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(54) Benævnelse: **ANORDNING TIL ADMINISTRATION AF ET FLYDENDE LÆGEMIDDEL**

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DEVICE FOR ADMINISTERING A LIQUID MEDICAMENT

Background of the Invention

The invention relates to a device for administering a liquid medicament.

Description

Devices for administering a liquid medicament are known from the prior art, which devices have a reservoir which is connected to a pump system. The outlet side of the pump is connected to a medicament outlet, such as a tube or hose, or to a nebuliser. The pump chamber of the pump often has an inlet valve and an outlet valve. The inlet valve closes the pump chamber just as the pump is creating dispensing pressure to deliver medicament through the tube, hose, or nebuliser to prevent back flow of medicament into the reservoir. To refill the pump chamber, a negative pressure is created in the pump chamber, causing the medicament to flow from the reservoir into the pump chamber through the opening inlet valve, while the outlet valve closes to prevent back flow of medicament out of the tube, hose, or nebuliser. The valves are thus designed as common one-way valves, for example as check valves. Similar devices are described in WO 2013/191011 A1, US 8,628,517 B2, and WO 2013/072790 A1. WO 2012/007315 discloses a device for administering a liquid medicinal formulation, which is located in a container inserted into the device and is discharged from the device through at least one nozzle opening, the liquid medicinal formulation flowing through the at least one nozzle opening through an ultra-fine filter, which is formed by a microstructured component.

In medical applications in particular, it is often desirable for the device for administering the liquid medicament to be built as small as possible and thus take up little space. In particular, the usually purely mechanical inlet and outlet valves known from the prior art cannot be reduced in size indefinitely so that there is a need to improve such valves even further, or possibly even to make them completely superfluous.

It is therefore the object of the invention to propose a generic valve and a corresponding device for administering a liquid medicament, which have the smallest possible dimensions.

According to the invention, this object is achieved by a device having the features of patent claim 1.

The dependent claims 2 through 10 each relate to advantageous embodiments of the invention.

The invention relates to a device for administering a liquid medicament, having a reservoir in which a medicament is held or can be held, and having a pump which has a pump chamber which is fluidically connected to the reservoir via a one-way valve which is permeable only in the direction from the reservoir into the pump chamber and is fluidically connected via a valve according to the invention having a medicament outlet.

The valve according to the invention has a valve body which includes an inner space for receiving a liquid, in particular a liquid medicament. The valve body has a liquid inlet and an opposite liquid outlet, both of which open into the inner space. A multiplicity of microchannels is arranged in the inner space and extend in the connection direction between the liquid inlet and the liquid outlet.

The valve according to the invention makes use of the capillary effect. It is known that liquids can wet surfaces and move through complex structures due to capillary forces. The energy required for the movement of the liquid is determined by the difference in the atomic forces of attraction between the liquid atoms in the inner space of the liquid and the atomic forces of attraction between the liquid atoms which are on the liquid surface, and thus on the interface between the liquid and a gas. The interface between a liquid and a gas is also called the free surface. Likewise, energy must be expended for the removal of liquid atoms from the free surface, so that atoms that were previously lying deeper inside the liquid form the free surface. A force must therefore be applied to remove liquid components from heavily wetting surfaces.

The valve body forms a liquid channel which is delimited by side walls. The side walls may be parallel side walls of a polygonal or round, e.g., circular cross-section channel.

The inner space has a cross-sectional area that is larger than a cross-sectional area of the microchannels, with a cross-sectional area ratio between the microchannels and the inner space being between 1:50 and 1:100 according to the invention. According to the invention, the microchannels have a diameter of between 5 µm and 20 µm.

According to the invention, the microchannels are formed by a lattice of parallel, rod-shaped boundary elements, or by a plurality of parallel, mutually offset layers of a lattice of parallel, rod-shaped boundary elements. The boundary elements extend perpendicular to the connection direction between the liquid inlet and the liquid outlet. The boundary elements preferably have a round, in particular circular, or a polygonal cross-section. The boundary elements can, for example, have a diameter between 0.5 µm and 50 µm, preferably between 3 µm and 15 µm. The length of the boundary elements can be from a few µm to the full diameter of the inner space of the valve body. The length of the boundary elements is particularly preferably between 20% and 80% of the inner space diameter perpendicular to the connection direction between liquid inlet and liquid outlet.

For this purpose, the boundary elements can extend, starting from an inner face of the side wall boundary the inner space of the valve body, in the direction of an opposite side wall without reaching it, so that a distance is formed between the boundary elements and the respectively opposite side wall. This embodiment is also characterised in particular by the fact that it is easy to manufacture.

To increase the adhesion between the boundary elements and a liquid, one embodiment of the invention provides that the surface of the boundary elements has a functional coating, for example a hydrophilic coating. For this purpose, the inner face of the channel can also be hydrophobically coated.

According to the invention, the inner space, the liquid inlet and the liquid outlet have the same cross-sectional area perpendicular to the connection direction. This achieves a particularly compact valve geometry that is easy to produce.

It can be provided that the valve body has parallel side walls, the inner faces of which delimit the inner space, with the side walls opening into the liquid inlet or the liquid outlet at opposite ends. A valve that is easy to produce is achieved in that, in the last-mentioned embodiment, the valve body has a constant cross-section over the entire length thereof between the liquid inlet and the liquid outlet.

The valve body can have a round, in particular circular, or a polygonal cross-section.

Brief description of the figures

Further details of the invention are explained with reference to the following figures. In the figures:

Figure 1 shows a schematic longitudinal cross-section through an embodiment of the valve according to the invention without applied negative pressure;

Figure 2 shows a schematic longitudinal cross-section of the valve according to Figure 1 with applied negative pressure P1 > 0; and

Figure 3 shows a schematic longitudinal cross-section of the valve according to Figures 1 and 2 with applied negative pressure P2 > P1•

In the valve shown in Figure 1, the valve body 1 is shown in longitudinal cross-section. The valve body 1 is delimited by opposite parallel side walls 7. With their inner faces 8, the side walls 7 delimit an inner space 2 in which a liquid 20, for example a medicament, is accommodated. A liquid inlet 3 and a liquid outlet 4 are formed on opposite sides of the valve body 1. The liquid inlet 3 and the liquid outlet 4 lying opposite have exactly the same cross-section as the rest of the valve body 1, in particular as the inner space 2. For example, a pump with a pump chamber of a device for administering a liquid medicament can be connected to the liquid outlet 4.

The valve body 1 can have a circular cross-section, for example, or a polygonal, for example a rectangular and in particular a square cross-section. The boundary elements 6 shown in cross-section in Figure 1 are rod-shaped lattice struts which extend parallel to one another and extend perpendicularly to the plane of the drawing. Each two adjacent boundary elements 6 form a microchannel 5 therebetween, which extends in the connection direction x between the liquid inlet 3 and the liquid outlet 4 and is open towards both inlets 3, 4.

As shown in Figure 1, the microchannels are formed by a plurality of parallel, mutually offset layers of a grid of parallel, rod-shaped boundary elements.

If there is no negative pressure at the liquid outlet 4 (Po = 0), the liquid 20 forms a substantially flat, free surface between itself and the gas 30, as shown in Figure 1.

Only to whom 1 a negative pressure (P1 > 0) is present at the liquid outlet 4 (see Figure 2) does the free surface between the liquid 20 and the gas 30 form a concave geometry. As the negative pressure increases, the radius of the concave interface between liquid 20 and gas 30 decreases. Figure 3 shows the case in which P2 > P1 applies.

The radius of curvature of the free surface depends on the so-called Laplace pressure. This pressure increases with decreasing interface radius. Therefore, when the negative pressure exceeds the maximum Laplacian pressure applicable to the microchannel structure shown in Figures 1 to 3, the liquid is transported out of the valve body 1. The valve according to the invention is therefore particularly suitable for use as an outlet valve in a generic device for administering a liquid medicament.

As a rule, the Laplacian pressure increases proportionally to the surface tension of the liquid. Therefore, to adjust the threshold value for the negative pressure at which the liquid is transported out of the valve body 1 to a specific value for a given surface tension, it might be necessary to adjust accordingly the diameter of the microchannels 5, and therefore the distance between the boundary elements 6.

The embodiment shown in Figures 1 to 3 can, for example, have an inner space diameter perpendicular to the inner faces 8 of the side walls of between approximately 1 µm and 500 µm. This diameter is preferably between 10 µm and 100 µm.

The diameter of the microchannels 5, and therefore the free distance or the clearance between the boundary elements 6, can be between 0.5 and 50 µm. The free distance or the clearance between the boundary elements 6 is preferably between 3 and 15 µm.

The valve according to the invention has the advantage that the required structures can be produced using common microstructuring methods, for example using micro-injection moulding or silicon etching methods.

List of reference symbols

1 Valve body

2 Inner space

3 Liquid inlet

4 Liquid outlet

5 Microchannel

6 Boundary element

7 Side wall

8 Inner face

x Connection direction between the liquid inlet and the liquid outlet

ANORDNING TIL ADMINISTRATION AF ET FLYDENDE LÆGEMIDDEL

Patentkrav

1. Anordning til administration af et flydende lægemiddel, med et reservoir, i hvilket et lægemiddel er opbevaret eller kan opbevares, og med en pumpe, der indeholder et pumpekammer, som via en envejsventil, der kun er åben i retningen fra reservoiret til pumpekammeret, er forbundet fluidmæssigt med reservoiret, og som via en ventil er forbundet fluidmæssigt med et lægemiddeludløb, hvor ventilen omfatter et ventillegeme (1), der indeholder et indre rum (2) til optagelse af en væske (20), hvor ventillegemet (1) indeholder et væskeindløb (3) og et modsat væskeudløb (4), der begge munder ud i det indre rum (2), hvor der i det indre rum (2) er placeret et stort antal mikrokanaler (5), der strækker sig i forbindelsesretningen (x) mellem væskeindløbet (3) og væskeudløbet (4),
hvor mikrokanalerne er dannet af et gitter af parallelle, stavformede afgrænsningselementer (6) eller af flere parallelle lag, der er placeret forskudt i forhold til hinanden, af et gitter af parallelle, stavformede afgrænsningselementer (6), hvor afgrænsningselementerne (6) strækker sig vinkelret på forbindelsesretningen (x) mellem væskeindløbet (3) og væskeudløbet (4), hvor mikrokanalerne (5) har en diameter på mellem 5 µm og 20 µm,
kendetegnet ved, at tværsnitsfladeforholdet mellem mikrokanalerne (5) og det indre rum (2) udgør mellem 1:50 og 1:100, og at det indre rum (2), væskeindløbet (3) og væskeudløbet (4) har den samme tværsnitsflade vinkelret på forbindelsesretningen (x).

2. Anordning ifølge krav 1, ved hvilken en længde af afgrænsningselementerne (6) udgør mellem 20 % og 80 % af diameteren af det indre rum (2) vinkelret på forbindelsesretningen mellem væskeindløbet (3) og væskeudløbet (4), hvor afgrænsningselementerne (6) strækker sig fra en inderside (8) af sidevæggen (7), der afgrænser det indre rum (2) i ventillegemet (1), i retning mod en modstående sidevæg (7) uden at nå hen til denne, således at der er dannet en afstand mellem afgrænsningselementerne (6) og den respektive modstående sidevæg (7).

3. Anordning ifølge et af kravene 1 eller 2, ved hvilken afgrænsningselementerne (6) har et rundt, særligt cirkelrundt, eller et polygonalt tværsnit.

4. Anordning ifølge et af de foregående krav, ved hvilken ventillegemet (1) har parallelle sidevægge (7), hvis indersider (8) afgrænser det indre rum (2), hvor sidevæggene munder ud ved modsatte ender i henholdsvis væskeindløbet (3) og væskeudløbet (4).

5. Anordning ifølge krav 4, ved hvilken ventillegemet (1) over hele sin længde mellem væskeindløbet (3) og væskeudløbet (4) har et konstant tværsnit.

6. Anordning ifølge et af de foregående krav, ved hvilken ventillegemet (1) har et rundt, særligt cirkelrundt, eller et polygonalt tværsnit.

7. Anordning ifølge et af de foregående krav, ved hvilken overfladen af afgrænsningselementerne (6) er forsynet med en funktionel belægning for at øge adhæsionen mellem afgrænsningselementerne (6) og en væske.

8. Anordning ifølge krav 7, ved hvilken den funktionelle belægning indeholder en hydrofil belægning.

9. Anordning ifølge et af de foregående krav, ved hvilken den frie afstand mellem afgrænsningselementerne ligger på mellem 0,5 og 50 µm.

10. Anordning ifølge et af de foregående krav, ved hvilken den frie afstand mellem afgrænsningselementerne ligger på mellem 3 og 15 µm.

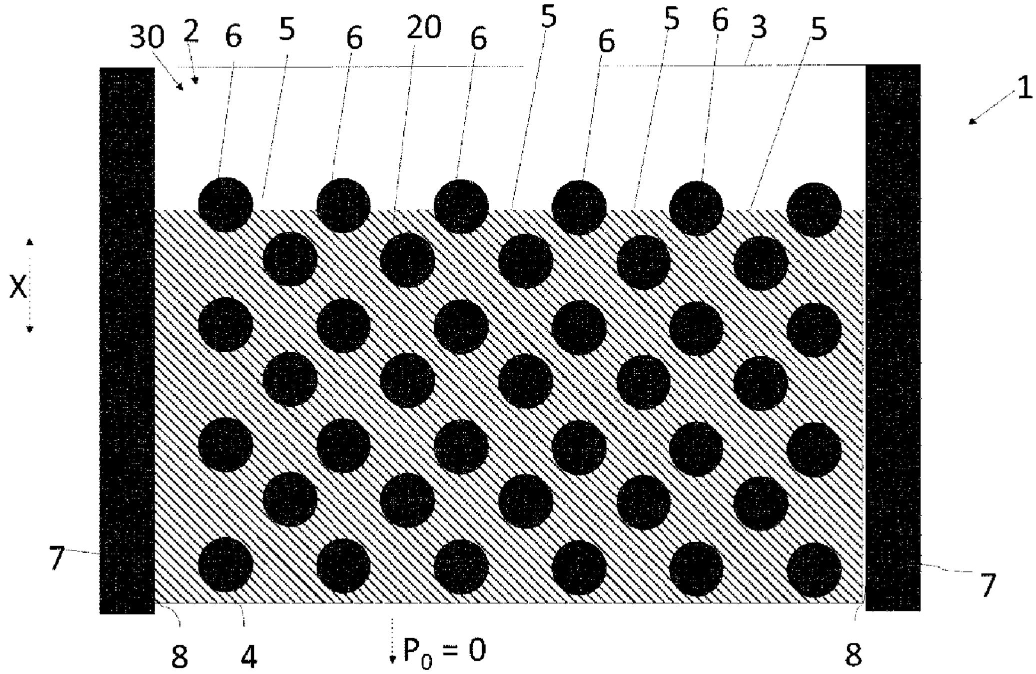

Fig. 1

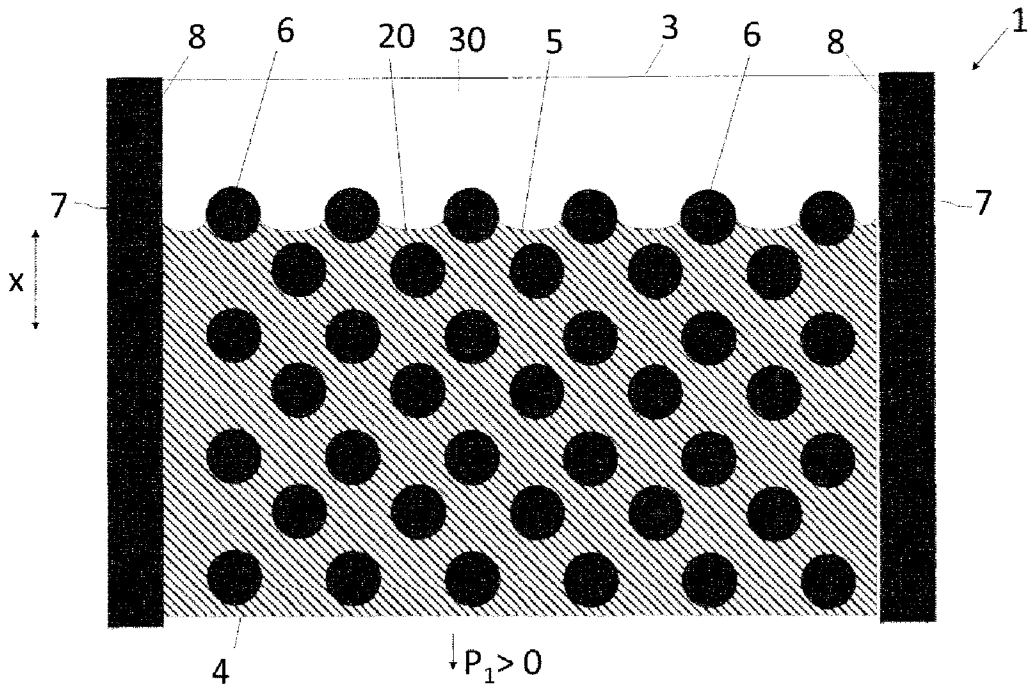

Fig. 2

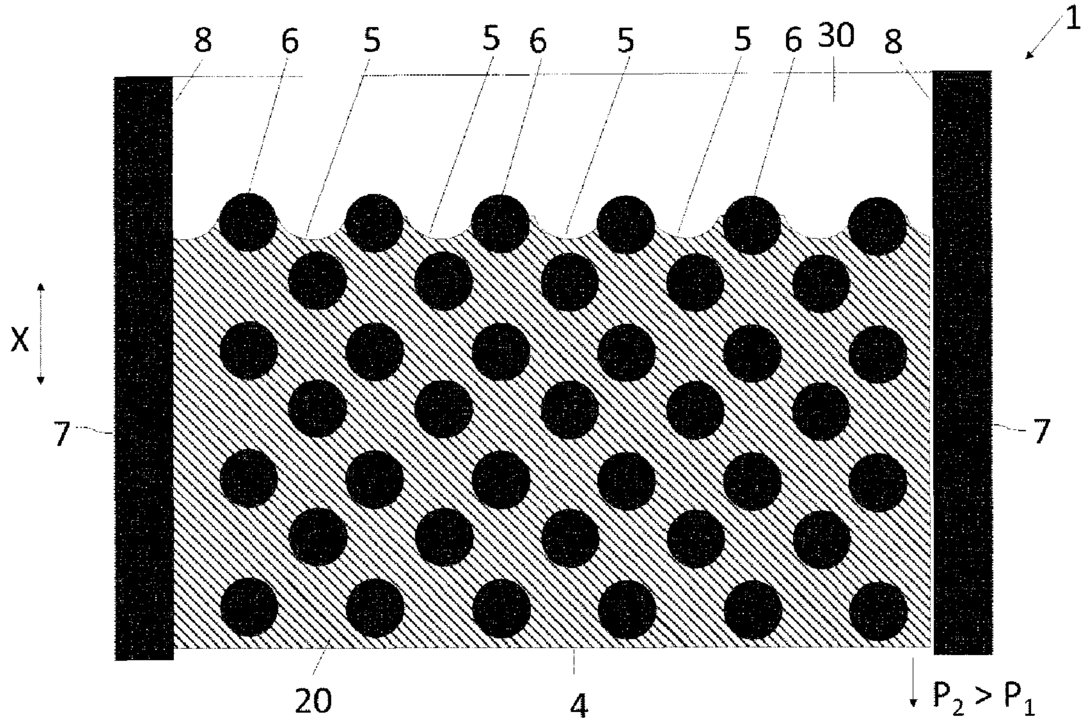

Fig. 3