l'une quelconque des revendications 1 à 3, caractérisée en ce qu'un noyau de fer doux (16) est inséré dans lesdites extrémités du corps de soupape (2) ou dans lesdites extrémités du piston.

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5. Soupape selon l'une quelconque des revendications 1 à 4, caractérisée en ce que ladite cavité est formée par un tube, un anneau ou analogues, qui entoure un aimant et/ou un noyau de fer doux ou analogues.

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