Title: MEDICINE RESERVOIR AND DEVICE FOR THE AUTOMATED RELEASE OF A LIQUID MEDICINE

Abstract: The invention relates to a medicine reservoir (1) with two identical receptacles (2) of circular cross-section arranged parallel with each other for receiving a liquid medicine, which receptacles are fluidically connected at their end walls (4) via a common medicine outlet (5). The inner chambers (3) of the receptacle are in each case separated from the outside in a fluid-tight manner by a longitudinally slideable displacement piston (6), wherein the displacement piston can slide longitudinally within the receptacle (2) such that when the inner chamber (3) of the receptacle is filled with a liquid medicine it is possible by sliding the displacement piston (6) to displace liquid medicine from the receptacle inner chamber (3) to the medicine outlet (5). The surface area of the displacement piston (6) effective for the displacement is the overall surface area which is enclosed by its outer circumference. In addition, each receptacle (2) is formed in such a way that the displacement piston (6) at the end position of the displacing, which it assumes at the end of the medicine delivery with the medicine reservoir (1) fully emptied, abuts on the end wall (4) of the respective receptacle (2) from which the common medicine outlet (5) leads to the outside. Through the medicine reservoir (1) according to the invention it is possible to provide a medicine pump which can be worn on the body, is extremely flat and at the same time satisfies high hygienic requirements.
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
Medicine reservoir and device for the automated release of a liquid medicine

Cross References to Related Applications
This application claims the priority of the European patent application 07 007 305.1, filed April 10, 2007, the disclosure of which is incorporated herein by reference in its entirety.

Technical Field
The present invention relates to a medicine reservoir, a device for the automated release of a liquid medicine with such a medicine reservoir and a set comprising such a medicine reservoir and a filling aid according to the preambles of the independent patent claims.

Devices for the automated release of liquid medicines find preferential application in the case of patients which have a need for the continuous subcutaneous administration of a medicine, the dosage of which varies during the course of a day. Specific examples of applications are certain pain therapies and the treatment of diabetes, in which computer-controlled medicine pumps, e.g. insulin pumps, that can be carried on the body are used, which often contain a quantity of medicine in a medicine reservoir adequate for a number of days and deliver medicine from the medicine reservoir to the body of the patient via an infusion cannula in accordance with a pre-programmed daily profile. In such applications there is an increasing desire that the pump should not be visible when worn by the patient, so that its dimensions and, in particular its thickness, should be as small as possible in order that it will not be perceptible through the patient's clothing and that it will be as comfortable as possible to wear.

The currently known medicine pumps which can be worn on the body have as a medicine reservoir a
cylindrical ampulla with a displacement piston arranged within the ampulla, which can be pushed into the ampulla by means of a piston rod adjoining to it from the outside in order to deliver the medicine. However, these known medicine pumps suffer from the disadvantage that they are relatively thick, which is significantly caused by the fact that the freedom of design with respect to the thickness of the pump is limited by the external diameter of the ampulla at a given medicine reservoir volume and at an acceptable length of the pump.

US 2003/0055380 A1 discloses a medicine pump with a medicine reservoir whose displacement piston is displaceable by means of a threaded spindle arranged inside the reservoir. Embodiments are disclosed in which the displacement piston has a non-round cross-sectional area, so that the piston cannot rotate in the medicine reservoir and a rotation of the threaded spindle can produce a sliding motion of the displacement piston. By this the construction of compact medicine pumps is rendered possible, but there is, however, the decisive disadvantage that the surface area of the displacement piston effective in delivering the medicine is reduced by the cross-sectional area of the threaded spindle and the mechanically highly-loaded threaded spindle remains in contact with the liquid medicine, by means of which a possible product of abrasion can enter into the medicine that is to be delivered and subsequently into the body of the patient, with fatal consequences for the health of the patient. Also, a suitable means of sealing the outlet of the spindle from the reservoir is complicated and therefore cost-intensive and technical problems associated with hygiene result with multiple use of the medicine reservoir, since areas of the spindle in contact with the liquid medicine are temporarily arranged outside the reservoir.
Disclosure of the Invention

The task is to provide a medicine reservoir and a device for the automated release of a liquid medicine which are not subject to the disadvantages of the state of the art, or at least partly avoid these.

This problem is solved by means of the medicine reservoir and the device according to the independent claims.

A first aspect of the invention relates to a medicine reservoir with one or more receptacle/s, which is/are provided for receiving a liquid medicine or which already contains/contain a liquid medicine. As liquid medicines, for example a liquid painkiller or insulin are considered. Each receptacle has an inner receptacle chamber with an end wall, from which a medicine outlet leads to the outside. The medicine outlet can, for example, be closed by a septum, which has to be punctured with a cannula to provide an outlet to the outside to enable the release of the liquid medicine. The inner receptacle chamber is sealed off in a liquid tight manner from the outside by a displacement piston, which can slide longitudinally. The displacement piston abuts in a liquid tight manner in the radial direction over its whole circumference on the enclosing bounding wall of the receptacle, wherein the receptacle is formed in such a way that the displacement piston can slide longitudinally within the receptacle whilst retaining its liquid tight contact with the bounding walls. By this it is possible to reduce the volume of the inner receptacle chamber by sliding the displacement piston inside the receptacle, whilst displacing liquid out of the inner receptacle chamber. Correspondingly, with the inner receptacle chamber filled with a medicine it is possible, by sliding the displacement piston, to displace liquid medicine out of the inner receptacle chamber and deliver it into the medicine outlet. In this action, the surface area of the displacement piston effective for the displacement, that
is to say its surface area projected in the direction of
displacement, is the total area that is enclosed by its
outer circumference or is enclosed by the walls bounding
its outer circumference, respectively. Further, each re-
ceptacle is formed in such a way that the displacement
piston at its end position, which it takes up at the end
of the delivery of the medicine with the medicine reser-
voir fully emptied, abuts on the end wall of the recep-
tacle from which the medicine outlet leads to the outside
and on which it preferably abuts with a large area. In
embodiments with a single receptacle, the displacement
piston of the medicine reservoir is formed in such a way
that the smallest extent of its surface area effective
for the displacement is smaller than the diameter of a
cylinder which, with a cylinder height corresponding to
the design displacement path of the displacement piston,
has a volume corresponding to the design delivery volume
of the medicine reservoir. In the case of reservoirs with
one receptacle, the design delivery volume is given by
the product of the design displacement path and the dis-
placement surface area of the displacement piston. In the
case of reservoirs with a number of receptacles, this is
correspondingly given by the sum of the products of the
design displacement paths and displacement areas of the
individual displacement pistons. In embodiments with a
number of receptacles, the displacement pistons of the
medicine reservoirs are formed in such a way that the
largest of the respective smallest extents of the surface
areas of the displacement pistons effective for the dis-
placement is smaller than the diameter of a cylinder
which, with a height corresponding to the longest of the
design displacement paths for the delivery of the medi-
cine of the displacement pistons, has a volume corre-
sponding to the design delivery volume of the medicine
reservoir.

By means of the medicine reservoir according
to the invention it becomes possible to provide devices
for the automated release of liquid medicines which are both, extremely flat and also suitable to satisfy high hygienic requirements.

In a preferred embodiment of the medicine reservoir, the surface area of the displacement piston effective for displacement is a non-circular area, and in fact preferably an oval, bone-shaped, elongated hole-shaped, rectangular, triangular or hexagonal area, where in the last named preferably has a flat or stretched hexagonal form. Such embodiments have the advantage that medicine reservoirs according to the invention can be devised, which comprise a single receptacle and are therefore simple in construction and cost-effective to manufacture. In order to stabilize the receptacle, it is also provided that the walls of the receptacle, which abut on the longer sides of the surface area of the displacement piston that is effective in displacement, are equipped on their outside surfaces with supporting ribs at right angles to the direction of displacement of the displacement piston or with an increased wall thickness, so that a tendency of these to bend outwards under internal pressure is opposed by the increased resistance to bending. This is particularly advantageous with displacement pistons having a bone-shaped surface area effective for displacement, since this measure can be applied here without increasing the overall thickness of the medicine reservoir.

In a further preferred embodiment of the medicine reservoir, it comprises several preferably identical receptacles, and in fact with advantage two or three receptacles which are preferably identical. This solution enables extremely flat medicine reservoirs to be provided, which can also be extremely compact, e.g. in the case of identical receptacles of square cross-section arranged in parallel next to each other.

In this solution, it is preferred if at least one receptacle and preferably all the receptacles of the
medicine reservoir have a displacement piston having a circular surface area effective for displacement, since by this the highest requirements with regard to sealing and hygiene can be satisfied and, in addition, simple and cost-effective manufacturing is possible.

Also, with the medicine reservoirs according to the invention which comprise many receptacles, it is preferred that the displacement pistons of the receptacles are mechanically coupled together and preferably in such a way, that their displacement is constrained to take place simultaneously. This has the advantage that a delivery from all the receptacles is possible by means of a common drive unit, so that costs and construction space can be saved by the provision of a medicine pump with such a medicine reservoir.

Further, in the case of medicine reservoirs according to the invention which comprise a number of receptacles, it is preferred that the receptacles be arranged with their longitudinal axes, i.e. with their displacement axes of the displacement pistons, parallel to each other, in particular in such a way, that the longitudinal axes of all the receptacles are arranged in one plane. By this, a particularly compact construction can be achieved.

Furthermore, with medicine reservoirs according to the invention which comprise a number of receptacles, it is preferred that the receptacles are fluidically connected together, i.e. their inner receptacle chambers communicate with each other. In this way, the receptacles behave as a single receptacle.

In addition, with medicine reservoirs according to the invention which comprise a number of receptacles, it is preferred that the receptacles be formed together in one piece, in which it is preferred that these have a common one piece built-in medicine outlet. Such medicine reservoirs are robust, safe in operation and cost-effective in manufacturing.
As an alternative to the previously mentioned embodiment, for medicine reservoirs according to the invention which comprise a number of receptacles it is preferred that the receptacles are formed as separate components, wherein it is preferred that these are fluidically coupled together via a further component, preferably in such way that the medicine outlets communicate with each other.

By this it is possible to provide a large number of different types of medicine reservoirs according to the invention from a limited number of different receptacles and coupling adapters.

In yet a further preferred embodiment of the medicine reservoir according to the invention, the design exit direction from the medicine outlet runs transverse, preferably perpendicular to the direction in which the displacement piston slides or, in the case of medicine reservoirs with a number of displacement pistons, perpendicular to the direction in which at least one of the displacement pistons slides, wherein it is preferred that a medicine conveying line can be or is directly connected to the medicine outlet of the medicine reservoir. Through such a design, the overall length of the medicine reservoir and thus also the overall length of a medicine pump formed with such a reservoir can be minimized. However, embodiments are also provided in which the design outlet direction from the medicine outlet is parallel to the direction of displacement of at least one displacement piston.

In a further preferred embodiment with medicine reservoirs which comprise a number of receptacles, it is preferred that between two neighbouring receptacles there is an intermediate space. In this way, for the design of medicine pumps with such medicine reservoirs, there exists the possibility of positioning elements, in particular of the drive unit for the actuation of the displacement piston, such as for example a motor with a
drive spindle and/or a gear, between the receptacles and
in this way to save in overall construction length. In
addition, by this it is possible to achieve a symmetrical
arrangement of the receptacles with respect to the point
of introduction of forces from the drive unit, so that
conditions are favourable for a twist-free operation of
the motion train provided by the drive unit and the
displacement piston.

It is also preferred in the case of medicine
reservoirs according to the invention which comprise a
number of receptacles that the displacement pistons in
each case are coupled, preferably through one piece de-
sign, with an assigned piston rod, wherein it is prefer-
red that the piston rods of the displacement pistons are
connected with each other by one piece design, such that
the displacements of the displacement pistons are con-
strained to take place simultaneously by the same amount.
In this way, a cost-effective and functionally safe medi-
cine reservoir can be made available, which from the
point of view of the medicine pump to be formed with the
reservoir results in a minimum of internal pump componen-
ts for the drive of the displacement pistons.

It is preferred that the piston rod is formed
from a harder material than that used for the displace-
ment piston, in order to take account of their different
functions. It is of advantage in this case if the piston
rod and the displacement pistons are formed together in
one piece through multi-component injection moulding. By
this, these components can be manufactured to a high
quality in mass production at low unit costs.

In yet a further preferred embodiment of the
medicine reservoir, the piston rod, in the medicine re-
servoir or in the respective receptacle which is housing
the displacement piston connected with the rod, is guided
radially by the walls of the receptacle such that the
overall length of the displacement piston can be reduced
to the extent that this then only takes care of the sea-
ling functions and not, due to its reduced length, of the anti-tilting/jamming function. This last named function is taken over in this case by the guided piston rod. This also leads to a saving in terms of overall length.

In a further preferred embodiment of the medicine reservoir, it comprises a stop which positively limits the displacement path of the displacement piston/s in a direction opposite to the design direction of displacement for delivering the medicine. This prevents the displacement piston from being pulled out of the receptacle when being pulled back within the receptacle, e.g. when filling the medicine reservoir, which would be problematic in terms of hygiene considerations.

In a further preferred embodiment, the medicine reservoir is filled with insulin, preferably with a quantity of insulin corresponding to at least 150 IU (Insulin Units), or even more advantageously with at least 300 IU (Insulin Units). This corresponds, at the insulin type U100 commonly used for such pumps, to a filling quantity of at least 1.5 ml and 3.0 ml, respectively, of insulin. Such medicine reservoirs are preferred trade goods, in particular in the form of packaged disposable items.

A second aspect of the invention relates to a device for the automated release of a liquid medicine, also referred to as medicine pump or, in the case of the release of insulin, as insulin pump. The device according to the invention comprises a medicine reservoir in accordance with the first aspect of the invention, for the provision of a liquid medicine, as well as a drive unit with a preferable electronic control, by means of which the displacement piston or, in the case of a medicine reservoir with a number of displacement pistons, the displacement pistons of the medicine reservoir in the respective receptacle receiving them can be displaced, for a delivery of liquid medicine from the receptacles.
Such medicine pumps according to the invention can be extremely flat and simultaneously satisfy high hygienic requirements.

In a preferred embodiment of the device, it has a medicine reservoir with at least two receptacles, wherein the displacement pistons of the receptacles are mechanically interconnected in such a way that their displacement is constrained to take place simultaneously, in particular by an identical amount. Through this construction, cost-effective and at the same time robust medicine pumps can be made available.

In a further preferred embodiment of the device, the direction for connecting the medicine conveying line to the device runs transverse, preferably perpendicular to the direction of displacement of the displacement piston or, in the case of several displacement pistons, perpendicular to the direction of displacement of at least one of the displacement pistons. In this it is preferred that the device is constructed in such a way that the medicine conveying line can directly be connected to the medicine outlet of the medicine reservoir or is so connected. This provides the advantage that a reduction in the overall length of the medicine pump is possible.

In yet a further preferred embodiment, the device has a medicine reservoir with at least two receptacles, wherein an intermediate space is provided between two neighbouring receptacles of the medicine reservoir in which at least a part of the drive unit is arranged, in fact preferably a drive motor, a drive spindle and/or a gearbox for the drive unit. In this way, overall construction length can be saved and it becomes possible to arrange the receptacles symmetrically with respect to the point of introduction of forces from the drive unit, so that a tilt-free operation is possible.

In a further preferred embodiment of the device, the device is an insulin pump, which can be carried
on the body of a patient. In such embodiments of the device the advantages of the invention become particularly apparent.

A third aspect of the invention relates to a set comprising a medicine reservoir in accordance with the first aspect of the invention and a filling aid, which can be coupled to the completely or partly emptied medicine reservoir to pull back the displacement piston/s for the purpose of filling the medicine reservoir. By this, the filing of the medicine reservoir with liquid medicine from a large dispensing package is eased considerably.

**Brief Description of the Drawings**

Further preferred embodiments of the invention are given in the dependent claims and the following description on the basis of the figures. The figures show:

- **Fig. 1**: A perspective plan view of a first medicine reservoir according to the invention;
- **Fig. 2**: A longitudinal section through the medicine reservoir in Fig. 1, with the displacement piston in the rear end position;
- **Fig. 3**: A representation as Fig. 2, with the displacement piston in a forward position;
- **Fig. 4**: A perspective plan view of the displacement piston of the medicine reservoir in Fig. 1;
- **Fig. 5**: A section along the line A-A in Fig. 2;
- **Figures 6 to 8**: Representations as Fig. 5 through preferred versions of the medicine reservoir according to the invention of Fig. 1;
- **Fig. 9**: A representation as Fig. 4 through a preferred version of the displacement piston of the medicine reservoir of Fig. 1;
Fig. 10: A perspective plan view of a filling aid for a medicine reservoir according to the invention with the displacement piston from Fig. 9;

Fig. 11: A perspective plan view of the filling aid from Fig. 10 and the displacement piston from Fig. 9 in the coupled state;

Fig. 12: A perspective plan view of a medicine reservoir according to the invention with the displacement piston from Fig. 9 after the forward displacement of the displacement piston to the front end point and the subsequent coupling of the filling aid from Fig. 10;

Fig. 13: A longitudinal section through the arrangement from Fig. 12;

Fig. 14: A perspective plan view of the medicine reservoir from Fig. 12, after the displacement piston has been drawn back with the filling aid to the rear end point;

Fig. 15: A longitudinal section through the arrangement from Fig. 14;

Fig. 16: A perspective plan view of a second medicine reservoir according to the invention;

Fig. 17: A longitudinal section through the medicine reservoir from Fig. 16 with the displacement piston arranged at a front displacement position;

Fig. 18: A representation as Fig. 17, with the displacement piston arranged at a rear displacement position;

Fig. 19: A perspective plan view of the displacement piston of the medicine reservoir from Fig. 16;

Fig. 20: A section along the line B-B in Fig. 18;

Figures 21 to 23: Representations as Fig. 20 through preferred versions of the medicine reservoir according to the invention from Fig. 16;

Fig. 24: A longitudinal section through a third medicine reservoir according to the invention; and
Fig. 25: A longitudinal section through a fourth medicine reservoir according to the invention.

Modes for Carrying out the Invention

A first preferred embodiment of a medicine reservoir according to the invention in the form of an insulin ampulla for an insulin pump is represented in Figures 1 to 5. As can be seen, the medicine reservoir 1 comprises a receptacle 2, within whose bounding walls 7 there is arranged a displacement piston 6 which can be displaced longitudinally for the displacement of liquid from the inner chamber 3 of the receptacle. The receptacle 2 has an oval cross-section and the displacement piston 6 has a correspondingly oval surface area effective for displacement, wherein the smallest extent of the piston surface area effective for displacement corresponds to the distance H of the two parallel bounding walls (see Fig. 5). The receptacle inner chamber 3 has an end wall 4, on which a medicine outlet 5 with a design outlet direction which runs perpendicular to the direction of displacement of the displacement piston 6 provides a path to the outside. The medicine outlet 5 discharges into a connecting component 12, to which a medicine conveying line (not shown) can be directly connected. The displacement piston 6, which for sealing against the bounding walls 7 of the receptacle 2 is formed of a soft material, in the present case of a thermoplastic elastomer, is carried by a supporting body forming two-piston rods 8 made from a comparatively hard material, in the present case PP (Polypropylene). The displacement piston 6 and the supporting body are manufactured as one piece, in the present case by multi-component injection moulding. However, it is also conceivable that a supporting body with a piston component could be made from the hard material and arranged with a seal around the circumference of the piston component, e.g. an O-ring, for the radial sealing against the bounding walls 7. As can be seen from Figures
2 and 3, which show the piston 6 once in a specified maximum drawn back position (Fig. 2), in which the distance V between the front side of the piston and the end wall 4 corresponds to the design displacement path V for the delivery of medicine and the receptacle inner chamber 3 thus contains the design delivery volume of the medicine reservoir 1, and once in an almost completely exhausted position (Fig. 3), in which the volume of the inner chamber 3 is almost zero, the displacement piston 6 can be pushed into the receptacle 2 by means of the supporting body or the piston rods 8 formed by this, respectively, for the displacement of medicine from its inner chamber 3 and through the medicine outlet 5 to the outside. In this action, the supporting body is guided within the receptacle 2 with the piston rods 8 on the bounding walls 7, so that a tilting or tipping/jamming of the displacement piston 6 is reliably prevented. As can be seen, the two piston rods 8 each have a spring-loaded device 13 in the region of their free ends, which in the fully drawn back position of the displacement piston 6 shown in Fig. 2 engage with assigned cut-outs 9 arranged in the bounding walls 7, and thus positively limit the displacement path of the displacement piston in a direction opposite to the design direction for the delivery of medicine, in which it is displaced for example in order to fill the medicine reservoir. As can also be seen, the two piston rods 8 also each have two cut-outs 14 (Fig. 4) in the region of their free ends, in which the spring loaded devices of a filling aid (not shown) can be engaged in order to couple the filling aid to the medicine reservoir 1. The figures 6 to 8 show representations like Fig. 5 through preferred versions of the medicine reservoir according to the invention from Fig. 1, which have other cross-section shapes. As can be seen, the embodiments in accordance with Figures 6 and 8 likewise have oval cross-sections, however without parallel bounding walls 7. In the case of the embodiment shown in Fig. 6, the bounding walls are
formed such that they are exclusively concave to the inner chamber 3, which is advantageous in terms of the stability of the shape in the event of a build up of pressure in the inner chamber 3. With the embodiment shown in Fig. 8, the bounding walls of the inner chamber 3 are formed such that they are alternately convex and concave to the inner chamber 3, wherein it is preferred here to attach supporting ribs on the outside of the convex bounding walls (indicated by the broken line) which oppose any tendency of the walls to flex outwards in the event of a pressure build up in the inner chamber 3 of the receptacle 2. The smallest extents H of the surface areas of the displacement piston 6 effective for the displacement extend in these two embodiments along the shortest axis of symmetry of the respective cross-section shape. The embodiment shown in Fig. 7 has a prolate hexagonal cross-section form, wherein here the smallest extent H of the surface area of the displacement piston effective for the displacement is the distance between the longest parallel bounding walls 7.

The rest of the design of this medicine reservoir is, apart from the different cross-section shape of the receptacle 2, identical to that shown in the Figures 1 to 5.

Fig. 9 shows a representation as Fig. 4 through a preferred version of the displacement piston 3 with the supporting body. As can be seen, this arrangement has a threaded rod 16 which can engage the thread of the nut of a linear drive (not shown). In addition, through the connection with the linear drive, a piston retention (free flow prevention) can be achieved by simple means.

Fig. 10 shows a perspective plan view of a filling aid 10 for filling the medicine reservoir according to the invention with the displacement piston of Fig. 9. The filling aid 10 is manufactured in one piece by injection moulding and has a protective tube 17 for
the threaded rod 16 of the displacement piston 6. As can be seen, the filling aid 10 has two spring arms, on each of whose free ends there are two latching projections 18 to engage in the cut-outs 14 of the piston rods 8. For the coupling to the medicine reservoir 1, the filling aid 10 with the protective tube 17 is pushed onto the threaded rod 16 until the latching projections 18 engage in the cut-outs. This coupled situation is represented in Fig. 11 in a perspective view without the receptacle walls, in Fig. 12 in a perspective view with the complete medicine reservoir 1 and in Fig. 13 in section with the complete medicine reservoir 1. Then, for the filling operation, the medicine reservoir 1 is gripped with one hand and the filling aid 10 is gripped on its grip portion 19 with the other hand and the filling aid 10 is pulled out of the receptacle 2 along with the coupled displacement pistons 6, 8 in a direction opposite to the design direction of movement for delivery, until the spring-loaded devices 13 of the piston rods 8 engage in the cut-outs 9 in the bounding walls 7 of the receptacle 2 and thus positively limit this movement. This situation is shown in a perspective illustration in Fig. 14 and as a section view in Fig. 15. By pressing the uncoupling buttons 20 between two fingers, the spring arms, which form the latching projections 18, can be squeezed together, so that the latching projections 18 are brought out of engagement with the cut-outs 14 and the filling aid 10 can be removed.

Figures 16 to 20 show representations similar to figures 1 to 5 of a second preferred embodiment of the medicine reservoir according to the invention, namely Fig. 16 a perspective plan view of the medicine reservoir, Figures 17 and 18 longitudinal sections through the medicine reservoir from Fig. 16, in one instance with the displacement pistons arranged in a forward displacement position (Fig. 17) and in a second instance in the rear displacement position (Fig. 18), Fig. 19 a perspective
plan view of the displacement pistons of the medicine reservoir and Fig. 20 a section along the line B-B in Fig. 18. As can be seen, the medicine reservoir 1 here comprises two receptacles 2, within whose bounding walls 7 the respective displacement pistons 6 are arranged to slide longitudinally to displace liquid from the receptacle inner chamber 3. The receptacles 2 are arranged parallel with respect to their longitudinal axes x and have equally sized, circular cross-sections and correspondingly circular displacement pistons 6. For each receptacle 2, the smallest extent of the piston surface area effective for the displacement corresponds here to the respective diameter of the receptacle cross-section or the diameter of the assigned displacement piston 6, respectively. Since the diameters of both receptacles 2 and displacement pistons 6, respectively, are identical, the according to the claims largest of the respective smallest extents H of the surface areas of the displacement pistons 6 effective for the displacement corresponds in the present case to the diameter of one of the two displacement pistons 6 or receptacles 2, respectively. The receptacle inner chamber 3 has an end wall 4, on which a medicine outlet 5 common to both receptacles 2 with a design outlet direction that likewise runs perpendicular to the direction of displacement of the displacement piston 6 or of the longitudinal axes X of the receptacles 2, respectively, leads to the outside. The medicine outlet 5 leads in this case also into a connecting component 12, to which a medicine conveying line (not shown) can be directly connected. The displacement pistons 6 are here likewise made from a soft material and the respective piston rods 8 assigned to the displacement pistons are made from a hard material, wherein here also the hard 8 and soft 6 components are formed together in one piece by multi-component injection moulding. However, it is also conceivable here that a supporting body with a piston component made from the hard material could be manufac-
tured and provided with a seal around the circumference of the piston component, e.g. an O-ring, for the radial sealing of the piston against the bounding walls 7. As can also be seen, the two piston rods 8 of the displacement pistons 6 are linked together as one piece via a bridge 22 in such a way that both pistons are constrained to move simultaneously and in the same manner. The receptacles 2 are likewise formed as one piece with each other and with the component forming the medicine outlet 5, in the present case by injection moulding.

As can be seen from a comparison of figures 18 and 19, the displacement pistons 6 or their piston rods 8, respectively, each have a shoulder stop 23 which strikes a stop 9 on the bounding walls 7 of the assigned receptacle 2 on the movement of the displacement piston 6 in the direction opposite to the design direction of movement for delivery of the piston 6 and thus the displacement path of the respective displacement piston 6 is positively limited in a direction opposite to the design direction of movement for the delivery of the medicine. At the same time, the shoulder stops 23 serve to guide the arrangement consisting of the displacement pistons 6, the piston rods 8 and the bridge 22 on the bounding walls 7 of the receptacles 2, such that a tilting/tipping of the displacement pistons 6 is safely prevented. As can also be seen, the two piston rods 8 each have a spring projection 21 in the region of their free ends, which can serve both for the coupling of a filling aid as well as for the coupling of a drive unit for the displacement pistons 6.

Figures 21 to 23 show representations as Fig. 20 through several preferred versions of the medicine reservoir 1 according to the invention from Fig. 16, which show other configurations and/or cross-section shapes. As can be seen, the embodiments in figures 21 and 22 have three identical receptacles 2 in each case, once with a circular cross-section (Fig. 21) and once with an oval...
Figure 23 shows an embodiment, in which four receptacles 2 with identical triangular cross-sections are arranged next to each other, in such a way that the points of the sections point alternately up and down.

In all the embodiments, the receptacles 2 are formed as one piece with each other and with the common medicine outlet 5. In these embodiments, the in accordance with the claims largest of the respective smallest extents H of the surface areas of the displacement pistons effective for the displacement result once as the diameter of one of the receptacles 2 or the related displacement piston, respectively (Fig. 21), once as the height of the cross-section of one of the receptacles 2 along the shortest axis of symmetry of the oval cross-section shape (Fig. 22) and once as the height of the triangular cross-section of one of the receptacles 2 (Fig. 23). The embodiment shown in Fig. 7 has an extended hexagonal cross-section shape, wherein here the smallest extent H of the surface area of the displacement piston effective for the displacement is the distance between the longest parallel bounding walls 7. The rest of the design of this medicine reservoir is, apart from the different configuration or cross-section shape of the receptacle 2, respectively, identical to that shown in the figures 16 to 20.

Figure 24 shows a longitudinal section through a third medicine reservoir 1 according to the invention, however without the displacement piston arranged within it, which essentially differs from that shown in Fig. 17 in that the receptacles 2 and the component forming the medicine outlet 5 are formed as separate components and are joined together by a plug-in arrangement. A further difference is that here the design outlet direction from the medicine outlet 5 runs in the direction of the longitudinal axis X of the receptacle 2. The rest of the design of this medicine reservoir is identical to that shown in the Figures 16 to 20.
Fig. 25 shows a longitudinal section through a fourth medicine reservoir 1 according to the invention, which differs from that shown in Fig. 17 merely in that a space 11 is provided between the receptacles 2 for receiving a drive unit (not shown) of an Insulin pump and that the two piston rods 8 have no spring-loaded projections in the region of their free ends for the coupling up of a filling aid or of a drive unit, respectively. The rest of the design of this medicine reservoir 1 is identical to that shown in the Figures 16 to 20.

While there are shown and described presently-preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.
Claims

1. Medicine reservoir (1), comprising one or several receptacles (2) for receiving a liquid medicine or containing a liquid medicine, which receptacles (2) comprise in each case a receptacle inner chamber (3), a medicine outlet (5) on an end wall (4) of the receptacle leading to the outside and a displacement piston (6) separating the receptacle inner chamber (3) towards the outside, which is sealed liquid-tight in the radial direction over its entire outer circumference against the bounding walls (7) of the receptacle (2), and which can be displaced longitudinally within the receptacle (2) whilst retaining its liquid-tight contact with the bounding walls (7), to enable a supply of liquid medicine from the receptacle inner chamber (3) to the medicine outlet (5) through displacement by means of the displacement piston (6), wherein the surface area of the displacement piston (6) effective for the displacement is the surface area surrounded by its outer circumference and the displacement piston (6) at an end position, which it assumes at the end of the medicine delivery with the medicine reservoir completely emptied, abuts on the end wall (4) of the receptacle (2) from which the medicine outlet (5) leads to the outside, wherein the smallest extent (H) of the surface area of the displacement piston (6) effective for the displacement or, with a number of receptacles (2), the largest of the respective smallest extents (H) of the surface areas of the displacement pistons (6) effective for the displacement is smaller than the diameter of a cylinder which, with a height corresponding to the design displacement path (V) of the displacement piston (6) for the medicine delivery or, with a number of receptacles (2), corresponding to the longest of the design displacement paths (V) of the displacement pistons (6), has a volume corresponding to the design delivery volume of the medicine reservoir (1).
2. Medicine reservoir (1) according to claim 1, wherein the surface area of the displacement piston (6) effective for the displacement is a non-circular surface, in particular an oval, bone-shaped, elongated hole-shaped, rectangular, triangular or hexagonal surface.

3. Medicine reservoir (1) according to one of the preceding claims, wherein the medicine reservoir (1) comprises a number of in particular identical receptacles (2), in particular two or three identical receptacles (2).

4. Medicine reservoir (1) according to claim 3, wherein at least one receptacle (2), in particular all receptacles (2) of the medicine reservoir (1) each have a displacement piston (6) whose surface area effective for the displacement is circular.

5. Medicine reservoir (1) according to one of the claims 3 or 4, wherein the displacement pistons (6) of the receptacles (2) are mechanically coupled together, in particular in such a way that their displacement is compelled to take place simultaneously.

6. Medicine reservoir (1) according to one of the claims 3 to 5, wherein the receptacles (2) are arranged with their longitudinal axes (X) parallel with each other, in particular in such a way that the longitudinal axes of all the receptacles (2) are arranged in one plane.

7. Medicine reservoir (1) according to one of the claims 3 to 6, wherein the receptacles (2) are fluidically connected with each other.

8. Medicine reservoir (1) according to one of the claims 3 to 7, wherein the receptacles (2) are formed with each other as one piece, and in particular that these have a common medicine outlet (5) formed with them in one piece.

9. Medicine reservoir (1) according to one of the claims 3 to 7, wherein the receptacles (2) are formed
as separate components, and in particular that these are fluidically coupled together via a further component, in particular in such a way that their medicine outlets (5) communicate with each other.

10. Medicine reservoir (1) according to one of the preceding claims, wherein the design outlet direction (A) from the medicine outlet (5) runs transverse, in particular perpendicular to a direction of displacement of the displacement piston/s (6), and in particular that a medicine conveying line can be connected or is connected directly to the medicine outlet (5) of the medicine reservoir (1).

11. Medicine reservoir (1) according to one of the claims 3 to 10, wherein an intermediate space is provided between two neighbouring receptacles (2).

12. Medicine reservoir (1) according to one of the claims 3 to 11, wherein the displacement pistons (6) are coupled, in particular through one-piece construction, with an assigned piston rod (8) in each case, and in particular, wherein the piston rods (8) of the displacement pistons (6) are coupled together, in particular through one piece construction, such that the displacements of the displacement pistons (6) are compelled to take place simultaneously by an identical amount.

13. Medicine reservoir (1) according to claim 12, wherein the piston rod (8) is formed from a harder material than that of the displacement piston (6), and in particular, wherein the piston rod (8) and the displacement piston (6) are formed together as one piece by multi-component injection moulding.

14. Medicine reservoir (1) according to one of the claims 12 or 13, wherein the piston rod (8) is guided radially in the medicine reservoir (1).

15. Medicine reservoir (1) according to one of the preceding claims, wherein a stop (9, 13) is provided, which positively limits the displacement path (V) of the displacement piston/s (6) in a direction
opposite to the design displacement direction for the delivery of medicine.

16. Medicine reservoir (1) according to one of the preceding claims, wherein it is filled with insulin, in particular wherein it is filled with a quantity of insulin corresponding to at least 150 IU, in particular corresponding to at least 300 IU.

17. Device for the automated release of a liquid medicine, comprising a medicine reservoir (1) in accordance with one of the preceding claims, for the provision of a liquid medicine as well as a drive unit with an in particular electronic control, by means of which the displacement piston/s (6) of the medicine reservoir (1) can be displaced within the respective receptacle/s (2) containing them to deliver liquid medicine from the receptacle/s (2).

18. Device according to claim 17 with a medicine reservoir (1) with at least two receptacles (2), wherein the displacement pistons (6) of the receptacles (2) are mechanically coupled together in such a way that their displacement is constrained to take place simultaneously, in particular by an identical amount.

19. Device according to one of the claims 17 or 18, wherein the direction of the connection of a medicine conveying line to the device runs transverse, in particular perpendicular to the direction of displacement of the displacement pistons (6), and in particular, wherein the medicine conveying line can be connected or is connected directly to the medicine outlet (5) of the medicine reservoir (1).

20. Device according to one of the claims 17 to 19 with a medicine reservoir (1) with at least two receptacles (2), wherein an intermediate space (11) is provided between neighbouring receptacles (2) of the medicine reservoir (1), in which at least a part of the drive unit is arranged, in particular a drive motor and/or a gearbox of the drive unit.
21. Device according to one of the claims 17 to 20, wherein the device is an insulin pump, which can be carried on the body of a patient.

22. Set comprising a medicine reservoir (1) in accordance with one of the claims 1 to 16 and a filling aid (10) for coupling to the medicine reservoir (1) to pull back the displacement piston/s (6) for the purpose of filling the medicine reservoir (1).
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. A61M5/142

According to International Patent Classification (IPC) or, both national classification and IPC.

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>DE 102 33 925 A1 (MICHELER CLEMENS [DE]; RUHLAND BERND [DE]) 12 February 2004 (2004-02-12) figure 3</td>
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Date of the actual completion of the international search

7 May 2008

Date of mailing of the international search report

19/05/2008

Name and mailing address of the IS/V

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Authorized officer

Neiller, Frederic
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